Draft Report

The Nile Basin – Environmental Transboundary Opportunities and Constraints Analysis

October 2000

Task Order No. 27
Contract No. PCE-I-00-96-00002-00

The Nile Basin – Environmental Transboundary Opportunities and Constraints Analysis

Draft Report

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Prepared for:

United States Agency for International Development

October 2000

Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ)

Partners: International Resources Group, Winrock International, and
Harvard Institute for International Development

Subcontractors: PADCO, Management Systems International, and Development Alternatives, Inc.

Collaborating Institutions: Center for Naval Analysis Corporation, Conservation International, KNB Engineering and Applied Sciences, Inc., Keller-Bliesner Engineering, Resource Management International, Inc., Tellus Institute, Urban Institute, and World Resources Institute.

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CBA	Cost-Benefit Analysis
CIDA	Canadian International Development Agency
COM	Council of Ministers of the Nile Basin Initiative
DFID	Department for International Development (U.K.)
EAC	Commission for East African Cooperation
EAP	Environmental Action Plan
EA	Environmental Assessment
EIA	Environmental Impact Assessment
GEF	Global Environmental Facility
NBI	Nile Basin Initiative
NILE-SEC	The NBI Secretariat, located at Entebbe
NILE-TAC	Nile Technical Advisory Committee of the Nile Basin Initiative
O&M	Operation and Maintenance (costs)
PEA	Preliminary Environmental Assessment
SAP	Subsidiary Action Programs
SEA	Strategic Environmental Assessment
SIDA	Swedish International Development Cooperation Agency
SVP	Shared Vision Program
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
USAID	U.S. Agency for International Development
IUCN	World Conservation Union
WWF	World Wildlife Fund

This report establishes a framework for environmental transboundary management in the Nile Basin and, within this framework, constructs principles for assessing environmental aspects of proposed projects. The report addresses current environmental conditions and the forces affecting change; it also addresses transboundary environmental factors that are important in appraising proposed programs or projects, and develops criteria for determining priorities among environmental transboundary programs or projects.

The Nile traverses 35 degrees of latitude in its flow to the Mediterranean. Within this expanse, the Nile Basin encompasses unique wildlife habitat and broad biodiversity. At the same time, Nile Basin countries are home to 300 million people, a number projected to double by 2025. In this context, the challenge for the Nile Basin countries is to balance development and growth with sustainable use of the Nile's rich natural environment.

A growing effort at cooperation among the Nile Basin countries is taking shape in the Nile Basin Initiative (NBI), a cooperative effort of nine riparian nations to develop a shared vision for economic development and water resources management. This is an historic initiative. The central principle of the NBI is a shared vision embraced by all member nations *to achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources*.

Forces Affecting Environmental Change

The Nile Basin nations enjoy economic progress alongside poverty and conflict. A remarkable similarity of environmental problems exists throughout the Basin. The principal problems include deforestation, overgrazing, desertification, pollution from sewage and industrial waste discharge, and loss of habitat. Three main forces underlie the environmental stresses that lead to these problems: (i) population growth and distribution, (ii) economic growth and its converse, poverty, and (iii) ill-advised government policy responses. Programs must address these drivers.

Population growth and distribution in the Basin are dominated by an overall increase in human numbers as well as by a shift toward greater urbanization. The nine NBI countries together constitute 40 percent of Africa's population, and, under any plausible assumptions, the region will experience a substantial increase in human numbers over the coming decades. The overall increase will increase future water demand, but by how much depends on technology, policy, and the sectoral composition of economic growth.

The Nile Basin's population will increase disproportionately in urban areas. In four countries—Burundi, Ethiopia, Rwanda, and Uganda—the urban population will more than double as a percentage of the total. The consequences of this population redistribution will be profound for water management. Urban populations generally consume more water per capita for domestic and industrial use than rural populations. Overall demand for water, therefore, can be expected to increase.

GDP and GDP growth rates in the Nile Basin are uneven. In all nations except Egypt GDP per capita is low, and the war-torn nations of the Democratic Republic of the Congo, Rwanda, and Burundi experienced decreases in GDP during the 1990s—although they are poised for rebound. Not only the size but also the composition of an economy influences the demand for water. Increasing agricultural activity to feed growing populations is of great concern for future water demand, and increased industrial activity can be expected to have adverse effects on water quality unless pollution controls are required. Urbanization will pose special challenges for water delivery, drinking water, sanitation, and wastewater treatment.

Agricultural industry constitutes the heaviest water user relative to economic value added, contributing 15 percent to 60 percent of GDP in the countries of the Basin. During the 1990s, the value added by the agricultural sector grew at a rate of approximately 3 percent in most Nile Basin countries except Burundi and Rwanda. The 1990s witnessed the industrial and service sectors grow rapidly only in Uganda. In the other nations, growth in these sectors ranged from plus 4 percent to negative 12 percent.

Without economic growth, population increases will exacerbate existing problems of poverty and food insecurity, underlying causes of watershed degradation, water pollution, and loss of biodiversity. Improved land and water management are essential to improving food security and alleviating poverty in the Basin. Conversely, alleviating poverty and improving food security are requisites for achieving sustainable development of land and water resources. Ultimately, it is the sum of decisions made by individual people regarding family size, agricultural practices, water use, and economic activity that determine sustainability and environmental quality. Workable incentives must be put in place, and the end-users of water and land resources must be aware of the relevance of the environment to their own health and economic well-being. Continuation of the downward spiral of increasing population, declining environmental quality, and poverty is not inevitable.

Environmental and natural resources can be protected in a variety of ways. One school of thought believes that strong national or regional institutions are necessary to protect the environment. Others argue that privatization of resources are even more important. Both sides typically agree that without either strong institutions or private ownership for their protection, natural resources become abused and degraded in the face of population pressure, poverty, and economic development. One finds few strong institutions in the Nile Basin for protecting the environment, and to date there has been limited use of market-based mechanisms for environmental protection. Nonetheless, all the riparian states have programs under way in national environ-mental planning, and new policies and laws are beginning to appear.

A significant issue is that traditional land and resource tenure arrangements in many Nile countries present an obstacle to private land stewardship. Communal rights apply to many important resources, such as land, forests, and wildlife. Throughout the Basin, communal systems of resource management confront threats such as rapidly growing populations, nomadic lifestyles, and periodic drought and food shortage. Although many rural areas face this problem, areas near national borders that are especially vulnerable to abuse cause particular concern.

Factors Important in Project Appraisal

Watersheds and sub-basins of the Nile are well-defined systems that are the logical focus of natural resource management. Watersheds facilitate analysis and, thus, our understanding of land and water relationships. Integrated watershed management maintains that understanding the welfare of people and their use of watershed units creates a cumulative effect of improving the condition of the sub-basins and, subsequently, the condition of the overall Nile. The reverse is also true: continued degradation of watersheds affects the productivity and water flow within each sub-basin and, consequently, the entire Nile Basin.

Most Nile Basin countries have environmental legislation governing water quality and the protection of the environment, although many have yet to establish ambient water quality standards. Moreover, there appears to be few links between discharge permitting and in-stream standards. While some major point sources are subject to environmental permitting, such requirements do not apply throughout the Basin. The approaches used in each country generally follow norms established in the international community. The same holds true for environmental impact assessment (EIA) requirements. Every riparian country has an EIA policy if not yet a law. The approaches in place for the respective countries are close enough in principle that they could serve as building blocks upon which to base common environmental goals and objectives for management of the Nile River system.

Monitoring and data archiving represents an important element in effective transboundary environmental management. Although environmental information can be sensitive because many countries believe such information affects national security interests, sharing the knowledge gained by monitoring and evaluating environmental information is nevertheless critical to understanding upstream-downstream linkages and working toward improving the health and productivity of the Basin. There is less sensitivity about sharing knowledge than about sharing data, and such sharing could build confidence. An excellent network of universities exists in the Nile Basin, and these could form the basis for a consortium of web-networked environmental monitoring and analysis centers.

Managing international waters to maximize mutual benefits—the central goal of the Nile Basin Initiative—represents a step beyond the 1992 Helsinki Convention or the 1997 UN Convention. This principle would consider all potential uses in a basin, evaluate the contribution of each potential use to economic well-being in the basin, and allocate water for both consumption and waste assimilation according to where it creates the greatest value. Allocations made in this fashion would do the most to improve living standards in the basin. Moreover, development would be more sustainable, since potential future uses also would be taken into account. It is important that future projects be evaluated from a basinwide perspective so that the most efficient use is made of natural resources for the mutual benefit of the riparians. This will inevitably require greater economic integration, both of markets and infrastructure, among the riparian nations.

A straightforward and effective method for introducing greater integration and efficient usage is to apply market principles: beneficiaries pay for water deliveries and polluters pay for using water as a medium for disposal of wastes. Water is used where it adds the greatest value. Within countries, water is sometimes allocated through a market mechanism. This same prin-

ciple, however, is used less often among countries that share international rivers or lakes. The benefits of using markets within a country are great. If the same principles could be applied across countries, greater benefits would accrue to those who share international waters. The international allocations could be achieved through water pricing or through tradable allocations.

Criteria and Priorities for Projects

While the Nile Basin faces transboundary environmental threats, it also promises broad opportunities. The challenge is to manage land and water in harmony so that the welfare of people *and* the environment are improved across all land-use types. Opportunities exist to manage the natural resources of the Nile in a coordinated way to achieve shared benefits and sustainability. Important among these opportunities are (i) regional cooperation, especially in monitoring and sharing knowledge of environmental conditions; (ii) integrated watershed management, (iii) water quality control programs, (iv) environmental impact assessment, and (v) education.

The transboundary environmental impacts of a water resource project should be evaluated with a flexible but comprehensive procedure. The interactions of hydrology, people, ecosystems, and economics involved in a project need to be viewed as a system. Although the transboundary environmental analysis will be undertaken in this broad systems context, the specific methodology should deal explicitly with the environmental dimension, addressing the degree to which projects improve the transboundary management of environmental resources. Accordingly, as opportunities and constraints are weighed, criteria that must be considered include water quality, soil quality, biodiversity, and the quality of human life. The quality of human life reflects, at a minimum, public health and potential relocations of people to accommodate projects. An approach to project screening and rating using an issues and priorities matrix is discussed in the text of the report.

As noted, many opportunities exist for the coordinated management of the natural resources of the Nile to achieve sustainability, especially when there are transboundary impacts. Several opportunities should be highlighted: (i) the application of integrated watershed management techniques to issues of land use, agricultural practices, forestation, and wetlands protection; (ii) the expansion of environmental impact assessment practices within national environmental initiatives, and the coordination of EIA policies and procedures among different jurisdictions and nations; (iii) the development of regional environmental monitoring and information systems as well as common data standards for collecting, storing, and sharing environmental information, possibly by building on the excellent network of national universities in the Nile Basin countries; (iv) the development of web-networked communications, modeling, and analysis capabilities for environmental information among the relevant water, environment, and natural resource ministries of the riparian countries, and their corresponding technical universities; (v) the expansion of systematic water quality monitoring and control programs throughout the Basin, and the identification of critical nodes at which water quality and other environmental information should be systematically sampled; and (vi) the expansion of secondary and college education programs, industrial training activities, and public information outreach projects to inform end-users about water, land, and other natural resources as well as important transboundary environmental issues.

Arising in the rift valleys of East Africa and in the high mountains of Ethiopia, the Nile River crosses more than 6700 kilometers in its descent to the Mediterranean Sea. Within that vast area are scorched deserts, irrigated croplands, luxuriant wetlands, and tropical highlands. The Nile River Basin hosts unique wildlife habitats and broad biodiversity. It is naturally a treasure to be maintained for future generations. The countries of the Nile Basin contain some 300 million people, a number projected to double in 25 years. These riparian nations located along the Nile River enjoy growing prosperity amidst poverty and conflict and face a challenge in balancing development and growth with the sustainable use of this rich natural environment.

The Nile Basin countries have a history of cooperation in promoting economic development and, in recent years, environmental conservation. Although the Basin faces environmental threats, it also retains valuable and healthy ecosystems, and the riparian nations sense the time has come to build upon opportunities and overcome constraints. The twin goals of sustainable development and environmental conservation appear in the many national environmental plans, strategic programs, and policy guidelines that the riparian nations have developed in recent years. In achieving these goals, significant progress has been made in establishing national environmental policies and passing environmental laws.

The Nile Basin Initiative (NBI) attests to the growing cooperation among the Nile Basin countries. The NBI embodies an effort of the riparian nations to develop a shared vision for economic development and management of water resources. Many believe the NBI will bring enhanced economic development and transboundary environmental management for the benefit of all the peoples of the Nile Basin.

Nile Basin Initiative

Established in February 1999, the NBI represents a Basin-wide partnership of nine of the 10 riparian nations to achieve sustainable development and management of the waters of the Nile.[1] The member nations of the NBI—Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda—will work jointly under a transitional arrangement pending a permanent legal framework. This historic cooperative initiative seeks to realize the potential benefits of development in a region that has been subject to rivalry and suspicion in the past.

The NBI is governed by a council of ministers (Nile-COM) comprising the ministers of water resources or equivalent officials of the member countries. Chairmanship of the council rotates annually. The Nile Technical Advisory Committee (Nile-TAC) supports the council of ministers and comprises senior water resource officials of the respective countries. The NBI

[1] The NBI is built upon the earlier and now disbanded Technical Co-operation Committee for the Promotion of the Development & Environmental Protection of the Nile Basin, or TECCONILE, which comprised a subset of the current nine member nations of the NBI. Eritrea is the one riparian nation not yet a member of the NBI.

maintains a secretariat in Entebbe, Uganda, that coordinates activities of the group, serves as a meeting place, and archives information.[2] The planning efforts of the NBI receive direct support from the Canadian International Development Agency, the United Nations Development Program, and the World Bank, but the NBI is an organization driven entirely by its stakeholders.

The central principle of the NBI is the shared vision jointly embraced by all member nations:

> *To achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources.*

Building upon the shared vision, the NBI has two complementary components, a Shared Vision Program (SVP) and a Subsidiary Action Program (SAP).

The NILE-COM is the main policy forum for the NBI, and is at the lead of the riparian consultative process. The principal role of the NILE-TAC is to coordinate joint activities and to establish working groups as needed to undertake specific tasks. The NILE-TAC is responsible to the NILE-COM or preparation of the Shared Vision Program, to be coordinated and implemented at the basin-wide level. While the NILE-TAC establishes working groups to identify SAP projects at the sub-basin level, responsibility for SAP projects rests with the involved riparians. Throughout he process, high priority is placed on strengthening the process of consultation in order to build trust and confidence.

An International Consortium or Cooperation on the Nile (ICCON) is being established to support the NBI Strategic Action Program. The first meeting of the ICCON is scheduled for early in 2001. The ICCON will be a forum organized by the World Bank at the riparians' request to establish a long-term partnership of the riparian states and the international community. The first meeting of the ICON will seek to raise funding for a portfolio of basin-wide SAP projects and for preparation of projects identified under the SAP program. In the words of the NBI, the first ICCON meeting will also celebrate cooperation and demonstrate international solidarity for cooperative development of the Nile Basin.

The Shared Vision Program includes a number of Basin-wide projects in capacity building, sectoral studies, and participatory stakeholder activities. It incorporates six broad themes, called pillars:

Pillar A: The shared vision
Pillar B: The cooperative framework[3]
Pillar C: Confidence building and stakeholder involvement
Pillar D: Socioeconomic, environmental, and sectoral analyses
Pillar E: Development and investment planning
Pillar F: Applied training

[2] The NBI Secretariat maintains an informational web site at www.Nilebasin.org.

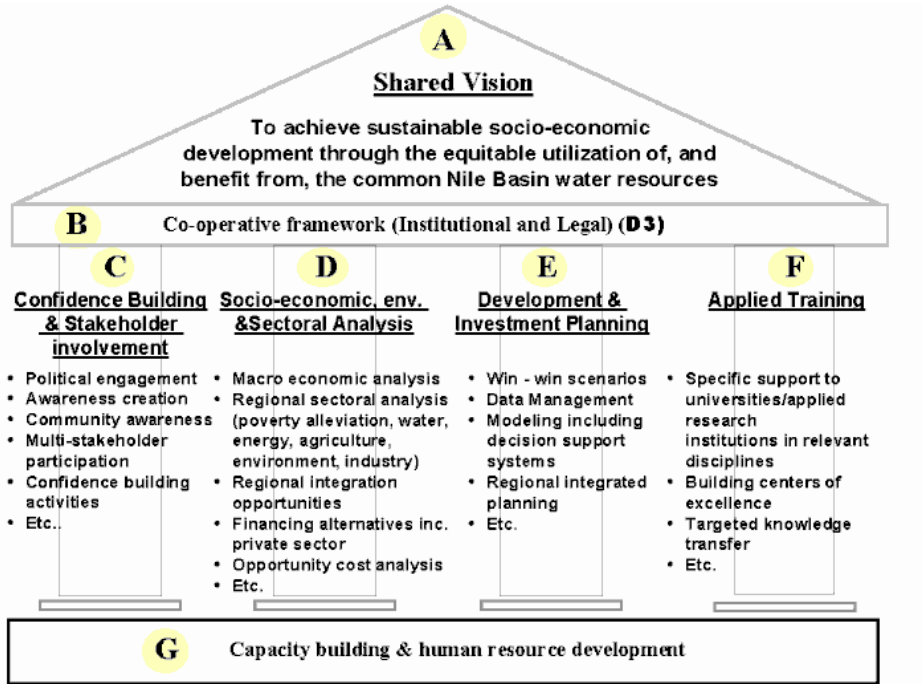
[3] Pillar B is also sometimes called "Project D3" based on an earlier program organization.

Figure 1 shows a schematic drawing, adopted by the NBI, of these six pillars. This drawing suggests that achievement of the shared vision (pillar A) requires a cooperative framework (pillar B) and, correspondingly, to achieve a cooperative framework, progress on the supporting pillars (C–F) is needed. Capacity building and human resource development constitutes the foundation of all of this NBI structure.

The SAP, involving subsets of riparian countries, aims to identify and initiate investment projects offering mutual benefits at the sub-basin level. The SAP intends to develop "action on the ground." To date, two principal SAP activities are under way—an eastern Nile Region SAP (EN-SAP) involving Egypt, Ethiopia, and Sudan, and a Nile Equatorial Lakes Region SAP (NEL-SAP) involving the six riparian nations of the equatorial lakes.

This report falls under pillar D—socioeconomic, environmental, and sectoral analyses—which has four subcomponents: (i) socioeconomic development and benefit sharing (integration of pillars), (ii) efficient water use for agricultural production, (iii) assessment of opportunities for power trade and pooling, and (iv) environmental analysis and management. Specifically, the present work relates to the last of these. To date, most environmental analyses and management activities pertain to the Nile Basin focus on national issues. The transboundary environmental analysis and management component of pillar D aims to expand the purview of these existing national environmental activities to regional or Basin-wide frameworks for sustainable development of the entire Nile Basin.

Figure 1. Temple Structure of the Nile Basin Initiative



Source: Nile Basin Initiative (www.Nilebasin.org).

Purpose of This Report

This report seeks to establish (i) a framework for transboundary environmental management in the Nile Basin and (ii) principles within this framework for assessing transboundary environmental aspects of proposed projects. To accomplish these goals, the report addresses transboundary environmental factors important for appraising potential projects and develops approaches to comparing projects with respect to environmental transboundary opportunities and constraints. The report assesses current environmental conditions, trends, and drivers.

The report supports the Nile Basin Initiative on two fronts. First, it makes general recommendations that can be incorporated into NBI activities that address the management of environmental resources on a transboundary scale. In this way, it contributes to the implemen-tation of broad, environmentally sound, cross-border development efforts, within the concept of the Shared Vision Program. Second, it supports the design and implementation of investment projects under the NBI Subsidiary Action Program, especially transboundary activities. This support takes the form of recommended guidelines for environmental impact assessment of projects at the sub-basin level.

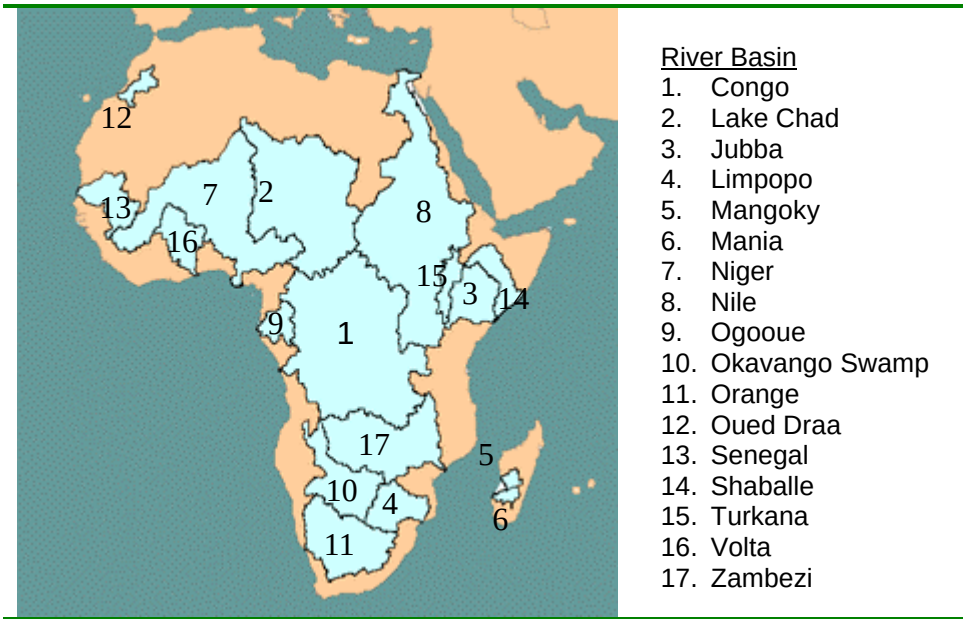
Transboundary environmental issues associated with water resource development are not unique to the Nile. Such issues are common to vulnerable river basins around the world. For various reasons, however, the Nile is different in degree if not in concept. The 10 riparian countries of the Nile constitute a larger number than most other rivers of the world (Figure 2).[4] This large number of riparian countries creates complexity in seeking solutions to transboundary problems. Second, there is limited water per capita combined with a large and growing population. Third, poverty in parts of the Basin limits the resources that can be applied to manage water resources efficiently. Lastly, land and water degradation has caused growing concern over food security in parts of the Basin. All these factors make for complex management of environmental resources.

This report develops a framework for analyzing environmental transboundary opportunities and constraints in water resource management. Several broad themes are explored through this approach:

- What are the issues of biodiversity and of land, water, and other types of environmental degradation that should be of concern? What are the economic, population, and land use factors that underlie these environmental issues? (Chapter 1 addresses these topics.)
- What is the framework of economic, policy, and watershed management upon which sound transboundary environmental management should rest? What lessons have been learned in other river basins of the world? (Chapter 2 addresses these topics.)

[4] The Danube is the only other major world river with as many riparian nations (10).

Figure 2. Large River Basins of Africa (numbers indicate location)



Source: World Resources Institute 1999.

The physical conditions of the Nile Basin have been studied extensively for at least a century (Figure 3). These studies focus principally on hydrology and water quantity issues; few integrative studies of water quality and even fewer studies of other environmental factors have been carried out. The present study attempts to fill a need for such integrative studies. It draws upon interviews with stakeholders in the Basin and upon published accounts, including reports by country sources, National Environmental Action Plans, National Action Plans, nongovernmental studies, scholarly publications, and other documents.

Importance of River Basins

River basins, sub-basins, and individual watersheds are important natural systems upon which human and wildlife populations depend. They provide resources of water, food, energy, transportation, and recreation as well as habitats for fish and animal species on land. They also represent systems that help us better understand land use and relationships that affect water supply, water quality, nutrient cycling, and land productivity.

Given the ecological, social, and economic importance of river basins, their degradation entails enormous environmental and socioeconomic cost. To achieve sustainable development, the provision of goods and services from by river basins needs to be achieved in concert with environmental protection. Water resource management driven by politics and engineering considerations may conflict with practices designed to protect land and water quality. The Nile Basin confronts pressures from growing populations, economic development, and wasteful use of natural resources. These pressures put the Basin at risk, with the consequent decline of available water supplies of adequate quality and the impairment of ecosystems upon which human society ultimately depends.

Wise use of river basins requires a balancing infrastructure and economic development on the one hand, and environmental policies to ensure sustainability on the other. A river basin therefore needs to be viewed as a whole, and management must take into account the full range of impacts, including those of a transboundary nature.

Sustainable Development of the Nile Basin

The Nile Basin is environmentally sensitive. Stretching from the Equator to the Mediterranean Sea, the Nile is a principal flyway for migrating birds that nest along its many marshes, lakes, and tributaries. Its wetlands, forests, and open lands are home to a broad array of flora and fauna. Its natural beauty has attracted tourists for centuries. But increasing population and limited water supply have put stress on both the people of the Basin as well as the environment (Table l).

Table 1. Select Environmental and Natural Resource Attributes of the Nile Basin

Indicator	*Nile Basin*	*Unit*	*Reference*
Basin area	3,254,555	km^2	Revenga et al. 1998
Basin population (UN 1995)	143,200,120	Millions	Revenga et al. 1998
Basin population density	44	People/km^2	Revenga et al. 1998
Available per capita water	587	CM/year	UNPD 1999
Major dams	7	(Each)	World Bank 2000
Number of fish species	343	(Each)	Revenga, et al. 1998
Threatened fish species	4	(Each)	Revenga et al. 1998
Number of mammal species	338	(Each)	WRI 1999
Threatened mammal species	18	(Each)	WRI 1999
Protected areas	5	Percent	Revenga et al. 1998
Wetlands (including rivers and lakes)	6	Percent	Revenga et al. 1998
Arid area	30	Percent	UNPD 1999
Forest	2	Percent	Revenga et al. 1998
Cropland	15	Percent	UNPD 1999
Irrigated cropland	5	Percent	Revenga et al. 1998
Shrub	4	Percent	UNPD 1999
Grassland	42	Percent	UNPD 1999
Loss of original forest	91	Percent	Revenga et al. 1998
Deforestation rate	6	Percent	Revenga et al. 1998
Eroded area	5	Percent	Revenga et al. 1998
Urban area	1	Percent	World Bank 2000

Total water and per capita water availability in the Nile Basin remain low (A number of transboundary environmental activities are under way in the Basin, and others have been discussed. Among the more prominent are the Lake Victoria Environmental Management Program, involving upper Basin riparian countries and the World Bank (Box 1), and the more recent Lake Victoria Initiative, also involving upper Basin riparian countries in cooperation with the Swedish International Development Cooperation Agency (Box 2). River Basin planning initiatives in which potential transboundary considerations are important involve Ethiopia and Kenya; Kenya and Tanzania; and Tanzania, Uganda, and Rwanda. On a smaller scale, forest and wildlife

management initiatives could evolve between Uganda and Kenya, Kenya and Tanzania, and possibly others.

Compared to other major river basins, the Nile Basin's disparity in water availability differs sharply among sub-basins. Arid portions (perhaps one-third of the area of the Basin) yield negligible flows; whereas, the Eastern Highland of Ethiopia, comprising perhaps as little as 10–20 percent of the land area of the overall Basin, yields 60–80 percent of the annual flow in the lower Nile.

Table 2. Nile Basin: Areas and Rainfall by Country

Country	*Total area of the country*	*Area of the country within the Basin*	*As % of total area of Basin*	*As % of total area of country*	*Average annual rainfall in the Basin (mm)*		
	(km^2)	*(km^2)*	*(%)*	*(%)*	*min.*	*max.*	*mean*
Burundi	27,834	13,260	0.4	47.6	895	1,570	1,110
Dem. Rep. of the Congo	2,344,860	22,143	0.7	0.9	875	1,915	1,245
Egypt	1,001,450	326,751	10.5	32.6	0	120	15
Eritrea	121,890	24,921	0.8	20.4	240	665	520
Ethiopia	1,100,010	365,117	11.7	33.2	205	2,010	1,125
Kenya	580,370	46,229	1.5	8	505	1,790	1,260
Rwanda	26,340	19,876	0.6	75.5	840	1,935	1,105
Sudan	2,505,810	1,978,506	63.6	79	0	1,610	500
Tanzania	942,782	84,200	2.7	8.9	625	1,630	1,015
Uganda	235,880	231,366	7.4	98.1	395	2,060	1,140
Nile Basin		3,112,369	100.0		0	2,060	615

Water resource management has been traditionally concerned with sustainable water supply. In the future, it will also need to be concerned with effects on water-dependent eco-systems. These effects relate to consumptive removal of water, dams, drainage, and other changes to the basin. Water management programs must be based on concepts of integrated river basin planning, explicitly addressing watershed management.

A number of transboundary environmental activities are under way in the Basin, and others have been discussed. Among the more prominent are the Lake Victoria Environmental Management Program, involving upper Basin riparian countries and the World Bank (Box 1), and the more recent Lake Victoria Initiative, also involving upper Basin riparian countries in cooperation with the Swedish International Development Cooperation Agency (Box 2). River Basin planning initiatives in which potential transboundary considerations are important involve Ethiopia and Kenya; Kenya and Tanzania; and Tanzania, Uganda, and Rwanda. On a smaller scale, forest and wildlife management initiatives could evolve between Uganda and Kenya, Kenya and Tanzania, and possibly others.

A common definition of sustainable development is the use of natural resources (land, water, wildlife, etc.) in a manner that provides the needed goods and services for today's

generation without diminishing use for future generations. Examples of nonsustainable development abound in the Nile Basin. For example, fuel wood has provided energy for people in the Nile for more than 5,000 years. Today the use of wood for fuel by the dense populations of rural poor in the upper portions of the Basin has degraded forests. This activity in combination with the widespread conversion of forest land to cultivation and illegal forest logging accounts for the fact that more than 90 percent of the original forest cover of the Basin has been lost. In the mountainous and hilly portions of the Basin, this loss of forest cover has caused serious soil erosion, loss of land productivity, downstream sedimentation, and localized flooding. In response to the fuelwood shortage and the need for energy, hydropower development in the Basin continues to be viewed as an important source of energy. The construction of dams, flooding of biodiversity rich habitat by reservoirs, impacts on migratory fish and aquatic ecosystems all add to the environmental concerns in the Basin.

Box 1. Lake Victoria Environmental Management Program (LVEMP)

The LVEMP is a Global Environmental Facility-sponsored program funded at a level of $77.6 million, with funds provided by the Global Environmental Facility, United Nations Environmental Program, United Nations Development Program, and UN Food and Agricultural Organization, and the three host countries. It will run from 1996 to 2002. It is executed by national secretariats from the host countries: Uganda, Tanzania, and Kenya.

The program addresses the major threats facing the Lake Victoria ecosystem, including overfishing, eutrophication and algae, pollution, and invasive exotic species such as water hyacinth. Program activities are geared to (i) regional cooperation in fisheries research, extension, and management; (ii) research and monitoring of water quality and pollution; (iii) stronger and harmonized pollution regulatory, incentive, and enforcement systems; (iv) priority investments in waste water management; (v) monitored and suitable use of wetlands; (vi) control of water hyacinth; and (vii) management of land use in the catchment, including soil conservation and afforestation.

Various national agencies are responsible for implementing project and program activities. For example, the three national fisheries research institutes play a leading role in all activities involving fisheries research and collaborate with local fisheries departments and ministries of water development. Water testing is undertaken by the Kisumu and Mwanza Municipal Councils, the Uganda Water and Sewage Corporation, and the Lake Basin Development Authority in Kisumu.

Capacity building is a special feature, and provision has been made to support 2,000 short-term and on-the-job training courses, 100 regional master's degrees, and 15 Ph.D.s. For water hyacinth control, national steering committees provide guidance, and biological control rearing units have been set up in national agricultural research institutes.

Scientific advisory groups, community-based micro projects, community training and stakeholders workshops implemented by the LVEMP ensure broad-based participation of interested parties from the top to the bottom.

Land and water scarcity contribute to poverty in the Basin. It is not surprising that governments try to increase the productivity of a finite land base with limited supplies of water in demand by others in the Basin. To avoid future conflicts and maximize the benefits derived from the Nile waters, collaboration among the riparian countries becomes necessary. Okidi (1994) writes that Basin agreements, while necessary, are insufficient to bring about successful management of the Nile waters. Among the additional conditions required are (i) water master

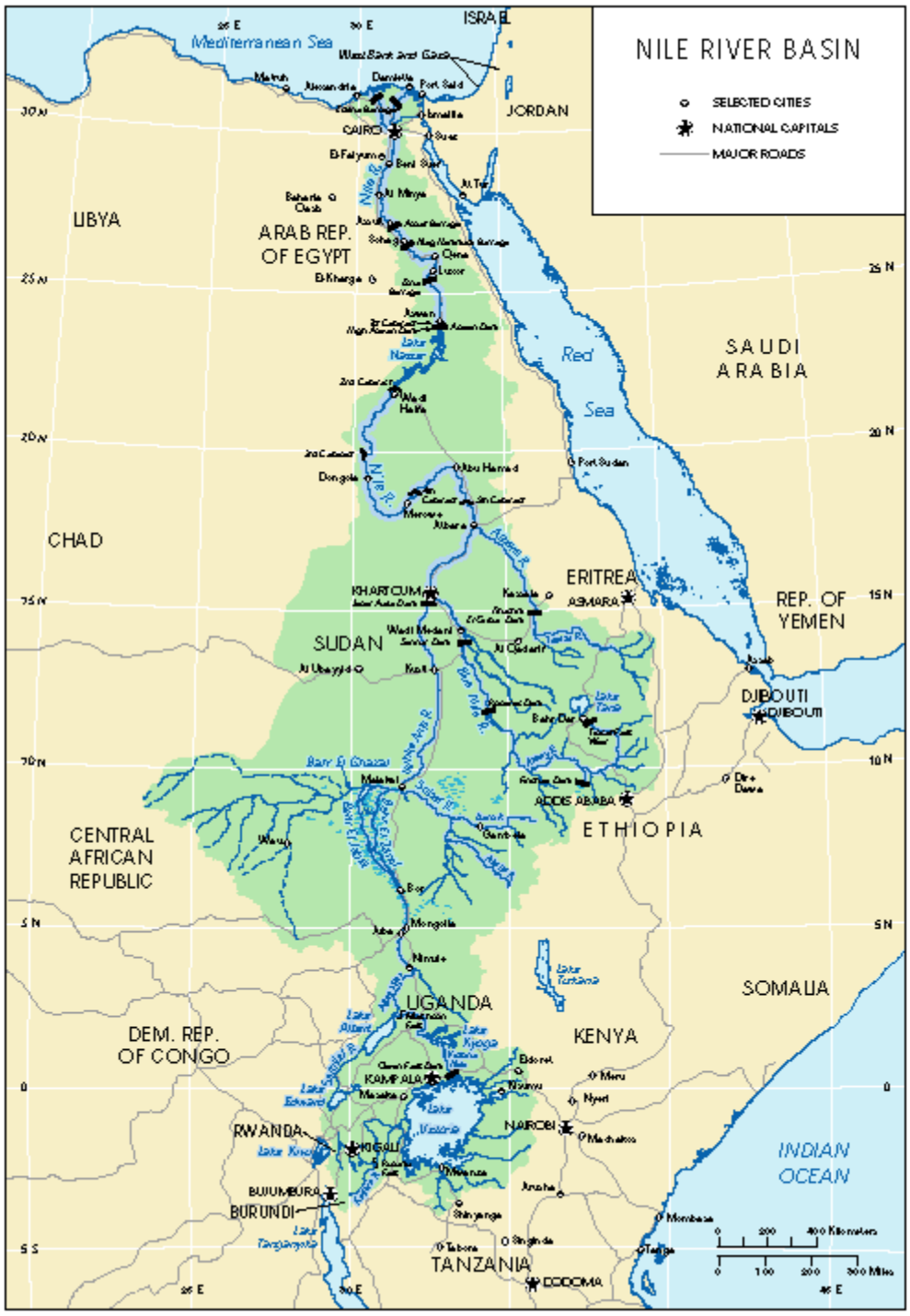
plans for the nations of the basin, (ii) expertise in water resources and environmental management in all riparian countries, (iii) financial support, and (iv) dealing with the population growth that fuels growing water needs and other aspects of environmental degradation.

Box 2. Lake Victoria Initiative

The Lake Victoria Initiative is an activity of the Commission for East African Cooperation aimed at transferring to the Lake Victoria Basin lessons learned from the "Baltic Sea model" for pollution cleanup and prevention. The Lake Victoria Initiative receives support from the Stockholm International Water Institute and the Swedish International Development Cooperation Agency and hopes to link cities, like-minded institutions, and nongovernmental organizations involved in the economic and social development of the Lake Victoria region. A Workshop for Networking Organizations on Environment of the Baltic Sea, Uganda, and Other East African Countries was held in Uganda in November 1999.

The Baltic Sea model is a progressive environmental action program for the protection of the marine environment of the Baltic Sea area, adopted under the Baltic Sea Environmental Declaration of 1992 (Baltic Marine Environmental Commission of the Helsinki Commission 1993). The program was developed in response to the Baltic Sea Declaration adopted by the prime ministers of the countries of the Baltic Sea area. The program established the long-term objective of ensuring the ecological restoration of the Baltic Sea and preservation of its ecological balance. It identifies problems and priority action in all the countries within the Baltic Sea catchment area.

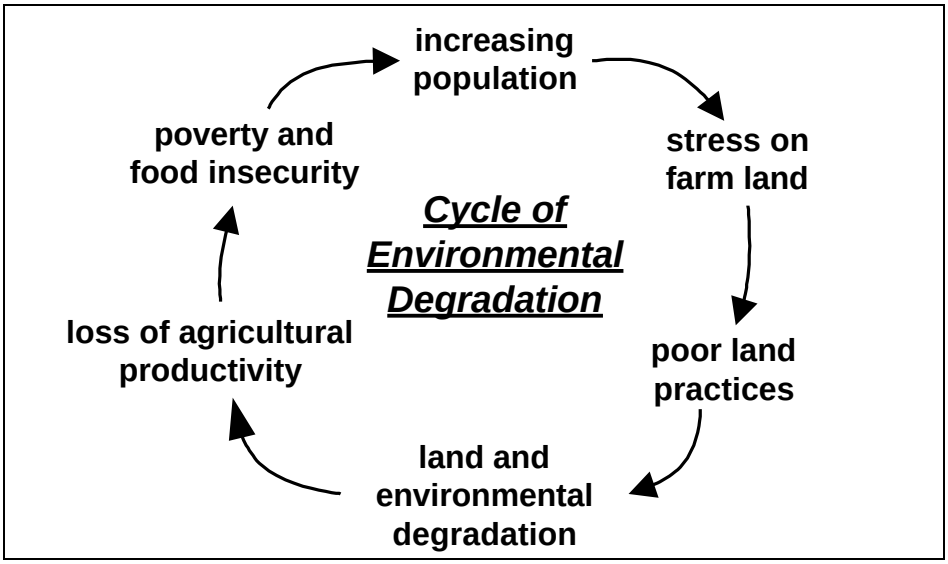
Figure 3. Map of the Nile Basin



Source: World Bank

The Nile Basin confronts population growth, resource degradation, and poverty. These factors do not operate independently of one another; they interact together in a complex cycle of cause and effect (Figure 1.1). For example, childbearing decisions affect household income and food security, which, in turn, affect agricultural productivity. Agricultural productivity is affected by resource degradation, which is affected by the land-use decisions people make based, in part, on family size. By affecting health and childbearing decisions, land use, and agricultural productivity, factors that affect rural household income and food security impinge upon national economics. Clearly, national economics, in turn, affect rural households.

Figure 1.1. Cycle of Land Degradation



Throughout the Nile Basin a remarkable similarity can be detected in the principal environmental problems (Box 1.1). Deforestation, overgrazing, desertification, pollution from sewage and industrial waste, and loss of wildlife and habitat are found in most of the Nile Basin nations. National governments, international agencies, and donor groups are working to identify the principal drivers of environmental and natural resource loss. However, partial analyses focusing individually on population, environment, or economics are limited in the ability to describe the forces driving the system, or to capture the complex interactions of increasing population, degrading environmental conditions, and continuing poverty in the Nile Basin.

Appendix A describes in some detail *how* environmental degradation is taking place; this chapter discusses *why* by identifying the driving forces behind the threats. Three driving forces are of principal importance to the Nile Basin:

- Population growth and distribution

- Economic growth and poverty
- Government policy responses

Programs and policy initiatives must address these three drivers as well as the linkages among them. Ultimately, the decisions made by individual people and families regarding family size, agricultural practices, water use, and economic activity will determine sustainability and environmental quality. Practical incentives for environmental quality must be implemented, and the ultimate users of water and land resources must be made aware of the relevance of the environment to their own health and economic well-being. Continuation of the downward spiral of increasing population, declining environmental quality, and poverty is not inevitable.

Box 1.1. Environmental Drivers: Tanzania

Government sources cite the following factors as reasons for the current deteriorating state of the national environment in Tanzania: inadequate water and land management at various management levels, inadequate financial and human resources, inequitable terms of international trade, vulnerability of some local environments, rapid growth of rural and urban population, and poor institutional coordination.

Other important but secondary factors include inadequate monitoring and information systems, inadequate capacity to implement programs, lack of involvement of major stakeholders (local communities, nongovernmental organizations, and the private sector) in addressing environmental problems, and poor integration of conservation measures in planning and developing programs.

Source: National Environmental Policy, government of Tanzania 1997.

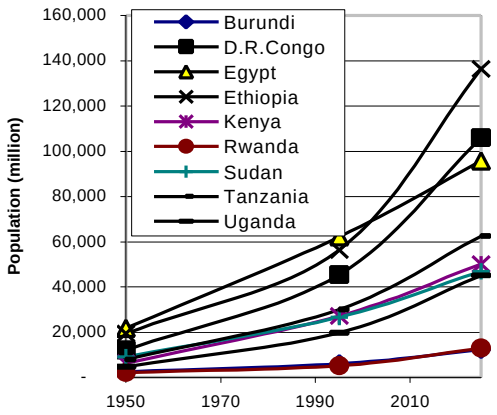
Population Growth and Distribution

The future of the Nile Basin's human population is dominated by two patterns: (i) an overall increase and (ii) a shift toward urbanization. Although increased population will add to future water demand, the degree of demand will depend on technology, policy, and the sectoral composition of economic activity. Increased agricultural activity to feed the growing population will increase threats from nonpoint pollution, siltation, and erosion. Urbanization poses special challenges for water delivery, drinking water sanitation, and wastewater treatment.

The nine Nile Basin Initiative (NBI) countries together constitute 40 percent of Africa's population, totaling some 300 million people. This number is projected to at least double by 2025. As shown in Table 1.1, fertility rate projections differ greatly when estimating population size in 2025. Under low-growth projections, the population increases by 90 percent, while under high-growth projections it increases by 115 percent. The difference between these estimates is 70 million people. Nevertheless, under any plausible set of assumptions, the region will experience a substantial increase in human population in the coming decades. The Democratic Republic of the Congo is included in this table even though most of its population lives outside the Nile Basin. Excluding it from this analysis would not change the overall picture.

Table 1.1. United Nations Population Estimates for Nile Basin Countries in 2025: Comparing 1995 Population to Low, Medium, and High Projections for 2025 (in thousands)

Country	*1995 Standard*	*2025 Low*	*2025 Medium*	*2025 High*
Burundi	6,064	11,986	12,341	13,209
D.R. Congo	45,453	102,760	105,925	114,132
Egypt	62,096	87,577	95,766	103,979
Ethiopia	56,404	125,993	136,288	145,072
Kenya	27,150	47,245	50,202	53,129
Rwanda	5,184	12,454	12,981	13,431
Sudan	26,707	44,226	46,850	49,356
Tanzania	30,026	60,309	62,436	64,557
Uganda	19,689	41,165	44,983	48,304
Nile Basin	281,944	539,959	574,276	611,934



Source: United Nations, Department of Economic and Social Affairs, Population Division 1998.

The change in population referred to above takes on a different aspect when population patterns are considered in relation to major sub-basins of the Nile. For purposes of discussion and summary data, this report uses five major sub-basins, illustrated schematically in figure A.12 of appendix A:

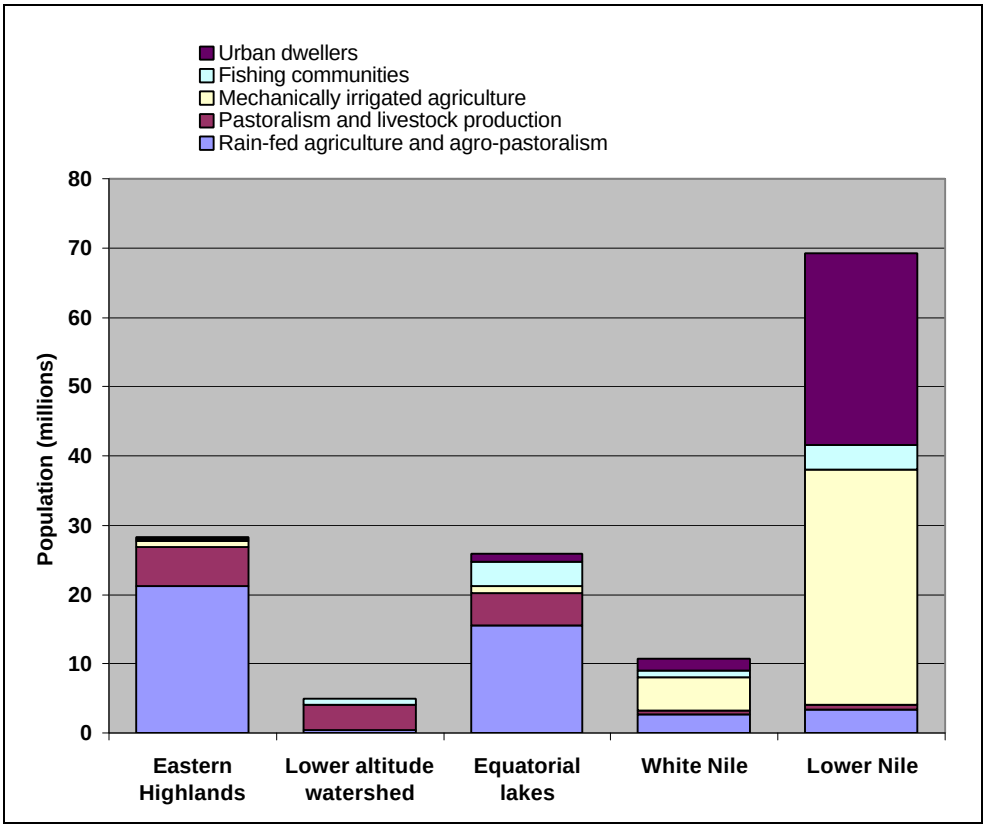
- **Equatorial watershed:** The Lake Victoria Basin and East African lakes, from the Kagera Basin to Lake Albert
- **Low-altitude wetlands:** The Bahr el Jebel and Sudd, Bahr el Ghazal Basin, Sobat Basin, and Machar Marshes
- **The White Nile:** The Nile after leaving the low-altitude wetlands from Malakal to Khartoum
- **Eastern Nile:** The Blue Nile/Abay and its tributaries to Khartoum
- **Lower (Main) Nile:** The combined Nile from Khartoum to the Mediterranean

Figure 1.2 shows a rough estimate of the distribution of population by sub-basin and by end-user group. This is the type of information that should be used to support environmental decision-making, if better data were more broadly available in the Basin.

The highlands of both Ethiopia and the equatorial lakes are home to a large fraction of the rain-fed agricultural population. The main Nile (the White and Lower Nile, from Malakal to the Mediterranean) houses a large percentage of the irrigated agricultural population. Pastoralists reside principally in the southern Nile. Urban dwellers, at least today, principally occupy the Lower Nile (from Khartoum northward), but this will change somewhat as the remainder of the Basin becomes more urbanized.

Table 1.2 presents a rough estimate of the present distribution in the Basin across sub-basins and the distribution projected for 2025. Considering only the low-population growth scenario, and assuming a development pattern of little or no increase in industrialization, those areas lying directly along the Nile (e.g., White and Lower Nile) will show a relative decrease in population in comparison to the outlying sub-basin areas, especially in the more extensive watershed and highland regions.

Figure 1.2. Population in 1995 by End-User Groups (estimated)



Source: United Nations, Department of Economic and Social Affairs, Population Division 1998.

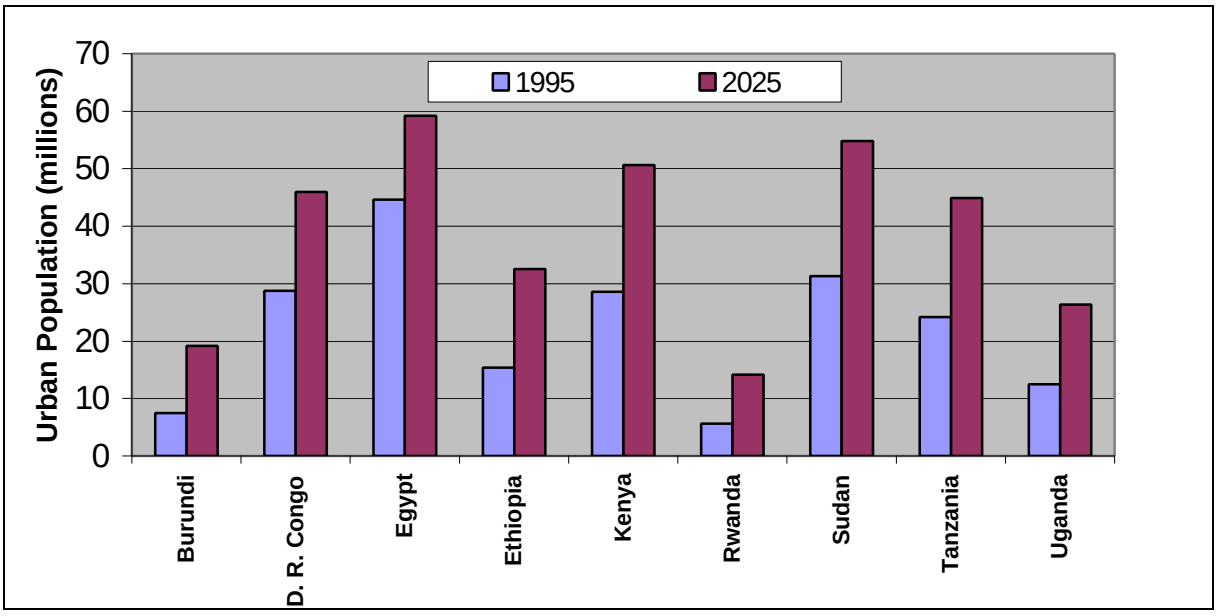
Table 1.2. Population Growth by Sub-Basin (estimated)

	Area (approx.) 000km²	*Population estimated 1995*		*Population (low) estimated 2025*	
		No.	*%*	*No.*	*%*
Equatorial watershed	650	25,825	19	51,813	21
Lower altitude watershed	650	4,943	4	9,561	4
White Nile	590	10,683	8	17,690	7
Lower Nile	960	69,240	49	100,932	42
Eastern highlands	400	28,202	20	62,997	26
Total	3,250		100		100

Source: United Nations, Department of Economic and Social Affairs, Population Division 1998.

The Nile Basin's population will increase disproportionately in urban areas. All the Nile Basin countries are expected to experience dramatic urbanization. In four countries—Burundi, Ethiopia, Rwanda, and Uganda—the urban population will more than double as a percentage of the total. Egypt, already the most urbanized of the Nile Basin countries, will have an urban population of nearly 60 percent by 2025. Indeed, by 2025, half of the Basin's countries will have more than 40 percent of their populations living in urban areas (Figure 1.3).

Figure 1.3. United Nations Projections of Percentage of Population Residing in Urban Areas for Nile Basin Countries: Comparing 1995 and 2025



Source: United Nations, Department of Economic and Social Affairs, Population Division 1998.

Assuming total agricultural production does not decrease, the consequences of this population redistribution will be profound for water management, since urban populations generally consume more water per capita for domestic and industrial use than rural populations. While urbanization can open opportunities for taking advantage of economies of scale in water delivery and sanitation, it also poses special challenges. Water must be delivered to urban areas—sometimes from remote distances. In densely populated areas, inadequate sanitation will adversely affect greater numbers of people. Waterborne diseases may be more likely to spread. Moreover, urban growth will likely be associated with further industrialization and greater water demand from that sector.

Assuming no significant increase in renewable water from 1995 to 2025, population growth will diminish per capita water yield (Figure 1.2). Even under a relatively low scenario of population growth, most Nile countries will experience declines in per capita water yield of approximately one-half (Table 1.3). Furthermore, calculations of per capita water yield have limitations. They do not account for seasonal or spatial variations within countries, nor do they

take into account nonrenewable groundwater supplies. Forecasts of water availability and scarcity do not account for changes in demand and use related to economic variables. While benchmarks of water stress and scarcity do not represent strict limits to growth, they are warnings of the increased likelihood of adverse circumstances.

Table 1.3. Per Capita Water Yield in 2025 for Nile Basin Countries: Comparing 1995 Availability (Cubic Meters) to that Estimated under UN Low, Medium, and High Projections for 2025 Population

Country	*1995 Standard*	*2025 Low*	*2025 Medium*	*2025 High*
Burundi	**594**	**300**	**292**	**273**
Egypt	**936**	**663**	**607**	**559**
Ethiopia	1,950	**873**	**807**	**758**
Kenya	**1,112**	**639**	**602**	**568**
Rwanda	**1,215**	**506**	**485**	**469**
Sudan	5,766	3,482	3,287	3,120
Tanzania	2,964	**1,476**	**1,425**	**1,379**
Uganda	3,352	**1,603**	**1,467**	**1,366**
D.R. Congo	22,419	9,916	9,620	8,928

Note: Numbers in bold represent water stress (below 1,700 cubic meters); those in bold underline depict water scarcity (below 1,000 cubic meters). The figures for the Democratic Republic of the Congo include Congo Basin water.

Economic Development and Poverty

Gross domestic product (GDP) presents a highly aggregated view of production and consumption. GDP itself is a rough indicator of water demand in the sense that, with other things being equal, higher per capita GDP is associated with greater water demand. The income elasticity of demand for water in the Nile Basin is likely on the order of 0.2 to 0.3, based on demand studies from other parts of the world. Thus a doubling of per capita income would be expected to produce a 20–30 percent increase in demand for water.

GDP and GDP growth rates in the Nile Basin are highly uneven (table 1.4). The GDP of Egypt is one-and-one-half that of the combined GDP of the other riparian countries. The war-torn nations of the Democratic Republic of the Congo, Rwanda, and Burundi have experienced significant decreases in GDP during the 1990s, but they are poised for a significant rebound. GDP per capita in all nations except Egypt is low.

The sectoral composition of economic production also tells much about demand for water. Agricultural production consumes large amounts of water, both in absolute terms and relative to economic value added. Industry occupies a mid-range position in water used per unit of GDP, while the service sector uses the least amount of water. The relative rates of growth of these sectors have a strong influence on future water demand (Table 1.5). Moreover, increased industrial activity will likely have adverse effects on water quality, unless pollution controls are required, monitored, and enforced.

For those riparian nations for which data are available, agricultural output has grown during the 1990s in all but Burundi and Rwanda. Industrial and service sectors have shown growth in all but Burundi, Rwanda, and the Democratic Republic of the Congo. A few details are worth noting.

First, if and when the political situation stabilizes, the war-torn areas are likely to experience a rapid economic recovery. Second, Uganda's high rate of industrial growth could eventually have adverse effects on water quality in the upper Basin. GDP growth of 3 percent per year in the region would double GDP in 23 years and, depending on the composition of that growth, would increase the demand for water by 20–30 percent (Table 1.6). Eventually, growth in the use of water as an input to agriculture and industry and as a medium for disposing of wastes will have measurable adverse effects on water quality. Consequently, mechanisms to allocate water through markets and to limit pollution of waters of the Basin will take on added importance.

Table 1.4. Distribution of Income, Land, and Poverty, 1977–96

	Income distribution		*Percentage of income in each quintile of income*					*Distribution of agricultural land ownership*			*Population in poverty*			
	Survey year	*Gini coef.*	*0-20%*	*20-40%*	*40-60%*	*60-80%*	*80-100%*	*Survey year*	*Gini coef.*	*Percent owning < 10 ha*	*Intl. poverty line $/day*		*National poverty line*	
											Year	*%*	*Year*	*%*
Burundi	--	--	--	--	--	--	--	--	--	--	--	--	1990	36.2
D.R. Congo	--	--	--	--	--	--	--	1990	39.4	--	--	--	--	--
Egypt	1991	32	8.7	12.5	16.3	21.4	41.1	--	--	--	1990-91	7.6	--	--
Ethiopia	--	--	--	--	--	--	--	1989-92	32.3	100	1981-82	33.8	--	--
Kenya	1992	54	3.4	6.7	10.7	17.3	61.8	--	--	--	1992	50.2	1992	46.4
Rwanda	1983	29	9.7	13.1	16.7	21.6	38.9	--	--	--	1983-85	45.7	1993	51.2
Sudan	1968	39	8.2	8.3	20.9	16.7	46	--	--	--	--	--	--	--
Tanzania	1993	38	6.9	10.9	15.3	21.5	45.4	--	--	--	1993	16.4	1991	51.1
Uganda	1992	41	6.8	--	14.4	20.4	48.1	1991	62.2	96.5	1989-90	50	1992-93	55.0

Sources: World Resource Institute (1999); World Bank; Food and Agricultural Organization. Dash indicates data unavailable.

On the other hand, without economic growth and development, population growth in the Nile Basin will worsen existing problems of poverty and food insecurity, arguably the most important underlying causes of watershed degradation and resulting water pollution, as well as loss of native forests, wetlands, wildlife habitat, and biodiversity. The rural poor have little choice but to cultivate steep uplands that are often unsuitable for intensive cultivation. And where the poor do not have secure tenure to land and resource access rights, overexploitation of natural resources to meet food and energy needs results (Boxes 1.2-4). People in desperate circumstances are forced to choose short-term exploitation over long-term management. These seemingly rational decisions are, of course, incompatible with maintenance of the natural resource base.

Table 1.5. GDP and GDP Growth

	GDP 1998 (millions $)	*Annual GDP growth in % (average 1990–98)*	*GNP per capita (1998 in $)*
Burundi	859	-2.5	173
D.R. Congo	6,101	-5.6	110
Egypt	68,743	4.1	1,250
Eritrea	681	5.2	198
Ethiopia	6,716	4.1	100
Kenya	9,791	1.7	350
Rwanda	1,813	-3.6	230
Sudan	8,383	7.3	290
Tanzania	5,552	2.9	210
Uganda	6,944	7.1	310

Source: World Bank, *African Development Indicators 2000*.

Table 1.6. Composition of GDP

	Agriculture (% of GDP)	*Growth rate (1990–98)*	*Industry (% of GDP)*	*Growth rate (1990–98)*	*Services (% of GDP)*	*Growth rate (1990–98)*
Burundi	52.4	-1.8	17.1	-6.3	30.0	-1.9
DR Congo	60.4	2.8	17.3	-13.3	20.9	-14.6
Egypt	14.9	2.8	30.4	4.2	47.1	4.0
Eritrea	--	--	--	--	--	--
Ethiopia	--	--	--	--	--	--
Kenya	26.1	1.1	13.4	2.0	45.7	3.6
Rwanda	35.2	-5.0	23.6	-1.8	39.2	-3.1
Sudan	--	--	--	--	--	--
Tanzania	42.4	3.6	14.2	1.9	35.2	2.3
Uganda	40.3	3.6	15.7	12.1	33.7	8.2

Source: World Bank, *African Development Indicators 2000*. Dash indicates data unavailable.

Sustainable development should be the main objective in managing the Nile River Basin. The Nile Basin urgently needs to alleviate widespread poverty, which if left unaddressed could get worse as human populations increase and people must use unsustainable practices to survive. Once people are forced to use natural resources unsustainably, their resource base disappears quickly and with devastating effects on local, national, and regional economies.

Improved land and water management are essential to achieving food security and alleviating poverty in the Basin. Conversely, alleviating poverty and improving food security are requisites for achieving sustainable development of land and water resources. Attention must be paid to meeting the resource needs of the poorest upland inhabitants as well as those of the expanding urban population.

Government Policy Response

Environmental and natural resources can be protected by a variety of means, and debate exists as to which method works best for which resources. Most analysts believe that secure ownership or user rights create incentives. At the same time, there are "resources," including the ambient environment, that by their nature cannot be "owned" in the sense that "nonowners" can be excluded from their enjoyment. Protecting such resources requires public policies and institutions. Without private ownership or strong institutions for their protection, natural resources will be abused and degraded in the face of population pressure, poverty, and economic development.

Few strong institutions exist in the Nile Basin for protecting resources and the environment. Few of the riparian nations have well-staffed ministries overseeing the environment and natural resources. Because of limited capabilities, many governments delegate responsibility for resource and environmental management to regional and local institutions. While there is much to be said for assigning authority and responsibility to management units who are close to the area where environmental problems are experienced, it is also true that local institutions are generally even less well equipped than national organizations in terms of staffing, budgets, and legal authority.

Many of the riparian nations have yet to establish ambient water quality standards or goals. There appear to be few links between discharge permitting and in-stream standards. While some major point sources are subject to environmental permits, it is not clear that such requirements apply throughout the Basin. When subject to discharge permits, industrial facilities typically are assigned the task of monitoring their own effluent and filing periodic reports with government agencies. The effectiveness of this approach and the degree of enforcement against violations are questions that need to be evaluated. The actual specifications of permits and their enforcement are important research questions that could not be answered within the scope of this project.

To date there is only limited use of market-based mechanisms or other approaches to harness market forces. No examples of effluent fees for industrial or municipal dischargers were identified in the course of the present study. Water monitoring stations are often unmaintained, and there seems to be little public disclosure of water quality or point source discharge data. Sharing of data on water quality with authorities in other riparian nations appears limited.

Several of the Nile Basin nations have some experience with water pricing, primarily as a means of recovering a portion of water delivery cost. Egypt imposes relatively high charges for industrial use of water. These prices are substantially above delivery cost and are used to cross-subsidize residential users, whose payments cover only a portion of the operating and maintenance costs of water supply systems. Water pressure in Cairo is so low that many residential users have running tap water for only part of the day, and tenants in multistory buildings install pumps to lift water to their apartments. With few exceptions, agricultural users do not pay for water, although efforts are under way to impose charges to recover a portion of operation and maintenance costs. Egypt imposes sewage charges on residential users that cover a portion of operation and maintenance costs and imposes charges on industry for effluent discharges.

Until 1991 Tanzania supplied water to rural areas without charge, and imposed only modest charges on urban residential users. A policy put into effect in 1992 now requires that urban users pay the full cost of water delivery and that rural users pay at least a portion of the cost. The tariff schedule differentiates among classes of users such that commercial and industrial users pay more than full delivery cost while residential users pay much less than full cost. Those with sewage connections pay a water delivery surcharge for the service. Agricultural users in rural areas are heavily subsidized. Collecting charges for water delivery presents a continuing problem with bills not delivered in some cases and many users months or even years behind on payments while experiencing no disruption in service.

About 90 percent of the population of Uganda lives in rural areas, where less than one-half have access to safe drinking water (Table 1.7). About 34 urban centers in Uganda have access to some type of piped water. The policy instituted in 1971 of free water supply was changed in 1984 with charges designed to encourage conservation and to make water utilities self-supporting. Because metering is far from universal, charges for unmetered residences are based on the number of taps, and unmetered institutions pay based on the number of employees. Commercial and industrial users pay several times as much as households per cubic meter of water. Where sewage connections exist, users pay a surcharge for sewerage services. The public attitude that water should be free remains strong and many users are delinquent in their payments. Because there is little irrigation in Uganda, no system has been established for charging rural users who divert rivers or streams to their fields.

Access to safe drinking water is a public health concern. People with unsafe water experience higher rates of infant mortality and infectious disease than do people with safe water supplies. In urban areas of Egypt, Sudan, and Tanzania, access to safe water has actually fallen in recent years because urbanization has outpaced the expansion of water service. Due to the failure to price water to recover the full cost of delivery, there has been inadequate incentive to economize water use, and water supply authorities have inadequate financial support to expand supply.

Table 1.7. Percentage of Population with Access to Safe Drinking Water by Country

	1988		*1993–96*		
	Urban	*Rural*	*Urban*	*Rural*	*Total*
Burundi	92	27	97	55	58
D.R. Congo	62	16	89	26	--
Egypt	100	90	95	74	84
Eritrea	--	--	--	--	7
Ethiopia	--	--	90	20	26
Kenya	--	--	74	43	45
Rwanda	--	--	79	44	--
Sudan	100	20	84	41	60
Tanzania	80	--	65	45	49
Uganda	45	12	60	36	42

Source: World Bank, *African Development Indicators 2000*. Dash indicates data unavailable.

Land and resource tenure rules in many Nile countries present an obstacle to private land stewardship. Communal rights apply to many important resources such as land and wildlife, although the precise rules differ significantly among and even within countries. With communal rights, individuals might respect the resources and manage them in a sustainable fashion. However, communal rights can easily deteriorate into open access when exclusion of outsiders cannot be enforced or communities are not cohesive. Under open access, no individual has an incentive to care for the land or the resource. Tradition dictating that the same agricultural plots revert to the same families each year encourages responsible management. A lack of physical ownership or traditions of access creates a reluctance to make investments necessary to protect the land. Many of the grazing lands truly are open access, so individuals have little incentive to protect against overgrazing, loss of soil cover, or erosion. While these problems are well recognized, finding acceptable solutions is difficult.

Box 1.2. Land Tenure Arrangements: Sudan

The right to own, bequeath, and inherit property in Sudan was established by the permanent constitution of 1973; this right was suspended in 1985. Sudan had long maintained a system of land registration through which an individual, an enterprise, or the government could establish title to a piece of land. Such registration had been extensive in northern Sudan, especially in Khartoum, Al Awsat, and Ash Shamali provinces. Before 1970 all other (unregistered) land belonged to the government, which held ownership in trust for the people, who had customary rights to it. In 1970 the Unregistered Land Act declared that all waste, forest, and unregistered lands were government lands. Before the act's passage, the government avoided interfering with individual customary rights to unregistered land, and in the late 1980s it again adhered to this policy.

The government owned most of the land used by the modern agricultural sector and leased it to tenants (for example, the Gezira Scheme) or to private entrepreneurs, such as most operators of large-scale, mechanized, rain-fed farming. In the late 1980s, however, the great area of land used for pasture and for subsistence cultivation was communally owned under customary land laws that varied somewhat by location but followed a broadly similar pattern. In agricultural communities, the right to cultivate an area of unused land became vested in the individual who cleared it for use. The rights to such land could be passed on to heirs, but ordinarily the land could not be sold or otherwise disposed of. The right was also retained for land left fallow, although in Bahr al Ghazal, Aali an Nil, and Al Istiwai communities existed where another individual could claim such land by clearing it.

Among the communities of the north, the rights to cultivated land were much the same, but the dominant position of livestock in community activities had introduced certain other communal rights that included common rights to grazing land, the right-of-way to water and grazing land, the right to grass on agricultural land unless the occupier cut and stacked it, and the right to crop residues unless similarly treated. In the western savannas, private ownership of stands of hashab trees could be registered, an exception to the usual government ownership of the forests. But dead wood for domestic fuel and the underlying grass were common property. Water, a matter of great importance to stock raisers, was open to all if it was freestanding, but wells that had been dug and the associated drinking troughs were private property and were retained by the digger season after season. In northern Sudan, especially in the western savanna where increasing population and animal numbers have exerted pressure on the land, violations of customary laws and conflicts between ethnic groups over land rights have been growing. Local government agencies have attempted to resolve these problems, but only on a case-by-case basis.

Source: Congressional Research Service, *Sudan: A Country Study* 1991.

Box 1.3. Land Tenure Arrangements: Egypt

Prior to 1952 land ownership in Egypt was highly concentrated in a few hands. The top 0.1 percent of owners held one-fifth of the land, and the top 5 percent controlled 65 percent of the land. In addition, nearly one-half of the rural inhabitants were landless. The new government initiated a phased land reform program that targeted for distribution the property of the upper class of landowners. The 1952 land reform law limited individual ownership to 200 feddans (approximately one acre, or 0.4 ha). The beneficiaries were to be tenants, estate workers, and the poorest villagers. The 1952 law was followed by laws in 1961 and 1969 that aimed at deepening the reform and further reducing the maximum size land holding. The ceiling was reduced to 100 feddans in 1961 and to 50 in 1969. According to official statistics, 864,500 feddans were redistributed, equivalent to about 12 to 14 percent of the cultivated area, and more than 341,000 families, primarily tenants who presumably were more skillful at farming than other workers, received land.

Official accounts indicate that some reduction has occurred in the area owned by the upper stratum, those with 50 or more feddans. However, the number of small owners, those with fewer than five feddans has increased substantially, while the area they own has declined. This suggested that land fragmentation worsened as a result of the continual division of land among heirs in accordance with Islamic inheritance laws.

Land tenure rather than land ownership, however, reflects how land is actually operated in Egypt. Land is either operated by the owner with family and/or hired labor, rented for cash, or sharecropped. The system is complex in that the same person might be engaged in several arrangements simultaneously. The operational unit is called the hiyazah (holding); cooperatives (see below) keep records of such holdings in allocating government crop quotas and amounts of subsidized inputs. The tendency is for the number of holdings to be smaller than that of ownerships, indicating that in actual practice a measure of consolidation takes place. Nevertheless, by the end of the 1970s, the average size of a holding was somewhat less than two feddans; figures are not available for any period subsequent to the 1970s. The small average size of individual holdings undoubtedly has a major adverse effect on efficiency in Egyptian agriculture.

To implement its agricultural policy, at the outset the government established agricultural cooperatives in rural areas. Initially, only land recipients were obligated to join; by 1962 all farmers were required to do so. The cooperatives performed several functions. They consolidated resources through distribution of inputs; preserved private incentives, such as profits; determined responsibility for planting government quotas of particular crops, such as cotton; and bought the government share of procurement crops at prices fixed by the government. The cooperatives enhanced agricultural growth by encouraging the use of fertilizers and other inputs and a three-year crop rotation that the Ministry of Agriculture considered ecologically superior to the traditional two-year rotation.

Source: Congressional Research Service, *Egypt: A Country Study*.

Box 1.4. Land Tenure Arrangements: Ethiopia

In early decades the major form of land tenure in Ethiopia had been the *gult*, an ownership right acquired from the monarch or from provincial rulers who were empowered to make land grants. Gult owners collected tribute from the peasantry and, until l966, when gult rights were abolished, gult owners, in principle, exacted labor service as payment in kind from the peasants. Until the government instituted salaries for government service, gult rights were a typical form of compensation for an official.

Pastoralists inhabit Ethiopia's lowland periphery and the Great Rift Valley. The pastoral social structure is based on a kinship system with strong interclan connections; grazing and water rights are regulated by custom. Until the l950s, this pastoral life remained largely undisturbed by the highlanders, who intensely disliked the hot and humid lowland climate and feared malaria. Beginning in the l950s, however, the malaria eradication programs made possible irrigated agriculture in these areas. The government's desire to promote irrigated agriculture, combined with its emphasis on increasing tax revenues, placed pressure on many pastoralists. Concessionaires acquired tracts of traditional grazing land and converted them into large-scale commercial farms. The loss of grazing land to these concessions significantly affected traditional migration patterns for grazing and water.

In northern and southern Ethiopia, peasant farmers lacked the means to increase production because of the fragmentation of holdings, lack of credit, and the absence of modern facilities. In the south particularly, the insecurity of tenure and high rents dampened the peasants' incentive to increase production.

On March 4, l975, the government nationalized rural land without compensation, abolished tenancy, forbade the hiring of wage labor on private farms, put all commercial farms under state control, and granted each peasant family so-called "possessing rights" to a plot of land not to exceed 10 hectares. Tenant farmers in southern Ethiopia welcomed the land reform. But in the northern highlands, where communal ownership (*rist*) was dominant and large holdings and tenancy were exceptions, many people resisted land reform. Land reform had the least impact on the lowland peripheries, where the new proclamation gave nomads rights of possession to land they used for grazing. Not surprisingly, the large commercial estates opposed land reform.

Land reform destroyed the feudal order; changed landowning patterns, particularly in the south, in favor of peasants and small landowners; and provided the opportunity for peasants to participate in local matters by permitting them to form associations. However, problems associated with declining agricultural productivity and poor farming techniques persisted. Government attempts to implement land reform also created problems related to land fragmentation, insecurity of tenure, and shortages of farm inputs and tools.

Peasant associations were periodically compelled to redistribute land to accommodate young families or new households moving into their area. The process meant not only smaller farms but also the fragmentation of holdings, which were often scattered into small plots to give families land of comparable quality. Consequently, individual holdings were frequently far smaller than the permitted maximum allotment of 10 hectares. One problem related to security of tenure, which was threatened by increasing pressure to redistribute land and to collectivize farms. Many peasants were reluctant to improve their land because they feared not receiving adequate compensation for upgrades. Another problem developed as a result of the military government's failure to provide farmers with basic items like seeds, oxen, and fertilizer.

Source: Congressional Research Service, *Ethiopia: A Country Study.*

Climate Variability

Climate variability, manifested by droughts and floods, has long plagued the Nile Basin (Table 1.8 and 1.9). The high variability of climate leading to high variability of stream flows, in conjunction with the large number of people dependent on floodplains, creates the potential for periodic disaster. Droughts and floods have direct effects on the natural environment; they destroy wetlands and other habitat, causing erosion, altering stream channels, and in other ways affecting the land and water resource. They have indirect effects through the actions of affected populations responding to the need for scarce food, shelter, and fuel brought on by disasters.

Data on droughts and floods are difficult to obtain for earlier periods in history. Tables 1.8 and 1.9 summarize data collected by the U.S. Agency for International Development (USAID) Greater Horn Information Exchange. These data should be considered indicators rather than absolute values. The apparent increase in incidents in recent years is thought to reflect more complete data collection, not a natural change. Information on current droughts and forecasts can be obtained from the USAID Famine Early Warning System. Forecasts incorporating global climate oscillations are currently made by the World Meteorological Organization and the U.S. National Oceanic and Atmospheric Administration. Recent scientific studies suggest that the effects of global climate oscillations appear in the long-run hydrological record of Nile flows (see, for example, Eltahir 1996).

Widely differing results of global circulation models show that the state of climate change research is, nonetheless, inadequate to permit long-term predictions of how Nile flows may be affected. Research does indicate, however, that future hydrological conditions in the Basin may differ substantially from those at present. It has been widely speculated in the scientific literature that climate may become more variable, leading to an increased frequency and severity of droughts and floods. The consequences of such increased variability for the Nile Basin is apparent. However, such predictions are uncertain.

Sub-Basin Concerns for Watershed Management

A pressing environmental challenge for the Nile Basin concerns the means by which valuable habitats, with unique animal and plant species, can coexist alongside expanding human populations and economies. While drylands constitute 76 percent of the land area of the Basin, the most critical areas for watershed management are the forests and wetlands. The latter constitute only 8 percent of the Basin, supporting fewer than 20 million people. Nevertheless, they are the most critical parts of the watershed for both habitat and water management. Table 1.10 suggests the dependence of human populations on different land cover.

The challenge for riparian countries is to manage land and water cooperatively so that the welfare of people *and* the environment improve across all of these land types. Integrated watershed management (Boxes 1.5, 1.6) is a tool that attempts to balance thee complex interacting demands of population, development, and sustainability. Although key issues for watershed management are similar across the major sub-basins, differences also exist.

Table 1.8. Historical Drought Disasters in the Nile Basin

Country	*Year*	*Killed*	*Affected*	*Region and comment*
Burundi	1943			No details available.
Ethiopia[a]	1993		6,700,000	Drought and pests damaged crops.
	1992		500,000	Eastern and southern.
	1991		6,160,000	Tigray, Wello, Gondar, Ogaden, Harer and other parts of the south.
	1990		6,500,000	Eritrea, Tigray, Harer, and Ogaden.
	1989		2,300,000	Northern Ethiopia, Eritrea, Tigray, Wollo, Gondar, Harergeup to 3.8 million people at risk.
	1987	0	7,000,000	Eritrea, Tigray, Wello, and Shewa most affected.
	1987	367	330,000	Ogaden; extensive livestock losses.
	1983	300,000	7,750,000	Wollo, Tigray, Eritrea, Shoa, Gonder, Harerge, and Sidamo; estimates of killed range from 250,000 to 1 million.
	1979	157	25,000	Southwest Gamo Gofo; dysentery epidemic.
	1978	0	140,000	Famine; Wollo, and Tigre provinces.
	1977	0	300,000	Famine; Wollo and Tigre provinces.
	1975			Kangra.
	1973	100,000	3,000,000	Tigre, Wollo, northern Shoa.
	1969	0	1,700,000	Hamasion division.
	1965	2,000	1,500,000	Nationwide.
Kenya	1992			No details of region.
	1991		2,700,000	Worst drought in 50 years; northeastern region most severely affected.
	1990		1,200,000	Northern and northeastern districts; worst maize crop in 10 years.
	1984		600,000	No details available.
	1979		40,000	Turliana district.
	1971		150,000	Countrywide.
	1965		260,000	Dry belt.
Sudan	1991		8,600,000	Drought in west and poor agricultural conditions in central, eastern, and northern provinces.
	1983	0	40,000	Maban.
	1983	150	8,400,000	Countrywide, especially western provinces; figure for persons killed estimated by U.S. Committee for Refugees.
	1983	0	1,000,000	Northern regions.
Uganda	1988	0	600,000	Northwest; poor seasonal rains and hail storm.
	1987	0	331,000	Karamoja; crop failure due to inadequate spring rains; figure is number of persons needing food assistance.
	1979	0	500,000	North and northeast, especially Karamoja.
	1967	0	25	Karamoja.

a. Some data for Ethiopia include Eritrea.
Source: U.S. Agency for International Development (2000)

Table 1.9. Historical Flood Disasters in the Nile Basin

Country	*Year*	*Killed*	*Affected*	*Region and comment*
Burundi	1989	7	3,600	Bujumbura; about 1,000 homes and over 2,000 ha crops destroyed; five people missing.
Egypt	1998			Nile flooding: 50 houses swept away in a village near Cairo; 40 houses washed away and aid distributed to villages in the south.
Ethiopia[a]	1990		350,000	Gambela region; storms and flooding destroyed thousands of homes.
	1988	45	2,240	Sidamo province/Dollo; flash flood; thousands of animals drowned.
	1985	9	8,000	Rift valley region.
	1978	9	1,000	No details available.
	1977	0	16,000	Awash river valley.
	1976	0	50,000	Gode, Kelafo, Mustahil.
	1968	1	10,000	Vicinity of Kelafo.
Kenya	1982	75	3,000	Flash flood near Lake Victoria.
	1977	100	20,000	Widespread.
	1975	0	16,000	No details available.
	1968			Nyanza and western provinces.
	1964	0	15,000	Nyanza and western region.
Sudan	1998		1,000,000	Worst floods for more than 50 years touched 18 of Sudan's 26 states, affecting about 1 million people of whom over 100,000 were displaced; dramatic increase in incidence of malaria, diarrhea, and other water-related diseases. Damage included 165 primary schools destroyed and another 438 damaged; portion of the Khartoum-Port Sudan road destroyed; production in irrigated agricultural sector seriously reduced; up to 20 percent of date palm trees destroyed; large losses of livestock. Preliminary cost estimate for emergency recovery program was US$230 million.
	1988	96	1,500,000	East-central Sudan, including Khartoum and environs; hundreds of thousands of homes destroyed; severe damage to hydroelectric turbines and other infrastructure. Return period estimates: 10 years for Blue Nile at Khartoum, 100–150 years for Atbara at Kilo; 35–100 years for Nile at Dongola.
	1983	0	2,000	Flash floods, Mundri district.
	1983	0	100,000	Heavy rains; Kassala.
	1978	34	100,000	Gezira province.
	1975	0	145,000	Gash river (central and eastern).
Uganda				No flood disasters noted.

a. Some data for Ethiopia may include Eritrea.
Source: U.S. Agency for International Development (2000)

Table 1.10. Human Dependence on the Different Components of the Nile Basin

Land cover in Nile River Basin component(s)	*Approx. area (km^2)*	*Population (millions)*	*Human dependence*
1. Developed/urban	32,500	30	Hydropower, domestic and industrial water supply
2. Wetlands	195,300	20	Irrigated and flood recession, arable land, livestock production, fisheries, wild plants and animals, domestic water supply and transport
3. Forest	65,000	0.2	—
4. Cropland	325,500	33	Irrigated and flood recession, arable land, livestock production, fisheries, wild plants and animals, domestic water supply, transport
5. Irrigated cropland	163,000	25	Irrigated and flood recession, arable land, livestock production, fisheries, wild plants and animals, domestic water supply
6. Shrubland	130,182	2.6	Dry season pasture, wild plants and animals, domestic water supply
7. Grassland	1,366,913	27	Dry season pasture, wild plants and animals, domestic water supply
8. Desert/semiarid	976,367	7	Dry season pasture, wild plants and animals, domestic water supply
Total	3,254,555	145	

Source: For areas, see Revenga and others (1998).

Box 1.5. Concepts and Principles of Watershed Management upon which the Watershed Framework and Approach Are Based

The watershed framework represents a holistic approach for planning and analysis of land and water. Watersheds are topographically delineated areas that are drained by streams. They are physical systems that facilitate the analysis of water flow and quality, the means by which water is affected by land use and, in turn, how water affects land use.

Watershed management is the process of organizing and guiding land and other resource use in a watershed to provide needed goods and services (e.g., food, fuelwood, fodder, water, wildlife) without affecting adversely soil and water resources. Watershed management explicitly recognizes the interrelationships among land use, soil, and water, and the linkages between uplands and downstream areas.

Watershed boundaries seldom coincide with political boundaries. The boundaries of cities, states, or countries are rarely based on watersheds. Furthermore, even organizations that have responsibilities for land and water management (e.g., forestry, agriculture, hydropower, irrigation) are seldom organized around watershed boundaries. As a result, decisions about land and water use are often made within boundaries based on political or organizational areas of responsibility.

Conflicts arise when people's use of water and natural resources adversely impact riparian neighbors. Conflicts are difficult to resolve unless and until the political and watershed issues can be resolved. The challenge is to develop policies and institutional arrangements that integrate the two points of view.

Sources: Brooks and others (1992, 1997); Brooks and Eckman (2000); Eckman, Gregersen, and Lungren (2000); Griffin (1999); Montgomery, Grant, and Sullivan (1995); Novotny (1999).

Box 1.6. Steps to Improve Watershed Management

Step 1: Identify the key environmental issues of concern in the sub-basin. Many of these have already been highlighted for the overall Basin, including land degradation, water pollution, sedimentation of reservoirs, loss of wildlife habitat, deforestation, etc.

Step 2: Identify the root causes of environmental degradation; drivers that are to be considered include (i) population density and growth in rural and urban areas, (ii) economic growth and poverty, and (iii) policy and institutional limitations.

Step 3: Determine how people respond to the drivers (causes) and the environmental consequences of these responses. These must be identified and analyzed for each sub-basin. They would include responses such as (i) conversion of native forests to cultivated fields leading to deforestation, increased flow of water, accelerated soil erosion, etc.; (ii) stocking of livestock on rangelands at levels that exceed the carrying capacity of the land and subsequent soil erosion; (iii) excessive fuelwood harvesting leading to deforestation, loss of wildlife/bird habitat and native forests; (iv) burning of animal dung for cooking and heating in rural households leading to loss of nutrient capital for soil and declining land productivity; (v) development of irrigation schemes (small-scale irrigation, water spreading and water harvesting, dam construction, etc.) leading to reduced water available downstream and impaired downstream water quality; (vi) increased urban discharge of human waste leading to water pollution and reduced fish production, increase in human diseases, etc.; (vii) damming of rivers for hydropower affecting fish migration, altering flow regimes downstream and flooding upstream land/habitat; (viii) draining of wetlands and conversion to agriculture leading to reduced flood storage, increased flooding downstream, stream bank erosion, loss of wildlife habitat, etc.

Step 4: Identify the constraints and barriers that must be overcome to reverse adverse environmental consequences, including (i) insecure land and resource tenure that affect people's long-term vision of land and water management, (ii) lack of infrastructure, (iii) absence of well-conceived policies and institutions that can cope with watershed and transboundary concerns and inequities that may exist in watersheds between those who pay for watershed improvements and changes in land use and those downstream communities who benefit, (iv) lack of knowledge and appropriate technologies, and (v) insufficient resources.

Step 5: Determine the economic and environmental benefits to be derived from improved watershed management: (i) the welfare of rural poor is enhanced through increased productivity of the land; (ii) increased flows of higher quality water for upstream and downstream users, resulting in (a) improved health of people through improved quality of drinking water, (b) reduced localized flooding and flood damages, (c) increased fish production, (d) reduced sedimentation and extended reservoir life to meet the economic needs of people; (iii) improved aquatic and terrestrial ecosystems, benefiting fish and wildlife habitat; and (iv) increased land productivity that can relieve pressures for exploitation of remaining natural forests and rangelands, thereby protecting and sustaining critical habitats and biodiversity.

Step 6: Develop a blueprint for reversing environmental degradation that transcends country boundaries and is mutually beneficial. Include considerations of (i) the biophysical realties of watersheds that must be blended with social and economic realities within regions and countries to arrive at workable solutions; (ii) appropriate policies to integrate the political point of view and political boundaries with the reality of watershed boundaries, such as those that promote through education and extension the recognition by users of land and water that they should be responsible (accountable) for the impact of their actions on others; policies should provide the necessary incentives for stakeholders through direct public investments, fiscal measures, or regulatory arrangements; (iii) institutional arrangements for planning, coordinating, and implementing improved land and water management; and (iv) applying participatory approaches that involve all levels of stakeholders, from the rural poor to the highest levels of government.

Equatorial Lakes

The sub-basin of Lake Victoria and the Rift Valley lakes has major interest for Tanzania, Kenya, Uganda, Burundi, and Rwanda. Sustaining the health and productivity of these lakes, tributary streams and their fisheries, wildlife populations, and the overall landscape are important to the population in this sub-basin. All of these objectives depend on maintaining healthy and productive watersheds that are coming under more and more pressure from an expanding human population that in turn demands more and more from the watersheds.

Population density and growth, poverty and urban expansion are key drivers of land and water use. The expanding urban population is impacted by the land and water use of rural inhabitants and, in turn, exerts additional pressures on water supplies and, through production of municipal wastes and pollution, on the water quality of the lakes and fish resources.

Rain-fed agriculture, grazing, and agroforestry practices dominate land use in much of the watersheds. Forest harvesting for fuelwood and other products also occurs in selected areas. The challenge for resource managers is to develop the means by which these human activities can coexist with the valuable and critical wildlife habitats in the region. The ecosystems in this sub-basin contain extensive biodiversity, scenic beauty, and vital wildlife habitats that have great value for tourism in the region. But it is also evident that efforts by the rural poor to increase food production and demands for fuelwood in these watersheds result in deforestation, overgrazing, and cultivation on steep slopes. These actions pose serious environmental threats to the wildlife habitats and adversely impact water flow to the lakes. The upstream-downstream linkages are easily recognized here because of the proximity of watersheds and the lakes.

According to the World Bank, total forest cover in the Congo, Kenya, Tanzania, and Uganda diminished from 1980 to 1995. It is important to note that natural forest cover has been reduced the most; from 1990 to 1995 all these countries reported decreases in natural forest areas. The latter includes Burundi and Rwanda, two countries that actually experienced an increase in overall forest cover from 1980–95. The expansion of forest plantations in all the countries must be factored into the reported overall changes in forest cover. Incremental reductions in forest cover, as reported, may appear as small percentage changes overall. However, the cumulative effects of deforestation directly increase water flow from watersheds, and increase surface soil erosion, sediment delivery, and nutrient export downstream. Loss of native forest should be of the highest concern as it affects wildlife habitat. Although it is unclear the extent to which these deforestation figures can be related directly to watersheds in the equatorial lake sub-basin, or for the Nile River in general, this is an environmental issue of concern. Uganda provides a good case study for what is occurring in this sub-basin, because it is here that widespread deforestation has not only impacted habitat but has also increased soil erosion, affecting the livelihood of 90 percent of Uganda's population that depends on the land for crop cultivation and grazing.

Uganda is concerned that the resulting sedimentation is causing lakes, rivers, and streams to become shallow. Along with nutrient loading, eutrophication is occurring, which in turn adversely affects fish production. Forestland in Uganda is presently 21 percent of its 1890 level; gazetted forests are 14,900 km^2 (7.7 percent of land area), including 7,500 km^2 in savannah

woodlands, 5,900 km^2 in tropical high forest, and 1,500 km^2 in montane catchments (Ministry of Natural Resources 1994). In addition to encroachment by cultivators, deforestation in Uganda results from gathering fuelwood in a country where approximately 90 percent of the population depends on wood for energy, and this accounts for 70 percent of the energy consumption. Given the issues of poverty and resource tenure, the control of forest removal is a challenge for all these countries.

In Tanzania, where only 3 percent of the total land area is dense forest, the annual consumption of 43 million cubic meters of fuelwood is considered unsustainable. In an effort by the government to limit forest cutting, licensing is now required to remove wood from public and private lands (Tanzania 1997).

Arresting deforestation and expanding the forest resource base is considered vital for Uganda's development, according to the new economic policy framework established in the National Conservation Strategy. An imbalance exists between fuelwood demands and wood yield: demands cannot be met on a sustainable basis. Furthermore, there are important linkages between the forestry and fuelwood situation and agricultural development. The agricultural sector accounts for 45 percent of GDP, whereas forestry is only 5.5 percent of GDP. However, this may not accurately represent the true value of forests in reducing soil erosion-sedimentation and in sustaining high-quality stream flow. In addition, there is an indirect consequence of reduced forest cover for land productivity. When fuelwood is in short supply, the soil nutrient capital can become depleted on subsistence farm areas when animal dung is burned in place of fuelwood, and is thereby not available as fertilizer for crops. The Ethiopian Forestry Action Program (Ethiopia Forestry Action Program 1993) estimated that burning of animal dung and crop residues in 1990 reduced cereal production by 100,000 tons (one-fifth of the average harvest and enough to feed 4 million people).

Stakeholder groups in this sub-basin encompass the entire spectrum of population groups identified earlier, from urban dwellers to pastoralists, rain-fed agriculturalists, and fishing communities. Improving watershed conditions and water quality of lakes in the basin will benefit these groups, particularly fishing communities. All riparian countries in this sub-basin would directly benefit from programs that (i) reduce point source (urban) and nonpoint source pollution to the lakes (e.g., sediments, agrochemicals), (ii) coordinate management of fisheries to avoid overfishing and to achieve equity among communities, (iii) control exotic flora and fauna (e.g., water hyacinth), (iv) protect streams, riparian areas, and wetland systems that are integral to these lakes, and (v) improve the vegetative condition of upland watersheds.

Lake Victoria is a dominant feature in this sub-basin and is the focus of much transboundary concern. It is Africa's largest lake with a total surface area of 68,800 km^2, an area larger than all of Switzerland. It is, however, shallow with a maximum depth of only 80 m. The shores of the lake, bordering Uganda, Tanzania, and Kenya, are fairly densely populated, and the lake serves a variety of important socioeconomic purposes. Most importantly, the lake is fished commercially using trawlers and by artisans using seines and lines from beaches and canoes. But near the shore artisanal fisheries are in decline.

Lake Victoria plays a vital role in providing drinking water for the major urban areas and lake shore communities and provides cheap animal protein to the surrounding peoples. Other

water resources of Lake Victoria contribute to the welfare of human populations in the lake basin, which is also the most agriculturally productive and industrialized region in Uganda. The lake is distinctive for its long residence time and its dependence on rainfall to maintain water balance.

During the past decade research conducted on Lake Victoria (see USAID/NEMA 1998; Madete and Kisanga 1998) revealed that the lake has undergone profound changes during the last 30 years, and its aquatic resources are endangered by these changes. Many aspects of water quality have steadily deteriorated, and it is now certain that the lake has eutrophied. This is seen in the dramatic changes in the nutrient concentrations of Lake Victoria, with an observed drawdown of silica that is even more extreme than that found during eutrophication of lakes in temperate waters. The lake also exhibits relatively high concentrations of phosphates compared with other large lakes in the world. The present concentration of phosphate has doubled since the 1960s so that it is now in excess of that required to support the algal standing crops.

In addition, the algal biomass or chlorophyll levels of Lake Victoria have increased fivefold since the 1960s. The nitrogen cycle has changed tremendously to support the increased biomass. The algae that fix nitrogen now have a biological advantage in Lake Victoria, as evidenced by the dominance of blue green algae as algal blooms have become intense and common. These blooms are a potential threat to water quality through production of phytotoxins that further degrade the water environment and are accompanied by a dramatic reduction in the lake's transparency and clarity. Concomitantly, thermal and oxygen stratification of Lake Victoria is now more pronounced and prolonged than reported in the 1960s when Lake Victoria was characterized by a weak thermal and chemical stratification throughout most of the year. The oxygenated habitable water volume has decreased and may limit the habitable area for aerobic communities, especially fish. Oxygen depletion leads to fish kills during intense vertical mixing and puts in doubt the sustainability of the current high fish yield and biodiversity in Lake Victoria. Coincident with these changes in the water quality have come species invasions and massive extinctions of the endemic fish of the lake. Fish species composition and diversity have decreased dramatically while fish yield has increased five times.

Reductions in the tremendous diversity of the endemic fish species of Lake Victoria may be partly explained by the current changes in water quality, especially anoxia and the dominance of blue green algae that are unpalatable to fish and other aquatic organisms. In addition, loss of herbivore or enhanced nutrient recycling seem to stimulate algal production and biomass and, consequently, affect the biotic properties of the water. These, and perhaps climatic changes, have combined to cause a reduction in biological diversity. This decline has been exacerbated by the proliferation of water hyacinth.

The primary cause of the changes in the water quality of Lake Victoria is not known. It is likely that it is related to nutrient enrichment, but there is still a lack of knowledge regarding the sources and magnitude of pollution in the lake. There is also still uncertainty regarding other factors that facilitate nutrient buildup. The alteration in the trophic structure with a reduction in herbivorous fish, and a subsequent rise in algal biomass, may have contributed to the current changes. Thermal stratification and mixing patterns also may explain some of the observed changes.

Cooperation in the management of Lake Victoria and its catchment has developed through the Lake Victoria Environmental Management Program, the Lake Victoria Fisheries Organization, the Lake Victoria Fisheries Research Program, the FAO Regional Lake Victoria Water Resources Project, and the East African Cooperation. There exists here a model for integrated catchment management, including the accumulation of necessary data. The formation of a Lake Victoria Management Institution (Andjelic 1998) is an example of the kind of cooperation needed to deal with all transboundary issues of the Nile Basin. Such cooperation needs to involve not only governments but also nongovernmental organizations (international, regional, national, and local) and civil society, since all are stakeholders in the Basin.

Given the importance of wildlife habitat in the region, the improvement of upland forests, woodlands, and grasslands can be justified on the basis of maintaining wildlife habitat and biodiversity, which have economic benefits associated with tourism. Kenya, Tanzania, and Uganda have enormous areas of biodiversity and critical wildlife habitat that are threatened by high population densities and poverty. Throughout the area, extensive national parks with grasslands and savannas provide valuable wildlife habitat. Within the Nile Basin, Uganda is especially rich in wildlife resources; it is a crossroads of dry-wet/upland-lowland areas with key migration routes. The major declines of large mammals both within and outside of protected areas (national parks and preserves) in many areas is largely the result of the loss of habitat, which is itself largely the result of resource demands by the rural poor. There are direct economic implications, since tourism related to forest wildlife constitutes the third largest source of foreign exchange earnings behind coffee and cotton (Ministry of Natural Resources 1994).

A key point is that in order to protect and sustain the important wildlife resources in the Basin, the respective countries must deal with the major causes of diminished wildlife habitat. Improving land use by improving the welfare of the rural poor is essential to such change. The Basin needs innovative programs that can protect indigenous habitats and biodiversity while simultaneously improving watershed conditions through improved land use practices accepted by rural farmers.

Deforestation and loss of wildlife habitat can be mitigated to some extent by the development and expansion of land use practices such as agroforestry that provide needed wood, forage, and food resources without exploiting remaining natural forest and woodlands. Stall feeding of livestock has been used successfully in the Basin as well as in other parts of the world. However, changes in land use must be compatible with local culture and traditions. The presence of the International Center for Research in Agroforestry, headquartered in Nairobi, is a regional resource that can provide technologies suited to the region. Cooperative efforts, as discussed above in regard to the Lake Victoria Basin, also show promise.

Often missing in programs aimed at resolving environmental problems is the recognition of watershed benefits, such as improved water quality, reduced sedimentation, and so forth, that accrue to people on the land and those dependent on the downstream flow of usable water. Given the dependence of many countries on the lakes in this region, clear incentives exist for countries to work together to develop policies, plans, and programs that are mutually beneficial.

In this sub-basin as in others, most of the important environmental problems are well known. In some cases the important linkages between resource use and environmental impacts

are not completely understood. The actions needed to improve watershed conditions and the resulting benefits of biodiversity, water quality, and land productivity may be known, but corrective actions are often not taken. Weak policies, a lack of institutional mechanisms to implement programs, and the lack of economic and other incentives often present barriers to appropriate action. For the key environmental issues in the Basin to be addressed, both in-country and transboundary policies and institutional arrangements that provide the appropriate incentives for the key stakeholders must be developed.

Lower Altitude Watersheds

The extensive wetlands of the southern Sudan and the region of the lower elevation areas of eastern Ethiopia and Uganda are positioned in the Basin so that they receive water flow from portions of the Ethiopian highlands and the equatorial lakes. Yet, in some respects, they provide a buffer to the White Nile during periods of flooding. Inhabitants receive the by-products of degraded watersheds and pollution upstream, and through their use of land and water, they in turn alter the quantity and quality of water flow into the Nile. Poverty and food insecurity present paramount problems in this region with large populations of pastoralists who are vulnerable to the effects of droughts and desertification.

The 30,000 km^2 Sudd wetland in the southern Sudan is a major feature in this region. It is the largest freshwater wetland in the Nile Basin, stretching from Bor in the south to near the Sobat confluence, just upstream of Malakal in the north and westwards along the Bahr el Ghazal. The size of the Sudd varies from season to season and year to year. Between 1961–63, a great increase in the area inundated by water occurred when the level of Lake Victoria rose and its outflow suddenly increased, an increase that persists to this day. The total area is related to the amount of water reaching Bor from the Albert Nile but also from the "torrents" or seasonal flows from the watercourses in northern Uganda and just north of the Sudan border that can add substantial amounts to the flow in the upstream end of the Sudd. Pastoralists utilize the Sudd and surrounding areas extensively; livestock and rain-fed agriculture are the dominant means of support for the largely rural population, and the seasonally flooded grasslands along the Sudd provide valuable grazing lands for the rural poor.

Hydrologically, the Sudd plays an important role in storing floodwaters and trapping sediment from the White Nile, which ultimately benefits communities along the Lower Nile River and Lake Nassar (Box 1.7). However, over 55 percent of the water entering the wetlands is lost from the downstream Nile River through evapotranspiration, and thus only half the flow of the Bahr el Jebel at Bor reaches the northern outlet of the Sudd. Some of the flow of the Bahr el Ghazal is also lost here. It is not surprising then that downstream communities in Sudan and Egypt have an interest in diverting flow around the Sudd to enhance the supply of water downstream. Such schemes date back to ancient times. Earlier plans sought to bypass the Sudd in order to save 7 percent of the Nile's eventual flow to Egypt by way of the Jonglei Canal, which would have also reduced the area of the Sudd wetlands by around 35 percent. But the project was stopped by civil unrest in the region. Such diversions can bring with them many unwanted effects, which need to be fully investigated from a watershed and wildlife habitat perspective.

Box 1.7. Management Options and Biodiversity in the Sudd

In the case of the Sudd, it has been suggested that a better long-run solution to improving flowthrough might be to modify such structures as the partially finished Jonglei Canal so that only half as much water is bypassed. It may be that at its present size the Sudd and its goods and services are far more valuable to the Nile Basin in general and the global economy (considering biodiversity) in the long run than providing any extra water downstream. Or it may be that the people can find alternatives if the Sudd is reduced in size. But what about the Sudd biodiversity and its presently uncalculated values? The answer is to gather the necessary information and determine the economic/environmental costs and benefits, rather like an environmental impact assessment. Alternatively, investigation of the upstream water supply, its timing and levels, may find another solution when combined with the needs of the recipient ecosystem, the Sudd. It could be that using the bypass during only one season may not affect the wetlands too much and benefit the downstream users more. Thus every such decision should consider the greater Nile River Basin and its functions. This is especially true of water-dependent ecosystems, as there may be solutions that rely on environmental interpretations of an apparently hydrological problem. For example, an upstream storage that released an increased flow to enhance the Sudd flooding process at the critical time combined with a bypass might yield enhanced benefits to all and provide other services further upstream.

Reduced water flow within the vast permanent and seasonal wetland habitats in this area, which comprise permanent reed wetlands (Papyrus and Typha), aquatic emergent grasses (*Vossia cuspidata*), and seasonally inundated grasslands (dominated by Echinochloa and native Oryza species), would impact many population groups in the sub-basin. Many people, livestock, and fisheries depend on the lakes, seasonal pools, permanent and seasonal channels, and rain-flooded grasslands that make up the Sudd complex. A large population of pastoral and agricultural inhabitants are supported by this system. Thus the proposed bypass of the Sudd in order to "save" waters for downstream use would have large effects on the immediate users within the system itself. To provide support to pastures, as well as livestock and wildlife habitats, and to allow for fisheries, flood control and flow buffeting services, the Sudd needs to be periodically flooded.

This sub-basin can benefit from improved watershed management, including wetland and grazing management. Sustainable use of natural resources is constrained by waterborne diseases, political instability, and poverty. However, actions taken in this sub-basin that affect water use and diversions of water from wetland areas have important Basin-wide and downstream implications. Transboundary agreements and policies to address these issues need to be pursued.

White Nile

The confluence of the White Nile and Blue Nile is also a major feature of this sub-basin, which has large dams and reservoirs that provide hydropower and flood control and maintain river flows. The large Roseires reservoir and the downstream Sennar reservoir are affected by water and sediment flow from the Ethiopian highlands. The rate of sedimentation contributed to each of these reservoirs from upper elevation watersheds, although said to be significant, is not known. The two large reservoirs would certainly benefit from improved watershed conditions in the uplands. On the White Nile, the large Jebel Aulia Dam and reservoir, located just upstream of

Khartoum, is affected largely by the natural features of the arid lands to the south and the riverine wetlands that evapotranspire large quantities of water that are thus lost to downstream users. Such wetlands play an important role of trapping sediment that would otherwise flow into these reservoirs. With the vast arid watersheds and extensive grazing in the region, sediment levels can be high, although rates of sedimentation are unavailable.

Land use in the Ethiopian highlands, as it affects the flow of the Blue Nile, represents the most important environmental impact on the large reservoirs. The urban center of Khartoum and, ultimately, all areas in the sub-basin benefit from the reservoirs through hydropower production, flood control, and flow maintenance, and thus benefit from healthy watersheds above these reservoirs.

The Ethiopian highland wetlands and the riverine system that connects them to the Machar Marshes in Sudan are also an important multiple habitat system. The high-altitude wetlands of Ethiopia serve as mediators of stream flows that attenuate flood peak flows, and these watersheds represent perennial streams that feed rivers such as the Baro, which in turn feeds the Sobat River and ultimately the White Nile. In Ethiopia, the Didesa River feeds the Abay River and the Blue Nile. Recent studies of these upland wetlands (Ethiopia Wetlands Research Project 1998) show that water is passed slowly through the system throughout the year, a process that has been interrupted by drainage for agriculture.

The Baro River in high flow (August-September) spills into the Machar Marshes in Sudan a vast wetland habitat that reduces the volume of flow into the White Nile. The Machar wetlands also receive local rainfall and surface flows from numerous torrents that descend from the Ethiopian highlands. This water moves slowly across the marshes in braided channels and small streams to reach the Nile system much later in the season and maintains the Nile flow long after the rains have passed.

The main river channel at that point is not deep or wide enough to take the increased flows of the high water season, which usually lasts for several months between May and October. Water thus spills over the banks and side channels into the surrounding floodplain where it seeps both laterally and parallel to the main channel so that the flood expands and sweeps gradually northwards. Permanent wetlands become deeper and the seasonally inundated grasslands of the pastoral people, the principle end-users here, become flooded. The water and sediment sustains the yearly cycle of their life and migration pattern. The size of the flooded area varies from year to year, but the permanent wetland seems constant. Using remote-sensing imagery, it was estimated in 1980 that there were 16,200 km^2 of permanent wetland and 13,600 of inundated grasslands.

The flood waters slowly move northwards and reenter the main channel to produce the outflow, combined with the waters of the Bahr el Ghazal, which has been greatly reduced by evapotranspiration (and lateral storage in the surrounding flood plain). The flood takes much longer to reach Hillet Dolcib than water in the main channel, so that the high flows of the rainy season are buffered and the output from the Sudd is much less peaked than its input, further contributing to a sustained flow of the main river.

Lower Nile

Egypt and the lower Nile Basin are the major beneficiaries of sustained flow of high-quality water below the Aswan Dam. Large urban centers and ambitious irrigation schemes are at the heart of watershed issues in this part of the Basin. Water flow from the White Nile is critically important to sustain Lake Nassar, which is the primary source of water to meet the demands for irrigation and water supply of the large urban areas adjacent to the river to the Lower Nile. Issues of concern include accelerated sedimentation of Lake Nassar and reductions in stream flow entering the reservoir. It is clear that people living in the Lower Nile River Basin are the major beneficiaries of high-quality water flow from the upstream riparian countries. The development of institutions such as river basin commissions can play a role in cooperatively managing international rivers and lakes, and developing mechanisms to cope with inequities that arise (upstream people paying the costs for soil and water restoration and conservation, and downstream people reaping the benefits).

Eastern Highlands

The highlands of Ethiopia, called the "Water Tower of Africa," are the most critical watersheds of the Basin, contributing 60 to 80 percent of water flow to the Nile River (Sutcliffe and Parks 1999). Large rural populations and intensive land use have led to overgrazing, cultivation of hill slopes, and deforestation. High annual rainfall (more than 1,500 mm in higher elevations) and steep slopes combine to produce watersheds vulnerable to degradation from such land use (Box 1.8). The resulting soil erosion and loss of native vegetation not only threatens the welfare of the rural poor (amounting to more than 80 percent of the population of Ethiopia), but can potentially increase levels of sedimentation being passed on to downstream channels and reservoirs. An important transboundary issue concerns the contributions of sediment from the Blue Nile to the Roseires and Sennar reservoirs in the Sudan. Perhaps of greatest concern to downstream communities is the possibility of Ethiopia expanding its irrigation program through large dam construction, which could result in both diminished quantity and quality of flows to the Nile. The interconnected nature of all such water development schemes in this sub-basin must be understood to avoid unwanted environmental effects and potential conflicts with downstream parties.

Issues pertaining to poverty and food security within this sub-basin as well as elsewhere are linked to population growth and density, political instability, lack of infrastructure, and often the lack of policies and institutions. All of these are the ultimate causes of watershed degradation. Given the high rainfall and fertile soils in much of the highland sub-basin, the potential to increase the productivity of the land and increase overall watershed health appears to be good, but whether or not this potential can be realized depends upon the social, economic, and political situation of Ethiopia.

The decline in arable land has decreased the size of effective land holdings of a vast majority of subsistence farmers who comprise 90 percent of Ethiopia's 55 million people. Many farmers lack sufficient land to meet their nutritional needs. In addition, droughts, outbreaks of pests, and soil erosion have led to a 1.4 percent decrease in per capita per year agricultural productivity over the past 20 years (Ethiopia Forestry Action Program (1993). It is encouraging

that the Ethiopian government's conservation strategy stresses integration of environmental protection with agricultural development, recognizing that neither can be accomplished without the other (Federal Democratic Republic of Ethiopia 1996).

Box 1.8. The Highland Wetlands and Riverine System

The wetland-river system in the Sudd described earlier will obviously be sensitive to change in the quantity of water flows. Given the large increase in population expected in this area over the next quarter of a century, it is inevitable that changes will occur, and they will have large impacts downstream. Under normal conditions the Baro River bypasses the southern Machar Marshes until, at high flow, it flows over its northern banks and provides water to the Machar wetlands. If the stream flow remains low, no water can enter the marshes from the Baro. If water was extracted or stored upstream of this overflow so that the peak flows were reduced to a level that did not permit spillage northwards, the area of seasonally flooded marshes would be significantly reduced with serious effects on livestock and wildlife dependent on that wetland. This indicates that any dam built for storage and hydropower generation on the upper reaches of the Akobo or Baro Rivers must be reviewed for its ability as a regulator and flexible control structure. The goal would be to alter the rise of the Baro as little as possible because this is the system that sustains the southern Machar Marshes. Similarly, proposed dams on the Blue Nile need to be planned to coordinate with river flows, silt loads, and seasonal effects so that they harmonize with ecosystem and end-user needs downstream.

The quality of water released from such dams needs to be monitored and managed in terms of retention time, inflows, and local catchment concerns so that the waters downstream are affected within acceptable limits. Recipient ecosystems downstream will have different requirements. The first requirement is to know the size and timing of sediment load and water quantity needed to maintain floodplains and seasonal wetlands, as well as the stream bed and course per se. Even the spawning of fish (in both lakes and rivers) needs to be considered by upstream managers to ensure that the right amounts and qualities are provided at the correct seasons to sustain both subsistence and commercial fisheries.

Forest cover has declined dramatically in Ethiopia. From the 1950s to 1989, forest cover decreased from 16 percent to 2.7 percent of the land area (Ethiopia Forestry Action Program 1993). As noted previously, natural forest cover has continued to decrease from 1980 to 1995, even though there have been significant plantations established.

Historically, woody plants have been considered common property available to anyone, discouraging people from planting trees. Without the proper incentives, rural people do not have the long-term vision to invest labor and other resources in tree planting or any other technologies aimed at maintaining the productivity of the land. Box 1.9 offers a good example.

The potential for watershed improvements within the highland sub-basin include the following:

- With respect to reforestation and afforestation, less than 3 percent of the land area of the country remains as natural forests (Ethiopia Forestry Action Program 1993). Since nearly 80 percent of the rural population depends on wood for their major source of energy, forest cover should be increased to meet these demands (through plantations and peri-urban forests) as well as to improve the condition of watersheds on steep slopes.

- Small-scale irrigation practices such as water spreading and water harvesting have the potential to increase food production (Catholic Relief Services, personal communication with Dr. Tom Remington, CRS, Nairobi, 1999) and thereby relieve pressures of deforestation and overgrazing on the remaining natural areas.
- Agroforestry and improved grazing systems offer the potential for improved production for the rural poor.

If the above improvements are to be realized, policies must be in place to provide the necessary incentives for people to improve their use of the land and natural resources, including the planting of trees and protection of native forests. Improved soil and water conservation require a long-term planning horizon.

Box 1.9. South Kalu Project in the Ethiopian Central Highlands

The South Kalu project area is a food-deficient area 330 km north of Addis Ababa. It lies in the northern portion of the Ethiopian central highlands and has two primary agroecological regions with the following characteristics: (i) uplands surrounding the valley and mountainous, upper reaches that are forested (protected by the national government) as well as erodible, stony soils and a high-population density; heavy grazing and cultivated slopes result in soil mass movement, gully erosion, and surface erosion, and (ii) lowland areas and a floodplain with deep soils as well as marshlands, most of which are uncultivatable. The nonwet areas are productive and more suitable for cultivation than uplands. Rainfall is bimodal with small spring rains (February-May) and heavy summer rains (June-September), but is erratic and often insufficient. Droughts are common. Low infiltration rates and high runoff from uplands concentrates water in floodplains and marshes. The primary source of water for domestic and agricultural uses are unprotected natural springs, runoff surface water, and hand-dug wells. Many households do not have direct access to a water source.

The area has good agricultural potential for irrigation, livestock development, and agroforestry. Important economic factors in this area include the lack of sources of energy other than fuelwood, lack of cash credit, lack of skills, and poorly developed markets and transport infrastructure.

This nongovernmental organization project contained several elements to improve watershed conditions in the area. Environmentally related activities in the project area include (i) forestry—tree nurseries with free distribution of indigenous and exotic multipurpose tree species—fruit and cash crops (e.g., coffee), combined with training; (ii) water supply development—wells, ponds, hand pumps developed to irrigate vegetable gardens; (iii) soil conservation measures—afforestation and conservation works, terracing, and check dams.

In evaluating the effects of these environmentally related activities, the following lessons were learned: (i) Community woodlots were abandoned because of the lack of policy on land tenure; support shifted to planting private woodlots; individual households have benefited from fruit trees; (ii) water supply activities were not widespread; inappropriate technologies were a problem; different approaches were needed in the uplands versus lowlands; (iii) policies need to be in place to reduce erosion. Soil conservation efforts dwindled as a result of banning the Food for Work program. A lack of continuity in incentives prevented the achievement of long-term benefits of soil and water conservation.

Factors that constrained attainment of environmental goals were summarized as (i) insecurity of tenure, (ii) natural long-term cycle needed for environmental benefits to accrue, and (iii) ban on food-for-work incentives.

Watershed Management

There are good reasons for the people of the Nile Basin to develop coordinated and mutually beneficial plans for use of land and water resources. Most people in the Basin are affected by populations upstream of themselves, and they in turn affect people living downstream through their own use of land and water. Production of the land and protection of the environment are interdependent; the sustainable production of food and use of natural resources depends on sound soil and water management.

Watershed degradation produces and sustains poverty because a degraded watershed does not provide a sustainable or desirable flow of goods and services, and exerts even greater pressures on threatened plant and animal systems. Degraded watersheds export excessive sediment and poor quality water and alter stream flow regimes so that downstream communities—including urban areas—are affected. It is in the interest of all riparians that degraded watersheds be restored to productive states, and that healthy watersheds be sustained.

The watersheds and sub-basins of the Nile represent well-defined systems that should be, but often are not, the focus of natural resource planning and management. The concept of watersheds is useful in addressing wide-ranging aspects of land and water use, and is particularly pertinent to transboundary issues in the Nile Basin. It is an approach founded on the realization that understanding and improving the welfare of people and their use of land and water resources in watersheds is of paramount interest.

Maintenance of biodiversity is one of the many benefits of sound watershed management. The upland forests, woodlands, grasslands, riparian systems, wetlands, streams, rivers, and lakes all provide habitat for the rich biodiversity in the Basin (as described in appendix A). These terrestrial and aquatic ecosystems are connected through the flow of water, and thus biodiversity can be influenced through changes in land use and subsequent changes in the quantity and quality of water flow. Some of the transboundary issues, such as migratory birds and their habitats, are not necessarily confined to watershed boundaries. Nevertheless, knowledge of and planning for land and water use linkages can be important in coping with a wide variety of transboundary biodiversity issues.

Some plant species are threatened in the Basin due to overuse of the land and its cover or as a result of land clearing for various types of development (Table 1.11). Information is not available on the flora of the Nile Basin as a floristic area. However, it is possible to illustrate the comparative importance of the Basin flora by comparing the total for all plant species in at least three of the Basin countries whose flora lie for the most part within the immediate Basin region. The IUCN species total (10,619) lies midway among countries of high endemism—for instance, South Africa (23,420 species), the entire Democratic Republic of the Congo (11,000 species), Cameroon (8,260), and the whole of Tanzania (more than 10,000 species). In other words, if the Basin is taken as a whole, the number of threatened plant species, both endemic and nonendemic, is high. Certainly, the same case can be made for bird, fish, and mammal species.

The immediate causes of loss of biodiversity have to do with deforestation and general degradation of the land and wetlands, and, in some instances, direct impacts on water bodies, with resultant loss of habitat. These can all be addressed through improved planning and

implementation of watershed management. Other, nonwatershed factors include crop and livestock farming, encroaching on protected areas, poaching, overfishing, and introducing hybrid breeds of crops and livestock as well as exotic species. In nearly all instances, developing solutions to the loss of biodiversity requires dealing with the root causes. Although most would look to actions such as deforestation, land degradation, and water resource degradation as causal factors, it is more often poverty, the absence of adequate institutions and policies, inadequate environmental monitoring, and lack of awareness by the local population. The development of integrated watershed management programs to reverse overall land and water degradation and related loss of biodiversity must also consider these root causes before sustainable actions will be realize results.

Table 1.11. Endemism of Plant Species in Three Nile Basin Countries

Country	*Total of vascular plant species*	*No. of endemics*	*% endemics in country*	*Number threatened*
Uganda	5,406	15	0.3	30
Sudan	3,137	10	0.3	50
Egypt	2,076	82	3.9	70
Total	10,619	107	0.01	150

Source: Davis, Heywood, and Hamilton (1994); Walter and Gillett (1998).

Rivers, lakes, and aquifers shared by more than one country are international resources. Use of the resource in one nation—whether for consumption or waste disposal—affects the quantity and quality of the resource available to other nations. Among the roughly 300 international rivers worldwide, the Nile River is unusual in that it is shared by a large number of riparian countries. Only the Danube River has as many. The large number of riparians, and the important differences among them in terms of water needs, suggests why a comprehensive strategy for managing the Nile waters has yet to evolve (Box 2.1).

Economic Framework

International waters have at least four functions: (i) to meet human needs (irrigation, municipal and rural water supply, power generation, recreation, and fisheries); (ii) to provide a medium for waste disposal; (iii) to sustain wildlife habitat; and (iv) to define and shape the landscape through transport and storage of water, nutrients, and sediment. To date, attention has primarily focused on withdrawals to meet human needs and on the means by which international waters should be shared for such purposes. Relatively few examples from anywhere in the world exist in which water quality or wildlife habitat held important considerations in the design and implementation of international water agreements.

Shared Approach

What principles might be used to forge a water management agreement for the Nile? Several doctrines have been noted, some giving primary consideration to the needs of upstream countries (doctrines based on territorial sovereignty), some allocating primary consideration to downstream nations (doctrines based on territorial integrity), and others encouraging consideration of mutual needs (community of interests, equitable use) (Box 2.2). In the international water disputes successfully resolved in recent years, mutual needs have been an important consideration. It is also noteworthy that no single doctrine is universally accepted or accepted by a majority of nations worldwide. Rather, the various doctrines have served as a starting point in negotiations aimed at resolving international disputes.

These water rights principles have guided the design of several international treaties and conventions concerning water resources (Table 2.1). Of the water treaties and conventions identified, only one is a generic agreement on international waters: the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes, often referred to as the Helsinki Convention. All other treaties deal with specific international rivers and lakes. Among the international agreements, the Helsinki Convention comes closest to the shared vision that waters should be managed to maximize joint benefits to the signatories.

The Helsinki Convention lists 27 European nations as parties, plus the European Community (Table 2.2). The convention calls for discharge limits for hazardous substances at point sources based on the best available control technology. Since the objective of the convention is to prevent adverse impacts on transboundary waters, signatory nations with shared water bodies

agreed to use environmental impact assessments and consider basinwide impacts in their individual environmental management strategies.

Box 2.1. Historical Agreements Pertaining to the Nile Basin

The May 1902 treaty between Great Britain and Ethiopia established the border between Sudan and Ethiopia. In signing the 1906 agreement between Great Britain and the Independent State of the Congo, the Congo agreed not to impede the flow of water from its territories into Lake Albert without Sudan's permission. The 1925 exchange of notes between Britain and Italy acknowledged the historical right of Egypt and Sudan to the use of the Nile waters, and opposed construction or development on Lake Tana that would have impeded the flow of the Blue Nile into Egypt and Sudan.

The 1924 Britain and Belgium Protocol defined the boundary between Tanganyika and Ruanda-Urundi at Lake Tanganyika and determined rights of fishing and navigation.

The 1934 Great Britain and Belgium Agreement dealt with water rights on the boundary between Tanganyika and Ruanda-Urundi, dividing them in equal parts. In addition, the agreement addressed industrial and mine pollution issues. Inhabitants of both territories were given full navigation rights on both sides of the boundary as well as rights to fish and harvest aquatic plants.

The May 1929 Agreement between Egypt and Anglo-Egyptian Sudan gave Egypt the right to veto any construction project that would adversely affect her interests.

The 1949 exchange of notes between the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of Egypt authorized the construction of the Owen Falls Dam in Uganda.

The 1950 Exchange of Notes between Britain (on behalf of Uganda) and Egypt established a basis for hydrometerological cooperation with a focus on hydropower production.

The 1959 Egypt-Sudan accord established the average annual flow of the Nile to be 84 km^3 and allocated that flow between Egypt and Sudan. The agreement granted the right to construct the High Aswan Dam and the Roseires Dam and established the Permanent Joint Commission. Sudan agreed to enhance the Nile's water flow by preventing evapotranspiration losses of the Sudd, and the cost and benefits of this project development were to be shared equally between the two countries.

The 1977 Agreement Between Burundi and Tanzania, later joined by Uganda, established the Organization for the Management of Development of the Kagera River Basin. Its purpose was to provide for development, mobilizing natural resources of the basin for hydroelectric power production, irrigated agriculture, mining, wildlife management, forestry, livestock, fisheries, and transportation. Uganda joined the agreement in 1981.

The 1993 agreement of the Governments of Kenya, Uganda, and Tanzania established a tripartite commission for economic cooperation. In June 1994 the Lake Victoria Fisheries Organization was established under the auspices of the commission to "foster cooperation … to harmonize national measures for the sustainable utilization of the living resources of the lake and to develop and adopt conservation and management measures." In October 1998 the three governments signed a Memorandum of Understanding on Cooperation on Environmental Management that included provisions for joint management of the Lake Victoria ecosystem. In December 1999 the governments adopted the Treaty for the Establishment of the East African Community. The provisions of the earlier memorandum of understanding on environmental cooperation were incorporated into the treaty, including provisions for joint management of the Lake Victoria Basin.

Box 2.2. Doctrinal Principles for the Management of International Rivers

What principles might be used to forge a water management agreement for the Nile? As noted, no single doctrine has universal acceptance by the riparian nations of the Nile or by a majority of the nations of the world.

The doctrine of absolute territorial sovereignty states that a nation may use any amount of water flowing into its territory for consumption or for disposal of wastes. This doctrine, which in effect asserts the right of an upstream nation to use the water with little or no regard to adversely affecting downstream nations, was claimed in the late 19th century by the U.S. attorney general in rejecting Mexico's claim to waters of the Colorado River. The United States subsequently recognized a part of Mexico's claim in a 1944 agreement between the two nations.

Absolute territorial integrity is a contrasting doctrine under which a downstream nation claims the right to an uninterrupted flow of a fixed quantity of usable water from upstream countries.

The doctrine of prior appropriation grants rights to use water based on the time sequence under which users began to use the water. The doctrine is sometimes termed "first in use, first in right." Under this doctrine, water rights may be transferred provided that the transfer does not harm other parties. For rivers such as the Colorado in arid parts of the United States, water use is allocated according to this principle.

The doctrines of limited territorial sovereignty and limited territorial integrity state that every nation has the right to use the water flowing in its territory provided that the use does not harm the territory or interests of other nations. These doctrines recognize the reciprocal rights and obligations of nations in the use of water. Although these are commonly used approaches, they fail to provide adequate bases for resolving problems when demands for water or water quality exceed available supplies. Who must sacrifice to bring supply and demand into balance? Representatives of some upper basin nations have expressed the perspective embodied in these doctrines.

The doctrines of community of interest and equitable use try to take mutual interests of riparian nations into account. The community of interest doctrine states that no nation may use waters in its jurisdiction without consultation and cooperation with downstream nations. That doctrine appears to be the guiding principle in many of the river basin agreements signed by members of the European Community, including the agreement governing cleanup of the Rhine River.

Equitable use states that each nation in a river basin is entitled to a reasonable and equitable share of water for consumption and disposal of pollution. This principle attempts to take into account the respective needs of the various riparian nations in a basin. The water-sharing agreements for the Syr Darya in Central Asia could be characterized as based on the principle of equitable use.

The concept of maximum mutual benefit as a means of resolving international water disputes derives from the notion that welfare in a region is maximized if water quantity and quality are used by those who place the highest value on the resource. Such a "shared vision" includes the responsibility that water users adequately compensate those who forego some uses for the collective welfare of all relevant nations. This concept is at the heart of the recent water quantity agreements signed by Kazakhstan, Kyrgyzstan, and Uzbekistan, where downstream republics transferred energy resources to the upstream republic to obtain a different delivery schedule for waters stored in the Toktogul reservoir. It also is the guiding philosophy in the water transfer program of California's Central Valley Project. That program allows historic water users (farmers) to sell their allocations to new users with higher values (principally cities that need water for expanding municipal and industrial needs).

Table 2.1. Selected International Water Treaties and Conventions

International water treaties and conventions	
Agreement Concerning the Regulations of Lake Inari by Means of the Kaitakoski Hydroelectric Power Station and Dam	1959
Agreement on the Action Plan for the Environmentally Sound Management of the Riverbed Rio Pilcomayo	1995
Agreement on the Cooperation for the Sustainable Development of the Mekong River	1995
Agreement on the Preparation of a Tripartite Environmental Management Program for Lake Victoria	1994
Boundary Waters Treaty (United States and Canada)	1909
Convention Creating the Niger Basin Authority	1980
Convention Creating the Organization for the Development of the Senegal River	1972
Convention on Cooperation for the Protection and Sustainable Use of the Danube	1994
Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki Convention)	1992
Convention on the International Commission for the Protection of the Elbe	1990
Convention Relative to the Status of the Senegal River	1972
Fourth ACP EEC Cooperation	1989
Great Lakes Water Quality Agreement	1972
Indus Basin Development Fund of the Niger Basin	1980
International Commission for the Protection of the Rhine against Pollution	1950
Protocol Relating to the Development Fund of the Niger Basin	1980
The Indus Basin Development Fund (Supplemental) Agreement	1964
Treaty for Amazonian Cooperation	1978
Treaty on the Rio de la Plata Rio Vertrag	1969
Treaty Regarding Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande	1944
UN Convention on the Non-navigational Uses of Transboundary Watercourse Systems	1997

Maximizing Mutual Benefits

Managing international waters to maximize mutual benefits—the central goal of the Nile Basin Initiative—represents a step beyond the 1992 Helsinki Convention or the 1997 UN Convention. This principle would consider all potential uses in a basin, evaluate the contribution of each potential use to economic well-being in the basin, and allocate water for both consumption and waste assimilation according to where it creates the greatest value to all. Allocations made in this fashion would do the most to improve living standards in the basin. Moreover, development would be more apt to be sustainable, since potential future uses also would be taken into account.

How could such an approach be introduced? A straightforward, effective method would be to apply market principles: beneficiaries pay for water deliveries, and polluters pay for using water as a medium for waste disposal. Water would be used where it adds the greatest value. If urban dwellers were willing to pay substantial amounts for potable water supplies, their demands would receive priority over a polluter upstream that contributed relatively little to well-being or agricultural users that could pay only modest amounts for the water they used. Farmers with the most productive soils could justify paying more for water than could farmers with marginal lands. Hence only the more productive agricultural lands would be irrigated. Municipalities

would be encouraged to treat their discharge of sewage, since they too would have to pay for their use of water as a place to discharge wastes.

Table 2.2. Signatories to the 1992 Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes

Nation	*Date entered into force*
Albania	October 6, 1996
Austria	October 6, 1996
Belgium	Not ratified as of March 1, 1997
Bulgaria	Not ratified as of March 1, 1997
Croatia	October 6, 1996
Denmark	Not ratified as of March 1, 1996
Estonia	October 6, 1996
Finland	Not ratified as of March 1, 1996
France	Not ratified as of March 1, 1996
Germany	October 6, 1996
Greece	October 6, 1996
Hungary	October 6, 1996
Italy	October 6, 1996
Latvia	March 10, 1997
Lithuania	Not ratified as of March 1, 1997
Luxembourg	October 6, 1996
Moldova	October 6, 1996
Netherlands	October 6, 1996
Norway	October 6, 1996
Poland	Not ratified as of March 1, 1997
Portugal	Not ratified as of March 1, 1997
Romania	October 6, 1996
Russian Federation	October 6, 1996
Spain	Not ratified as of March 1, 1997
Sweden	October 6, 1996
Switzerland	October 6, 1996
United Kingdom	Not ratified as of March 1, 1997

Within countries, water is sometimes allocated through market mechanisms. This same principle, however, is used less often among countries that share international rivers or lakes. Great benefits result from using markets within a country. If the same principles can be applied across countries, greater benefits would accrue to those who share international waters. The international allocations could be achieved through water pricing or through tradable allocations.

The allocation of water through market mechanisms implies that those who pay the most get to use the water—for consumption or for waste disposal. Another implication is that charging water users raises substantial sums of money. These sums can be used as an income-sharing mechanism to compensate those who receive less water than they had historically. Farmers with marginal lands that are no longer irrigated would be compensated (indirectly) by farmers with productive lands that can be irrigated. Those who receive less get paid by those who receive more. Water is used where it is most productive and everyone benefits.

Prevention versus Remediation

Any environmental management program creates tension between remediating the legacy of past activities and preventing future impacts. The adverse effects of historical practice are seen everywhere, while the results of preventive actions may not be apparent for many years. Indeed, successful preventive actions may result in no significant adverse impacts, and thus there will be nothing to see. As a result, there is a bias toward remediation, while prevention gets relegated to an undefined future time. Remediation, however, can be exceptionally expensive, in that it usually involves physical activities to counteract the impacts of a long period of environmental abuse. Greater progress can often be made by addressing prevention, which in many cases can be achieved by correctly changing economic incentives (by imposing user fees, for instance) or by some similar policy of modest cost. Preventive actions could be readily promoted by explicitly taking environmental concerns into account in national development planning, mandating environmental assessments and audits, and promulgating national policies with respect to pollution prevention and control.

Policy Framework

International law governing transboundary water resources has evolved rapidly over the last 50 years. In earlier times, the focus of international water law was principally resource development and allocation; today that focus extends to water quality. Two recent international conventions on the protection and management of shared international waters deal with quality issues among other things: the 1997 United Nations Convention on the Non-navigational Uses of Transboundary Watercourse Systems and the 1992 United Nations-ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes. The 1997 convention represents the culmination of a 20-year effort by the International Law Commission to translate evolving transboundary water resource management principles into international law.

The need to cooperatively manage international lakes and rivers, thereby minimizing conflicts over their use, has led to a number of international commissions for river basin management. Transboundary environmental issues affect river basins around the world and have been a focus of concern in most regional water management programs. The World Bank and other international organizations have tried to derive lessons of good practice from earlier water resource management programs by studying factors that contribute to as well as inhibit success. Most of these lessons learned deal with water supply, power production, and economic development. But lessons can also be taken with respect to good practices for transboundary environmental management.

Sustainable development of water resources necessarily involves environmentally sound management. (see, for example, GFID 1998a, 1998b). Because many environmental issues are inherently transboundary, their management necessitates an approach that brings together riparians from the entire basin of an international river, both the organizations developed to address water and environmental management and those concerned with specific activities on the ground adopted as part of environmental management programs. Important lessons learned can be grouped within the following broad categories:

- For transboundary agreements to evolve, riparian nations must have the political will to negotiate in good faith.
- The playing field must be level. All riparians must have a voice in the process of negotiation to ensure success.
- Once negotiated, plans should be specific, achievable, pro-active, and flexible.
- Stakeholder awareness, buy-in, and participation are necessary to success.
- A shift in economic and management approach from supply-side to demand-side and from top-down controls to private sector involvement is important.
- Good management practices are a prerequisite to success.

The conventions, treaties, and national initiatives noted above share some common characteristics. In each the parties established broad goals and objectives for protection of the river system that serves as the basis for the framework. The policy tools, technical analysis, and management measures designed to support overarching goals and objectives include several themes:

- Agreement on institutional arrangements for management of the agreement or implementation of an action plan.
- Agreement on the uses and their relative priorities with respect to overall management of the common waters to be protected.
- Identification of the highest priority threats to those uses.
- Development of stream standards and criteria applicable to the river system to protect water quality and ecosystems.
- Joint surveillance monitoring and data sharing.
- Adoption of management principles, such as application of control technologies, preventive approaches, adoption of environmental impact assessment regulations, and economic incentives.
- Public participation and disclosure.
- Provisions for negotiations and dispute resolution.

Implementation takes place on the regional, national, and local level. Agreement on in-stream standards and water quality criteria, and surveillance monitoring in support of those standards, are joint tasks that must be coordinated at the international and national levels. However, implementation of management activities are most logically carried out at the national level where national legislation governs water quality protection, consideration of environmental impacts related to water withdrawals, requirements for environmental impact assessment, programs for ecosystem protection, hazardous waste disposal requirements, biodiversity programs, forest protection and conservation programs, and wetlands protection. In addition, activities undertaken at the local level, with full participation of the stakeholders, have proven in many instances the most effective means of achieving environmental results.

The readiness of the riparian states to fully participate in transboundary environmental management activities partly depends on each nation's national capacity. Transboundary environmental management requires national environmental legislation to be enacted or

harmonized for consistency with international agreements. It also requires the technical capacity of each country to enable full participation in dialogue and negotiation.

Water quality standards. There are typically three different types of environmental standards for water: treatment standards that apply to discharge sources, ambient standards that apply to surface waters, and drinking water standards that apply at a source of drinking water, including ground water sources. This chapter only addresses treatment standards and surface water quality standards. Treatment standards and water quality criteria were first conceived in the early 1970s in U.S. Clean Water Act. They are frequently the basis of many international agreements and national laws designed for environmental protection of water systems. Technology-based treatment standards define prescribed technologies for various industrial sources, and specify effluent levels for discharges that can become part of licensing agreements, or discharge permits, for various types of point sources of pollution. Ambient water quality standards apply to water bodies and vary based on the type of use to be protected. For example, stream standards for a pristine water body or one that is used as a source of drinking water might be more stringent that those for a water body used for irrigation. Technology-based controls are applied to industries located along a body of water. If ambient surface water quality standards for the water body into which the source discharges cannot be met with first-line technology requirements, then more stringent measures are typically required.

Adoption of stream standards as targets to meet water quality goals and objectives can be a good first step toward reaching common goals among basin nations of an international river system. Ambient standards can be used as a yardstick in which each riparian country can then determine the most cost-effective approach for meeting those standards through application of national laws and programs.

Discharge permitting. While adoption of ambient water quality standards can take place on the international and national levels as a means of achieving water quality goals and objectives, application of treatment standards and technological controls apply at the national level. Treatment standards, and corresponding effluent discharge limits, are effected through licensing and permitting processes elaborated in national water quality control legislation.

Although technology-based approaches are typically used with success in industrial nations, they are expensive. Accordingly, broad-based application may be impractical for developing countries. In addition, technological approaches, while effective in addressing point-source concerns, do not usually address nonpoint-source pollution, which may be a more pressing problem for rural areas. Therefore, application of technology-based approaches should be accompanied by complementary programs for prioritizing problems to address the worst problems first, pollution prevention approaches, and incentive-based programs, such as effluent discharge fees and public disclosure programs.

Water diversions can result in serious impacts on water quality and aquatic ecosystems. More attention is being given to environmental uses in the course of issuing water rights permits to ensure that increases in water diversions do not adversely affect aquatic ecosystems. This is effected either directly through an evaluation by the permitting agency, where environmental uses and impacts are considered in the evaluation of a specific permit issue, or through involvement of environmental authorities in the approval of water rights permits.

Water quality monitoring. There are two types of monitoring in support of water quality control programs. Surface water quality monitoring of an entire river system is generally undertaken to determine baselines and trends. Enforcement monitoring of specific discharge sites can be carried out locally to determine whether discharge limits are being met. Such monitoring can also be carried out as part of the licensing process in which the source has the burden of proof in showing that effluent discharges are within specified permit limitations. The source also bears the cost of such monitoring. Although some argue that allowing a discharge source to monitor its own effluent puts the fox in charge of the chicken coop, making monitoring results unreliable, strict quality controls and enforcement measures can do much to ensure the adequacy of such monitoring. Moreover, if governments are left with the cost burden of such monitoring, it is unlikely that most could afford it, and little enforcement monitoring would take place.

Water quality monitoring at the basin level is an important part of any transboundary water resources management activity. Reaching agreement on data collection and information sharing is one of the most difficult barriers faced by riparian states to agreements on the management of shared waters. Because monitoring can be one of the largest costs associated with management of water quality, it is important that priority issues be carefully framed and a monitoring design be carefully planned to ensure that data collected answers the right questions with regard to basin management goals and objectives.

Environmental Impact Assessment

The environmental impact assessment (EIA) was first required by the U.S. National Environmental Policy Act, which required environmental impact assessment of all major development projects to determine their potential for adverse effects on the environment. The EIA took a pro-active, preventive approach to environmental management, rather than relying solely on environmental remediation and mitigation. The concept later found its way into international conventions and has garnered broad acceptance as an effective means to prevent environmental degradation as a result of development projects. Although EIA provisions have not typically been applied to agricultural development projects, expansion of the application of EIA has been recommended as one way to reduce adverse impacts of irrigation expansion, including degradation of river basins (Postel 1996).

The first three stages of the impact assessment process—screening, preliminary assessment, and scoping—are extremely important in determining the extent and focus of the impact assessment required. The purpose of screening is to decide whether or not a project requires assessment and, if so, the level of assessment necessary. Past experience shows that certain types of projects are unlikely to have serious adverse environmental impacts. Other types have the potential to cause significant impacts and routinely require a comprehensive EIA. The extent of EIA required depends on the scale and complexity of the project and the nature of the local environment.

Within each riparian country, guidance to assist with the screening process may take several forms: screening criteria such as size, cost, or location of the project; lists of projects that do or do not usually require an EIA; and checklists of project and sensitive environmental con-

ditions that require further investigation. The types of projects that generally require an EIA include those that involve:

- Significant change in renewable resources use
- Substantial change in farming or fisheries practice

These account for transboundary impacts, but obviously screening criteria also need to include potential for air, water, and solid and hazardous waste discharges as well.

Strategic environmental assessment. A Strategic environmental assessment (SEA) is a pro-active tool for planning, policymaking, and environmental management. It is employed at a higher level and at an earlier stage of management than traditional EIAs. An SEA creates a framework in which to focus environmental impact assessment, environmental management, and environmental monitoring.

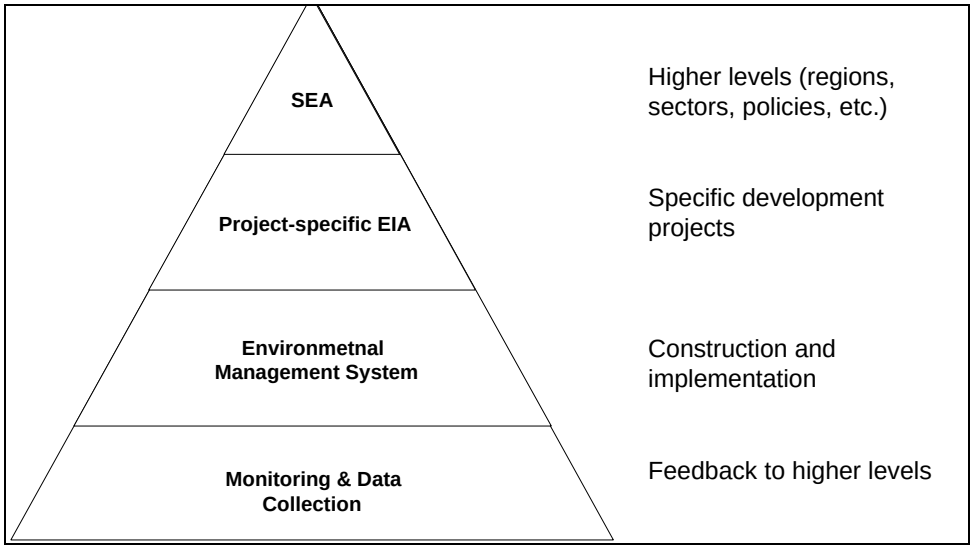
At present SEA is a generic term not yet linked to a clearly established methodology. While a few countries have attempted to codify SEA techniques, the limited practical experience available illustrates a range of goals, tools, techniques, and SEA processes. This process has recently evolved in response to the shortcomings of project-specific EIAs. The rationale for SEA is the following:

- To focus project-specific EIAs by ensuring that issues are addressed at the appropriate level of policy, plan, or program.
- To improve the assessment of cumulative impacts, particularly of policies and large projects that stimulate secondary and many small developments, each of which would not ordinarily warrant at EIA.
- To facilitate the application of sustainability principles and guidelines by, for example, focusing on the maintenance of a chosen level of environmental quality rather than minimizing individual impacts.

Comparing SEA and EIA. EIAs tend to focus on mitigating the impacts of proposed activities rather than justifying them and determining appropriate siting. SEAs differ from EIAs in a number of key respects. Most notably, SEA is a pro-active tool for environmental management, whereas EIA is used reactively to assess specific development proposals. Internationally, the practice of strategic environmental assessment has adopted many of the techniques of project-specific EIA. But because they deal with multiple impacts, including secondary and off-site ones, they are inherently more complex, sometimes requiring modeling approaches to analyze complex interrelationships and impact thresholds.

As noted, SEAs and EIAs are usually applied to different stages of planning and policy-making (SEAs earlier, EIAs later) and to different levels of decision-making (SEAs at the policy and planning level, EIAs at the individual project level). This has been referred to as a “tiered approach,” as shown in Figure 2.1.

Figure 2.1. SEA's Tiered Approach to Create a Framework to Focus on Environmental Impact Assessment. Environmental Management, and Monitoring



Note: Monitoring and data collection occupy the base of the pyramid, that is, they are necessary for all environmental management and planning functions depicted above them. Environmental management systems are tools employed at the plant level, EIAs are project-level tools, and SEA is a tool for earlier stage management such as policymaking and planning.

Implementing SEA. International experience reveals a number of important lessons for implementing SEA that can be summarized as follows:

- The initiation of SEA is a critical step because it includes screening of the proposal and obtaining the participation of stakeholders and community groups.
- The SEA approach must be tailored to the way policy and decision-making actually works, which is sometimes not in a clear hierarchical sequence.
- Screening of policy, planning, and proposal processes is needed to determine the most appropriate and effective stages at which an SEA should be applied.

Significant differences exist among the riparian countries of the Nile Basin in the application of EIA and SEA processes, and efforts are under way to harmonize the approaches (for example, in the EAC). One networking resource available to all riparians is the International Association of Impact Assessment (IAIA), an organization to which many individual Nile Basin scientists and technicians already belong. Although IAIA would probably not take on an active organizational role in coordination of the EIA and SEA processes in the Basin, it could possibly act as a type of clearinghouse or provider of information and application about EIA and SEA processes in other river basins worldwide.

Water Quality Control Programs and EIA Provisions of the Nile Basin Countries

Although acceptance of a shared vision for environmental quality among riparian states of the Nile Basin is an essential first step toward sustainable development, adoption of policy

tools at the national level that are not at cross purposes with the policies of other countries is essential for realization of that vision. If the countries already have national policies and laws in place that are consistent with those that could be applied within the context of a broader basin agreement, the task of reaching agreement becomes much easier. In this section we focus on two policy instruments for implementation at the national level: application of water quality control programs and provisions for environmental impact assessment requirements at the national levels of Nile Basin countries to ascertain the degree of similarity and difference among the riparian countries' national policies and programs.

During the conduct of this assessment, the team found that most of the Nile Basin countries have environmental legislation on the books that governs the protection of water quality, and that the application of differential surface water quality standards is well understood (Table 2.3 and 2.4). The approaches used in each of the countries are more similar than different and generally follow norms established in the international community. The same holds true for adoption of environmental impact assessment requirements. All of the countries have adopted in policy, if not in law, EIA requirements consistent with international norms. The countries are, however, at different stages of development of national legislation. While Egypt and Uganda have well-developed legal and regulatory frameworks, other riparian nations have laws in earlier stages of development. Nevertheless, the approaches of the policies and laws currently in place for the Nile Basin countries are close enough in principle that they could serve as substantial building blocks upon which to base common environmental goals and objectives for management of the Nile River system.

Coordination Efforts among the East African Riparians

The East African countries provide a heartening example of efforts to harmonize national laws on environmental standards and environmental impact assessment regulations to implement cooperation in management of shared natural resources. Kenya, Tanzania, and Uganda recently completed a UNEP/UNDP Dutch-sponsored activity to harmonize environmental standards and environmental impact assessment procedures and to develop a report on the legal and institutional issues in the Lake Victoria Basin. This effort may provide an excellent model for development of a regional environmental management framework for the broader Nile Basin. The effort was conceived in 1995 as part of an Africawide program that includes Malawi, Mozambique, South Africa, Sao Tome, Principe, Burkina Faso, and the combined subregion of Kenya, Tanzania, and Uganda (UNEP 1998).

An initial workshop of the East African subregional project was convened in February 1998. The workshop report reflects the areas of agreement for project activities in the following issue areas:

- Environmental impact assessment regulations
- Hazardous waste management
- Environmental standards
- Forestry management
- Wildlife management

In addition, the group decided to undertake an analysis of the legal and institutional framework for the protection of the environment in the Lake Victoria Basin (UNEP 1998, p. 64).

The three countries involved in this initiative—Kenya, Uganda, and Tanzania—are in various stages of the development process of their legal and policy frameworks for environmental management. In 1995 Uganda updated its environmental legislation to incorporate environmental policies articulated in its National Environmental Action Plan. The legislation provides mandates for control of air and water pollution and hazardous waste disposal, as well as requirements for environmental impact assessment, and protection of wetlands, biodiversity, and forests. By 1998 Tanzania and Kenya had completed national environmental policies and action plans but had not yet updated environmental legislation. Final harmonization reports for both countries indicate how results of the effort would be incorporated into national environmental laws. Kenya recently adopted new legislation. Tanzania is now in the process of drafting legislation. It appears that interaction at the regional level gave leverage to the process of enactment of national laws and perhaps accelerated the pace of enacting them.

Workshop reports stressed the importance of bringing these efforts under the auspices of the prevailing regional economic integration organization, the East African Commission. In October 1998 the permanent secretaries of the three countries entered into a Memorandum of Understanding for Cooperation on Environmental Management. The objective of the memorandum was to formalize efforts to cooperate and to ensure that these efforts became part of the proposed treaty forming the East African Community (Memorandum of Understanding Between The Republic of Kenya and the United Republic of Tanzania and The Republic of Uganda for Cooperation on Environmental Management. October 22, 1998, Nairobi, Kenya). The Treaty for the Establishment of the East African Community was concluded in December 1999, and included the recommendations of the memorandum of understanding in their entirety. According to an unpublished briefing note,

> this project may have had a major impact with a possible bottom up approach to treaty-making. The Permanent Secretaries requested the Joint Project for assistance in drafting a legally binding agreement on environment for the region (UNEP/UNDP/Dutch 1999, p. 7).

The final report on legal and institutional issues in the Lake Victoria Basin also stressed the need for a basin organization that addresses comprehensive management. One recommendation sought to expand responsibilities of the Lake Victoria Fisheries Organization and change its name to the Lake Victoria Organization to operate under the aegis of the East-African Cooperative Secretariat (UNEP/UNDP 1999).

Information needs. The need to develop information to develop basin management priorities may be an important priority for future funding. During our interviews with water resources management officials of the region, we found that Egypt and Uganda appear to be the only riparian states with ongoing water quality monitoring programs. Due to lack of funding and unmet human needs in other countries, particularly Burundi and Rwanda, water quality monitoring is a low priority for the governments. According to one author, “lack of extensive locally

derived scientific data, possibly reflects the first hurdle faced by anybody wishing to develop environmental standards." (UNEP 1998).

Training needs for water resources management and environmental impact assessment. Regional leaders in the field of water resources management with whom the team met during field visits emphasized the importance of training and capacity building in the area of water pollution control and management, watershed management, and environmental impact assessment. Development of expertise in water resource management has been identified as the primary condition for rational management and conflict avoidance and is the single most important factor in "leveling the playing field" so that all riparians can participate fully and equally in negotiations and dialogue regarding management of Nile Basin water resources (Okidi 1994). During the initial workshop on efforts to harmonize EIA procedures of the East African region, participants stressed the importance of training environmental agencies tasked with day-to-day administration of the EIA process (UNEP 1998).

Table 2.3. Current Status of Water Quality Control Policies and Legislation of the Nile Basin Countries

	Burundi	*D.R. Congo*	*Egypt*	*Ethiopia*	*Kenya*	*Rwanda*	*Sudan*	*Tanzania*	*Uganda*
WRM policy	Yes		Yes	Yes	Yes	Yes		Yes	Yes
Oversight agency	Ministry of Environment		Ministry of Public Works and Water Resources	Ministry of Water Resources	Ministry of Environment	Ministry of Hydropower and Water with Support from Ministry of Environment and Human Settlements		Proposed National Environment Management Agency (current agency has no licensing or enforcement authority)	National Environmental Management Agency
Status of WQ management legislation	Under development		Law No. 48		Recently adopted environmental legislation; water law near adoption	Water law under review		New laws drafted based on harmonization effort. Not yet adopted.	Laws adopted for environmental management and water resources management
Differential surface water standards based on use designation			Yes		Yes			In draft law	Yes
Surface water quality monitoring program	No		Yes			No			Yes
Environmental uses considered in water rights permitting									Yes

Source: In-country stakeholder interviews and national water, environment, and natural resource documents.

Table 2.4. Current Status of Legislative Requirements for Environmental Impact Assessment for Nile Basin Countries

Country	*Status of EIA requirements in legal and policy framework*	*Dedicated institutional arrangement*	*Irrigation and agricultural expansion included in provisions*
Burundi	Accepted in policy; legal framework under development		
D.R. Congo	Specific legislation for EIA	No	
Egypt	EIA requirements as part of Law No. 4	Ministry of Environment	
Ethiopia			
Kenya	Recently adopted environmental legislation	Ministry of Environment	Yes
Rwanda			
Sudan			
Tanzania	EIA provisions drafted; law not yet adopted	No	Yes
Uganda	EIA provision part of environmental law	National Environment Management Agency	Yes

Source: In-country stakeholder interviews and national water, environment, and natural resource documents.

Lessons Learned

Transboundary environmental issues affect river basins around the world and have been a concern in most regional water management programs. The need to cooperatively manage international lakes and rivers, thereby minimizing conflicts over their use, has led to a number of international commissions for river basin management. The World Bank and other international organizations have attempted to formulate lessons of good practice from earlier water resource management programs by reviewing factors that both promote and inhibit success. Most of these lessons learned have concerned water supply, power production, and economic development, but lessons can also be drawn for good practices for transboundary environmental management.

River Basin Management

The sustainable development of water resources without environmentally sound management practices is not possible. All studies of lessons learned to date make this essential point (see, for example, GFID 1998a, 1998b). Because many environmental issues are inherently of a transboundary nature, their management necessitates an approach that brings together riparians from the entire river basin, both in the organizations developed to address water and environmental management and those involved with the specific on-the-ground activities adopted as part of the environmental management program. Important lessons learned for basin management can be grouped within four broad categories.

Plans should be specific, achievable, pro-active, and flexible. Cooperation among riparians in managing water resources and environmental conditions within a large river basin has the potential to unlock similarly large development opportunities. Development should drive

cooperation, but it should be achieved within the context of sustainable use of environmental resources. These two goals are not incompatible. Ample evidence suggests that increased development and the resulting improvement in living conditions and educational levels, are important factors in enhancing people's awareness of the need for environmental protection (Pearce and Warford 1993).

Clearly, it is important that capacity and financial constraints necessitate serious attention to setting priorities. The problems that an environmental management program addresses should be those that have serious adverse impacts. The objectives the program pursues need to be achievable. When programs are developed with these considerations in mind, the probability of success is enhanced, confidence is gained, and stakeholders in the basin come to see that that their condition can be improved with well-directed effort.

Diversification in a portfolio of projects is also important to reduce risks. A diversified portfolio both with respect to problem focus and scale has the additional advantage of appealing to donor organizations, whose interests and capacity to participate vary from one to another.

To further enhance the probability of demonstrable success, development plans must recognize and address the constraints facing implementation, such as inadequate managerial and technical capacity, lack of capital, and poverty.

The corollary to the principle that environmental management programs should have identifiable impacts and address practical objectives is that these programs should achieve concrete results. Results might include emission inventories, application of the best available technologies, priority lists for the reduction of certain substances in the air or water, or environmental monitoring systems.

Benefits can be gained from a pro-active search for pragmatic solutions to problems, and from attempts to identify emerging environmental issues that should be addressed. This allows the program to stay ahead of developing concerns without simply reacting to problems that have already gained a foothold and are consequently difficult, and generally very expensive, to overcome. This suggests the need for a strategic plan for transboundary environmental action that can be agreed upon by the riparians. To remain focused on emerging environmental issues, flexible programs and management structures are required. Programs must accommodate changes in technology, political situations, investment patterns, and other factors.

Success requires stakeholder awareness, buy-in, and participation. Water and water bodies have more than just economic value. Development plans and environmental programs need to recognize the historical, religious, cultural, and social values of water, rivers and wetlands, and the water environment. Stakeholder awareness of water and environmental concerns, involvement in the process of managing water use and development, and acceptance of program objectives is necessary for success.

Essentially all modern water resource and environmental management programs recognize the need for riparian ownership of the process, objectives, and plans, and of the need for stakeholder involvement. Stakeholder involvement assures the fair consideration of a broad range of interests and provides accountability for decisions. Moreover, stakeholder involvement facilitates successful implementation of policy reforms to overcome constraints and build local

capacity. The larger the number of stakeholders and riparians, the more complex the process and the more involved the effort to reach consensus. Nonetheless, there needs to be an acceptance of this fact and a willingness to see the process through. There must be an acceptance of the principle of subsidiarity, as already adopted by the Nile Basin Initiative. Subsidiarity means accomplishing programs or projects at the lowest possible administrative and subregional level, under an overall basinwide initiative. Experience in other river basins demonstrates that seeing the complex process through requires high-level dialogue among riparians, political commitment, and public awareness of the importance of environmental issues and the relationship of the environment to water quantity and quality issues. Awareness and political commitment are, of course, closely related. Political commitment requires a solid base of public support, not least of all because the public will ultimately bear the cost of programs through taxes, user fees, or increased costs of goods and services.

Provision should be made in environmental management programs for participation by the public, private sector organizations, academic institutions, nongovernmental organizations, and other private sector representatives (Lintner, Arif, and Hatziolos 1996). This participation should solicit comment and experience from the private sector, and should provide a conduit for both the broad dissemination of information about the program and its objectives and plans as well as feedback on program status and problems during implementation. This feedback can be invaluable in informing policymakers and managers of the need to make modifications in the course of implementation to keep programs on track. National workshops, such as those in the Nile Basin riparian countries organized under Global Environmental Facility sponsorship, are an effective way of reaching a large spectrum of stakeholders who, in turn, can reach an even larger audience. The managers of environmental programs should develop organized plans for continuing outreach throughout the duration of the programs. Once a program is under way, user participation in managing and operating systems increases the likelihood that facilities and processes will work well and be well maintained, and fosters community empowerment.

Policymakers and the public should be made aware that environmental degradation affects specific people in specific ways, and that individual actions and behaviors make a difference. At the basin level this awareness creates mutual understanding, at the national level it strengthens commitment, and among the public it helps create a sense of stewardship (Sharma 1996) and elicits demand for government attention to issues, strengthening political commitment.

A shift in economic and management approach from supply-side to demand-side, and from top-down controls to private sector involvement is important. The public and private sectors have roles to play in water utilization and management as well as environmental stewardship. There is a need to transition from administrative command and control to more participatory approaches that treat water as a scarce resource and environmental quality as a valuable commodity (Sharma and others 1996).

Wherever appropriate, water and environmental quality should be treated as economic goods, thereby promoting the development of consistent policy frameworks. To the extent possible, market-like solutions should be favored that use economic instruments and analyses for environmental management planning and in making investment decisions. Unintended incentives that encourage inefficient use of water and/or environmental degradation must be identified and

replaced by incentives that are consistent with environmental goals. A need arises to develop effective pricing mechanisms for practices that bear on environmental quality, such as industrial waste disposal. For both water and environmental management, there should be a shift in emphasis from supply-side control toward demand-side management.

A major shift in approach is occurring in water resource management—and in infrastructure more generally—toward greater private sector involvement. Private sector participation now involves a range of activities including irrigation and drainage, hydropower, and environmental services. The private sector is seen as a new source of infrastructure funding, an important provider of management services for operations and maintenance, including specialized expertise in planning, finance, technical support, and the application of new design and construction technology. Private sector involvement in water supply has been common in the past decade (World Bank 1997). Private sector involvement has increased for water treatment, sanitation, and other environmental projects—for example, private contractor involvement in controlling water weed under the aegis of the Lake Victoria Environmental Management Program. Public-private partnerships are increasingly common in hydropower development.

In developing environmental management plans, two key financial issues are, first, success requires any environmental program to be affordable to the end-user. If it is not, individuals will find ways around the policies and procedures established by the program, negating the supposed benefits. In rural areas of the Nile Basin, affordability is of particular concern because of widespread poverty. The second financial issue is that recurring costs of operations and maintenance are often much larger than up-front capital costs of environmental programs. Recurring costs are a burden that must, but often are not, carefully considered in planning.

Good management practices are a prerequisite to success. The Nile Basin operates as a single system, irrespective of national borders. Thus a holistic Basin-wide approach to environmental management needs to be adopted. Decisions must be made that take a long-term view, fully considering both the ecosystems and socioeconomic structures that exist within the Basin. The goal is to ensure sustainability of the environment and the various uses of water, all in the context of meeting the legitimate development goals of the riparian countries. For that purpose, it is necessary to incorporate the salient elements of Basin-wide plans into the economic development plans of individual countries. This is true not least of all because such elements affect the allocation of national resources as well as decisions about international borrowing and seeking bilateral support. Cooperation among the riparians, from coordinating environmental policies and legislation to decisions about multilateral investment projects, is of course critical. The biggest obstacle to program success is shortcomings in project planning and management capacity. While this is a problem for all the riparian countries of the Basin, it is critical for some nations. Management skills need to be built to level the playing field among riparians. Management must proceed through action plans, regular conferences, and international framework agreements. Riparians can help achieve a level playing field by sharing data, information, and knowledge. As capacity is built, riparians become better able to coordinate environmental programs, reach agreements, and cooperate on joint projects.

Transboundary Environmental Management

Beyond the lessons learned about organization and management, three environmental principles also need to be kept in mind. First, a long-term perspective must be adopted. Program impact measured in biophysical terms is incremental. Adoption of sound polices in industry, agriculture, urban development, transportation, and other sectors may take decades to bear full fruit. Second, the use of natural biological and hydrological processes is key to preserving or improving environmental conditions. The interactions of land use, runoff, wetlands hydrology, ecology, and other natural factors will determine both national and transboundary effects. Third, emphasis should be placed on controlling pollution at its source. It is far cheaper and more effective to minimize waste emissions than to clean up residues downstream. Basin-wide programs should be developed to share the benefits and accurately account for the costs of environmental stewardship.

Transboundary environmental issues can be divided into at least two groups. One group involves processes that transcend country borders. These may include changes in upstream water quality that affect water quality downstream, or shared resources such as wildlife habitat overlapping country borders. The second group involves processes that may not transcend country borders but are common to many countries. These may include loss of fisheries on inland lakes or loss of land quality through deforestation. Communal efforts must address the first group, and are very helpful in addressing the second.

Although concern over transboundary environmental issues is a potential source of conflict—as is concern over water availability—success in dealing with these issues can be an important impetus to bring riparians together, helping to counter pressures that force them apart. Where such pressures exist, a good strategy might start with a modest but concrete goal, one from which all countries benefit and essentially none lose, then moving ahead to take specific actions on the ground. This helps build the habit of cooperation and creates a sense that common benefits are achievable. Based on practical successes with noncontroversial programs, more complex issues then become easier to address. Experience in managing the Rhine River provides an example. Little progress was made while the parties were searching for overarching issues that involved winners and losers among the participants. However, once reintroducing salmon into the river was identified as a common benefit that all could agree upon and work toward, actual work began that advanced progress. From this beginning, broader issues were identified, and a practical working relationship among the riparians was established. There are certainly other examples in which broader issues have been tackled successfully. In the Orange (South Africa/Lesotho) and Columbia River (United States/Canada) Basins, for example, downstream riparians have made investments in upstream river basins in return for downstream water supply, flood control, or energy benefits.

In the past, data collection has generally been supply-side driven, that is, data were collected without specific programmatic goals. Data collection must be demand-side driven. It needs to respond to the demands of decision-making. A viable first step along the path to environmental monitoring and knowledge sharing is the establishment of expanded web-networks among major national universities in each of the riparian countries, along with the principal water, environment, and natural resource ministries.

3. Project Appraisal and Priorities

This chapter considers the evaluation of transboundary environmental impacts caused by water resource management programs and projects on international rivers, particularly the Nile River. At issue are questions of how proposed programs and projects should be evaluated and screened and, given the transboundary environmental opportunities and constraints in the Nile Basin, what categories of programs and projects should have priority. Clearly, this is a big and complex topic, too big for more than a cursory overview. This chapter first sets out principles of good practice in evaluating and screening programs and projects, then it lists a set of priority areas that build upon the opportunities and work within the constraints identified in earlier sections.

In setting forth guidelines for evaluation and screening, special emphasis applies to Basin-wide issues and transboundary concerns for the environment, for sustainable economic development, and for stakeholder ownership of programs and projects. Among the questions at issue are the following: Do evaluations of programs and projects incorporate Basin-wide measures of benefits and costs? Are affected parties allowed to participate in the analysis and decision process? How can procedures for benefit sharing be designed and implemented?

Initially, policies, procedures, and accomplishments of the World Bank and were examined in relation to evaluation and screening. This was done to better understand the state of current practice with respect to the above issues. Large, respected organizations have procedures that are open to the public. These influential organizations have long been active in international lending for water-related projects.

World Bank and IFC policy on environmental assessment (EA) state that projects proposed for financing must have an EA to ensure environmental sustainability. The breadth, depth, and type of EA process varies with the individual project. Depending on project complexity, various forms of analysis support the EA. These include an environmental impact assessment (EIA), an environmental audit, and a hazard or risk assessment. In most cases these procedures are spelled out in a National Environmental Action Plan (NEAP) that is a requirement for project loans from the World Bank and IFC.

Projects with the greatest potential adverse environmental effects are classified as *Category A*:

> A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These projects may affect an area broader than the sites or facilities subject to physical works. EA for a Category A project examines the project's potential positive and negative impacts, compares them with those of feasible alternatives (including, as appropriate, the "without project" scenario), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and to improve performance. For a Category A project, the project sponsor is responsible for preparing a full report, normally an Environmental Impact Assessment

> (EIA), and for preparing and updating an Environmental Action Plan (EAP).

Projects that affect international waterways are subject to additional requirements. These additional requirements apply to

> hydroelectric, irrigation, flood control, navigation, drainage, water and sewerage, industrial, and similar projects that involve the use or potential pollution of international waterways.

The World Bank requires that countries seeking loans notify other riparian states regarding the proposed project and its details. If objections arise, the Bank asks that the riparian countries to resolve their differences, if at all possible, before loan commitments are signed. Certain exemptions apply, namely, if the borrower can demonstrate that there will be no adverse impacts on water quantity or water quality received by downstream riparian countries.

Principles of Project Appraisal in the Nile Basin

Basin-wide development should be approached as a program, or in a strategic fashion, not piecemeal. The danger of developing a host of small projects and appraising each without regard to the others is that, while each may appear to provide local net benefits, collectively they may fall far short of maximizing global net benefits because they do not fit well together. Furthermore, individual small projects may have irreversible elements, precluding future options.

SEA Approach

Programmatic and Strategic Environmental Assessments (SEAs), as discussed in chapter 2, are apparently uncommon as elements of World Bank or IFC policy. Yet SEAs are necessary for Nile Basin projects, because the SEA process is admirably suited to watershed management. SEAs, unlike standard environmental impact assessments (EIAs), employ a wide perspective and a low level of detail, and they offer a vision and overall framework against which impacts and benefits can be measured. Thus SEA is a continuing process aimed at providing information at the right time.

The World Bank's policy for water resources management (OP4.07, February 2000) states that "when the borrower develops and allocates water resources, it considers cross-sectoral impacts in a regional setting (e.g., a river basin)." While this policy supports comprehensive analysis of impacts on *sectors*, downstream environmental effects, especially when diffuse, can be difficult to measure and tend to get ignored. A recent review of environmental and social aspects of an IFC-funded dam in Chile concluded that the IFC "should have used a more *systematic* [italics added] approach to the analysis of environmental and social issues…. More complete information and analysis on the downstream impacts of the dam should have been available before IFC agreed to proceed with the project." World Bank dam projects have been subject to similar criticism.

Disclosure of findings and supporting analysis to interested parties comprises an important element of project analysis. IFC and World Bank policy do not seem to encourage full

and complete disclosure, especially to neighboring countries that may have an interest in project outcomes. The policy for Category A projects having significant environmental effects is to release "the draft EA in the host country as well as through the Public Information Center of the Bank (PIC) as early as possible in the appraisal process but no later than 60 days prior to the Board meeting."

Another recent review of IFC project lending noted that "consultation with affected groups was least effective during the early stages of the EA process, and most effective after finalization of the EA report and project implementation." However, it is during the early stages of the EA process, when alternatives are being considered, that public comment would be most useful in helping to improve project design.

Current methods of project design and appraisal encounter difficulty because distributional effects receive only limited attention. It is important to know in detail who will gain from a proposed project and by how much, as well as who will lose. From that information, supplementary activities can be included to share some of the project benefits with those who otherwise lose. At present, the World Bank and IFC do not have guidelines regarding the sharing of project benefits and costs among countries when environmental effects extend beyond national borders. Rather, the policy is to leave it to the riparian states to work out a solution.

Screening Projects: Transboundary Environmental Impacts

A systematic procedure for taking transboundary environmental impacts into account in project preparation should involve an *issues and priorities matrix*. The development of a system for appraising potential Nile Basin Initiative (NBI) projects, whether under the Shared Vision Initiative or the Subsidiary Action Plans, should involve two tasks. First, criteria need to be established for screening and for rating projects in order of priority. Second, recommendations need to be developed for undertaking environmental impact assessments, taking into account national policies. A networking resource (see chapter 2) available to all riparians could provide assistance. A good example of such as resource is the network established by the International Association of Impact Assessment, an organization to which many individual Nile Basin scientists and technicians already belong. Although IAIA would probably not take on an organizational role in coordinating EIA, PEA, and SEA processes in the Basin, it could perhaps act as a clearinghouse or provider of information about applications of EIA processes in other river basins worldwide.

The transboundary environmental impacts of water resource projects should be evaluated with a flexible but comprehensive procedure. The interactions of hydrology, people, ecosystems, and economics that a project involves must be viewed as a system. There are two important implications in viewing project interactions this way: (i) there is a need to consider the cross-border consequences of individual projects and (ii) there must be assessment of interactions within the portfolio of projects undertaken in different riparian countries. Although the transboundary environmental analysis will be undertaken in this broad systems context, the specific methodology should deal explicitly with the environmental dimension, addressing the degree to which projects affect environmental quality Basin-wide. Accordingly, as opportunities and constraints are measured, criteria for consideration should include effects on water quality, soil

quality, biodiversity, air quality, and quality of human life as reflected in public health and displacements.

A screening and prioritization scheme involves three stages. The first stage **identifies impacts and screens project alternatives**. This stage identifies the *stressors* through which a project produces adverse environmental consequences. Each stressor from a project could have a number of effects on the most important environmental parameters. Table 3.1 identifies the stressors likely to be associated with investment projects in the Nile Basin and the environmental issues of most concern. It is generally desirable to examine the individual stressors, as is done in table 3.2 for a hypothetical petroleum refinery project. In this examination, good practice (i) screens among the consequences for those that are important and can be evaluated quantitatively, identifying resources likely to be affected (table 3.1), and (ii) screens among the consequences for those with transboundary effects (table 3.2), identifying the resources likely to be affected.

The second stage **establishes a framework for assessment**. A description and analysis of effects, both quantitative and qualitative, should be based on a set of common assumptions. Determine an appropriate baseline (usually the "without project" condition), decide on which project alternatives will be evaluated, and determine a time frame for the various project activities. These project activities might be such things as planning, construction, operation, and decommissioning. Determine an appropriate geographic scope for the assessment, which in most cases is the extent of the relevant watershed. Finally, identify applicable international treaties and agreements, loan conditions, and other relevant factors, as appropriate.

The third stage **undertakes a quantitative analysis of economic efficiency along with an identification of distributional effects**. The economic efficiency part of this analysis involves benefits, costs, and net benefits; the distributional effects part involves who gains and who loses. It is important to incorporate some estimate of the uncertainty in costs, benefits, and environmental impacts, and an explicit identification of significant but nonquantified effects (Table 3.3).

An initial screening can be made using methods of rapid review such as benefits transfer, that is, transferring benefit estimates developed in other contexts to the project area with appropriate adjustment factors. An initial screening seeks to determine key outcomes. Is the project likely to develop large net benefits? Is this a worthy project that should move forward? Are there readily identifiable groups of losers that should be compensated? Is this a large and important project with large benefits and costs? The latter case should receive a more detailed assessment.

Following the rapid review, a more detailed assessment may be indicated to improve project design, produce greater net benefits, and reduce instances of uncompensated losers (be they individuals, groups within one or more countries, or countries as a whole). EIA is not as useful as cost-benefit analysis for such detailed assessment. Cost-benefit analysis specifically weighs projects quantitatively, even at the earliest stage of design. Cost-benefit becomes useful in evaluating projects and is necessary for any prioritization exercise. In contrast, EIA shows where environmental mitigations can be achieved.

Table 3.1. Potential Stressors and Consequences

Stressors	*Consequences of potential concern*						
	Water and water quality	*Air quality*	*Soils and soil quality*	*Endangered species*	*Wildlife habitat*	*Population migration*	*Public health*
Agriculture and irrigation							
Biodiversity and habitat maintenance							
Forest planting and protection, soil conservation							
Infrastructure development							
Power development							
Industrial development							
Tourism							
Weed control							
Measurement and monitoring							
Other							

Table 3.2. Potential Stressors and Consequences for Petroleum Refining Project

Stressor	*Localized impacts*	*Transboundary impacts*
Emissions (routine)		
VOC	Air quality	
SO2	Air quality	
CO2	Air quality	Global warming
NOx	Air quality	
Particulates	Air quality	
Heavy metals	Air quality	
Effluents (routine)		
Phenol	Water quality, wildlife, public health	Water quality, wildlife public health
Oil and grease	Water quality	Water quality
Accidental releases		
Crude oil	Water quality, wildlife, soils	Water quality, wildlife, soils
Refined products	Water quality, soils, wildlife, public health	Water quality, soils, wildlife, public health

Table 3.3. Considerations in a Quantitative Analysis of Project Priority

Consideration
1. Economic efficiency (benefits, costs, and net benefits)
2. Distributional effects (who gains and who loses)
3. Treatment of uncertainty in costs, benefits, and environmental impacts
4. Identification of important but nonquantified effects

It should be noted, however, that cost-benefit analysis often underestimates environmental costs, because such costs may be difficult to quantify. Cost-benefit analysis is not always the best tool for sorting out the kinds of projects associated with transboundary programs and dealing with environmentally sensitive shared resources. Perhaps a more sophisticated form of environmental assessment is needed. Especially attractive is the type of assessment referred to by the World Bank as a Sectoral Environmental Assessment (Goodland and Tillman 1995). This is one form of the strategic environmental assessment process referred to earlier in this report. A Sectoral EA reduces the costs and increases the effectiveness of the benefits of project-level EA, making it a powerful tool for project selection and improvement of economic cost-benefit analysis. It seeks to integrate environmental considerations into decision-making above the project level and, therefore, applies to selecting the next project in the sector examined. Sectoral EAs possess a great advantage in helping to rank potential projects in an environmental sequence, so environmentally superior projects are taken up before environmentally weaker ones.

Rating Projects

The results of a rapid review can be combined with the results of the initial screening of consequences to produce an overall rating of projects from an environmental perspective. This process groups projects into four categories (Figure 3.1).

Figure 3.1. Issues and Priorities Matrix for Rating Projects

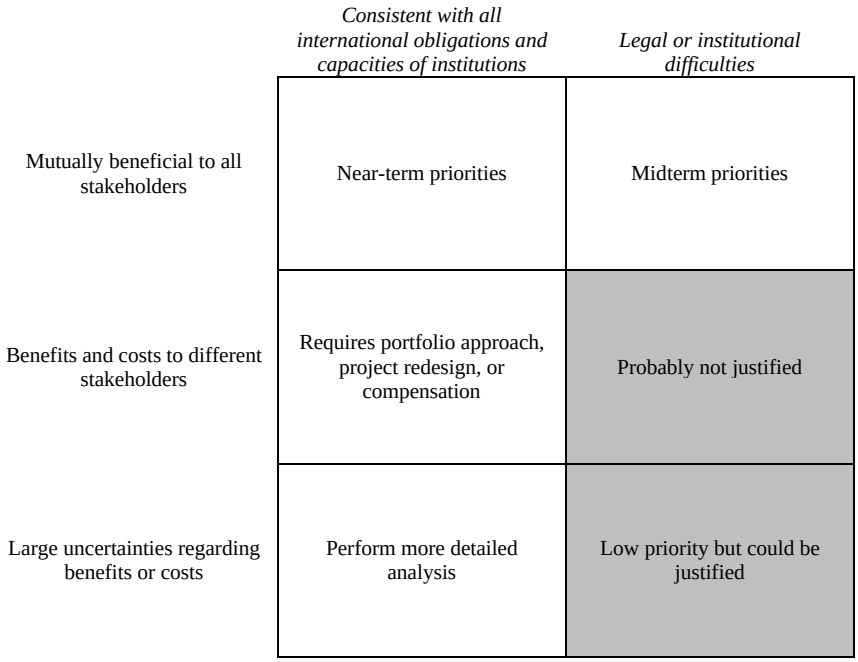


Figure 3.1 illustrates high priority projects that (i) provide benefits to all stakeholders while imposing negligible environmental costs, (ii) remain consistent with international obligations, and (iii) supply technical knowledge and institutional capacity.

Projects that rank high based on these criteria (upper left) include such initiatives as the following:

- Coordinating EIA policies
- Improving water quality monitoring
- Controlling water weed infestation
- Shared resource and land use mapping
- Transboundary forest and wetlands management
- Environmental education and awareness
- Enhanced networking among universities and research institutions

A second category of projects (upper right) include those that similarly provide net benefits to all stakeholders, but for which technical knowledge, institutional capacity, and/or an enabling legal framework need to be developed. These would be midterm priorities. A third category (middle left) encompasses those projects that, if combined within a portfolio that balances environmental benefits and costs, yield net environmental gains for all stakeholders. A fourth category (middle right) entail the unfavorable, excluded projects that cannot be justified as generating net benefits for all stakeholders and for which technical knowledge and institutional capacity still needs development. A fifth category (lower left) involves projects that are compatible with international

treaties, obligations, and institutional capacities yet whose benefits and costs cannot be easily determined by rapid review procedures, indicating a more careful assessment of benefits and costs. A last category (lower right) includes projects whose benefits and costs are uncertain and whose compatibility with institutional capacities and existing legal obligations is questionable. These are of lower priority but might deserve further analysis.

Transboundary Environmental Project Priorities

Many project opportunities exist to manage the natural resources of the Nile in a coordinated way to achieve shared benefits and sustainability, especially in the face of transboundary impacts. The following opportunities are important:

- Encouraging integrated watershed management
- Enhancing EIA practices
- Developing environmental monitoring and information systems
- Expanding education and public outreach
- Supporting the development of strong institutions and policies

While these opportunities are real and hold significant promise, two important constraints limit their effectiveness, and must themselves be considered important determinates of success when evaluating and selecting projects. These relate to population and institutional structures. Trends in population that pose constraints include an overall increase in numbers, a shift towards greater urbanization, and a spread of rural populations toward less developed parts of the basin. These trends will add to future water demand, although by how much will depend on policies, technologies, and the sectoral composition of economic activity. Governments of the riparian countries, nongovernmental organizations, donor organizations, and others active in development of the basin recognize these population trends, and programs are in place to address population issues. The success of these programs is crucial to sustainable resource use.

Constraints posed by institutional structures entail, first, the relative lack of strong institutions in the Nile Basin for protecting natural resources and the environment; second, many nations have yet to establish ambient water quality standards; and, third, institutions need to be strengthened, policies solidified, and approaches to natural resource and environmental management harmonized across countries. These conditions, too, are recognized by governments, nongovernmental organizations, donor organizations, and others. As with trends in population, the success of attempts to make institutional structures more responsive to good practices of environmental management will be crucial to sustainable resource use.

Encouraging Integrated Watershed Management

Projects that apply integrated watershed management techniques to environmental issues of land use, agricultural practices, forestation, and wetlands protection should be encouraged. Watersheds and sub-basins of the Nile represent well-defined systems that should be the focus for natural resource planning and management. Watershed-level planning facilitates analysis and thus, an understanding of land and water relationships. Watershed analyses prove useful in addressing wide ranging aspects of land and water use. The approach embraces the concept that

understanding the welfare of people and their use of natural resources within watersheds ensures a cumulative effect of improving the condition of individual sub-basins and, thereby, the condition of the overall Nile.

Environmental and natural resource agencies throughout the Basin should be encouraged to design project activities within an integrated watershed management framework. Guidelines for such analysis are provided by Gregersen and others (1987). Using this framework, projects that affect people's use of land and water resources can be examined directly as to measures of economic benefits and costs as well as measures of environmental changes that result from altered water flows, changes in water quality, and corresponding changes in soil erosion and sediment yield. With the watershed management approach, physical and biological effects of project activities on watersheds are quantified first. Conditions "with and without" project translate into changes of economic value. Reducing soil erosion in and of itself has no economic value until it is expressed as an impact of, for example, increased crop or animal production over time. Similarly, reduced sedimentation in a reservoir has no economic meaning until such changes are represented as an impact such as hydropower generation, irrigation capacity, or flood control storage.

By appraising projects from a watershed perspective, benefits and costs are examined from the viewpoint of both watershed inhabitants and those living downstream. Project alternatives can be compared based on established criteria for acceptance. Throughout this process, experience dictates the essential importance of local participation in the planning, appraisal, monitoring, and evaluation process. In addition to local participation in choosing among alternatives, country, regional, and international support are necessary, given the critical transboundary effects.

Enhancing EIA Practices

The expansion of environmental impact assessment practices within national environmental initiatives as well as the coordination of EIA policies and procedures among different jurisdictions and countries should be encouraged.

Economic development with sustainable resource use is a central goal of cooperative efforts among the Nile Basin riparian nations. A paramount requirement of sustainable development is programs and policies that protect the environment. With this in mind, EIA procedures—already in place in all the Basin countries—should be required of all major industrial and infrastructure development projects to determine the potential for adverse environmental effects. The EIA concept has found broad acceptance as an effective means to prevent environmental degradation resulting from development projects. Although EIA provisions have not typically been applied to agricultural development, expansion of the application of EIA has been recommended as one way to reduce adverse impacts of irrigation expansion.

The first stages of the impact assessment process—*screening, preliminary assessment,* and *scoping*—are important to determine the extent and focus of impact assessment required. The purpose of these stages is to decide whether or not a project requires more detailed assessment, and the level of assessment necessary. Past experience shows that certain types of projects

are not likely to have serious adverse environmental impacts. By contrast, other types do have the potential to cause significant impacts and routinely require a comprehensive EIA. The World Bank and other lenders require that a borrower consider cross-sectoral impacts in a regional setting. While this official policy supports a comprehensive analysis of impacts on sectors, downstream environmental effects can be difficult to measure and tend to get ignored, especially when those effects are diffuse. Programmatic environmental assessments are crucial in the case of the Nile. Basin-wide development must be approached as an integrated program, not piecemeal. The danger of developing a host of small projects is that, while each one may provide net benefits locally, collectively they may fall short of maximizing net benefits in the entire Basin, because the separate projects do not mesh. Collectively, many small projects may have irreversible elements that are not evident when each is assessed separately.

An important element of project analysis is the disclosure of findings and supporting analysis to neighboring countries that may have an interest in project outcomes. The policy for projects having significant environmental effects should be to release draft EIAs as early as possible in the appraisal process. The early stage of the EIA process is when alternatives are being considered and improvement in project design could most benefit from public comment.

Developing Environmental Information Systems

The development of regional environmental monitoring and information systems, and common data standards for collection, storing, and sharing environmental information, perhaps by building on the excellent network of national universities in the Nile Basin countries, should be encouraged.

An important issue concerns transboundary environmental monitoring and evaluation. This issue is sensitive because countries may have reservations about sharing information that they believe affects national security or national interests. Nonetheless, the sharing of environmental monitoring and evaluation information is critical to understanding upstream-downstream linkages and works to improve overall health and increase the productivity of the Basin's resources. Coordination of monitoring programs and the consequent sharing of information is also a first step along the path toward more complex cooperation.

Among the first needs of transboundary water resource and environmental management is an adequate, broadly accessible knowledge base of information on existing conditions. If possible, such information should be monitored and compiled at the basin level. This knowledge base does not exist today for the Nile Basin, except perhaps for water quantity and hydrological information. Experience in the Danube River and elsewhere suggests that cooperation in establishing shared information systems may be important in eliciting cooperation at higher levels. A recent United Nations Environmental Program study concludes that "lack of extensive locally derived scientific data possibly reflects the first hurdle faced by anybody wishing to develop environmental standards." Thus the development of shared information systems among riparian states and, in time, transboundary information systems, is an important opportunity for the Nile Basin.

A viable first step along the path to environmental monitoring and knowledge sharing would be the establishment of expanded web-networking among the major national universities

of each of the riparian countries, along with the principal water, environmental, and natural resource ministries. Strong capabilities already exist in many of the larger universities of the Nile Basin in the disciplines of geographic information systems, remote sensing, and spatial data management. These capabilities could be built upon. Creation of an electronic network of university scholars and government offices working on environmental monitoring within the Nile Basin would provide both a natural vehicle for the exchange of knowledge among riparians and a connection to the global network of environmental centers and data collection organizations. The latter include significant resources for the Basin, including the large European and American satellite remote sensing organizations, the host of nongovernmental organizations active in environmental management (e.g., the World Conservation Union, or IUCN, and the World Wildlife Fund) and the international network of research universities. Hosting such a network at the major universities would, in principle, have the added benefit of somewhat removing a potentially sensitive activity from the political realm of government ministries.

Expanding Education and Public Outreach

The expansion of secondary and college education programs, industrial training activities, and public information outreach projects to inform end-users of water, land, and other natural resources and about important transboundary environmental issues should be encouraged.

River basins have more than just economic value. Development plans and environmental programs and policies need to recognize historical, religious, cultural, and social values of water, rivers, wetlands, and the water environment. Stakeholder awareness of water and environmental concerns, involvement in the process, and acceptance of program objectives is a necessary condition for success. Supporting measures need to be developed that include intensive training programs, promotion of public awareness, and educational programs in principles of sustainable environmental management of river basins.

There are examples of regional networks that promote education, training, and cooperation among countries. One is the Southern African Development Community (SADC), which is committed to promoting equitable and sustainable development. Among the many activities of SADC is the publication of a newsletter entitled “Splash” that focuses attention on watershed management as well as related soil and water conservation activities and issues in the region. A network of professionals has evolved that promotes regional cooperation in training and sharing of knowledge and experience. This approach could serve as a blueprint for the Nile Basin riparian countries.

Regional leaders in water resources management across the Nile Basin emphasize the importance of training and capacity building in the area of water pollution control and management as well as environmental impact assessment. Development of expertise in water resource management has been identified as the primary condition for rational management and conflict avoidance and is the single most important factor in leveling the playing field so that all riparians can participate fully and equally in negotiations and dialogue regarding management of Nile Basin water resources.

In addition to training water resource and environmental professionals, a need exists to develop environmental awareness within the general population of the riparian countries.

Provision should be made in the development and implementation of environmental management programs for participation by the public, private sector organizations, academic institutions, and nongovernmental organizations. This participation should be structured to solicit comments, bringing to bear experience and knowledge in the private sector and other organizations, and should provide a conduit for the broad dissemination of information about the programs and plans.

Encouraging the Development of Institutions and Policies

Continuing development of strong government agencies and other institutions responsible for environmental planning, monitoring, and regulation, and the further development of effective environmental policy within the riparian nations should also be encouraged.

The readiness of each of the riparian states to participate fully in transboundary environmental management activities depends, in part, on their national capacity to do so. It requires enactment of national environmental legislation that is consistent with international agreements. It also requires that technical capacity be in place within each country to enable full participation in dialogue and negotiation.

While acceptance of a shared vision for environmental quality among riparian states of the Nile Basin is the essential first step toward protection and sustainable development, adoption of coordinated policy tools at the national level is likewise essential for realization of that vision. If countries already have in place national policies and laws that are consistent with those that could be applied within the context of a broader Basin agreement, the task of reaching agreement is made easier. Most of the Nile Basin countries have existing environmental legislation governing the protection of water quality, and the application of differential surface water quality standards is well understood. The approaches used in each country are more similar than different and generally follow norms established in the international community. The same holds true for adoption of environmental impact assessment requirements; all of the countries have adopted in policy if not in law EIA requirements consistent with international norms.

Managing international waters to maximize mutual benefits represents a step beyond the 1992 Helsinki Convention or the 1997 UN Convention. This principle could lead to national environmental policies that reflect concern for all potential uses in a basin, evaluate the contribution of each use to economic well-being in the basin, and allocate water for both consumption and waste assimilation according to where it creates the greatest value for all. Allocations made in this fashion would do the most to improve living standards in the basin.

Within countries water is sometimes allocated through market mechanisms. However this same principle is used less often among countries that share international rivers or lakes. The benefits of using markets within a country are great. If the same principles could be applied across countries, greater benefits would accrue to those who share international waters. International allocations could be achieved through water pricing or through tradable allocations.

Environmental threats in the Nile Basin can be categorized into a few small classes involving the principal types of resources—land, water, biological, and human—along with a special category for natural and man-made disasters.

Table A.1. Environmental Threats in the Nile Basin by Category

Land Degradation - Deforestation - Erosion - Overgrazing - Riverbank and shoreline degradation - Loss of fertility	**Water Degradation** - Siltation - Wetland destruction - Nutrient loads - Urban and industrial wastes - Eutrophication - Disease
Biodiversity Loss - Bird species - Fish species - Large animal species - Exotic species and weeds - Domesticated plant species	**Natural and Man-Made Disasters** - Flood - Drought - Refugee displacement - Accidents and spills

The more general effects of environment on people of the Basin are discussed throughout the report and are not singled out as a special subsection here.

Land Degradation

As indicated, the land resources of the Nile Basin range from tropical highlands to low-altitude wetlands and arid deserts, and support a variety of plant and animal communities. The principal threats to the land resource are degradation resulting from overgrazing by livestock, inappropriate cultivation practices (e.g., on steep uplands), deforestation, loss of wetlands, and in some areas artisanal mining. Land degradation is inextricably linked to the quality, volumes, and timing of water flow in the Basin and manifests itself as increased surface runoff, accelerated surface soil erosion, gully erosion, and soil mass movements that result in depleted land productivity and increased sediment delivery to downstream locations.

Overgrazing and Agricultural Cultivation Practices

Grazing by domestic livestock and rain-fed agriculture are the most widespread land-use practices in the Basin and, therefore, have the greatest impact on land degradation. The grasslands, shrub land, and arid zone areas where these land-use practices dominate constitute the majority (76 percent) of the land area in the Basin. Some degree of grazing occurs in the forested areas as well, and it would be hard to find many areas outside of urban centers where livestock are not found.

Range inventory data for the Basin as a whole seem to be lacking and, consequently, the degree of land degradation resulting directly from overgrazing was not available for this report. Similarly, because of the scattered nature of subsistence farming throughout the Basin, it is difficult to obtain Basin-wide data on overall rates of soil erosion and land degradation. There is little doubt, however, that increased livestock numbers are presently exceeding the carrying or grazing capacity of the land in many parts of the Basin. These effects are discussed in greater detail for each of the respective sub-basins, and some opportunities to reverse these effects through improved land use practices are also discussed.

Agricultural practices in irrigated and larger scale farms in rain-fed areas have the potential for contributing nonpoint pollution from use of chemical fertilizers and pesticides. In addition, poor cultivation practices can accelerate surface soil erosion, which is severe in parts of the Ethiopian highlands and the Egyptian delta, and salinization is common in irrigated lands. It is apparent that farmers everywhere in the Basin need more incentives to improve their agricultural practices. There also appears to be a great need to develop and strengthen agricultural extension programs and policies.

Deforestation

The removal of trees does not always lead to deforestation, since natural forests are sometimes allowed to regenerate in areas where trees have been cut, or often the area is replanted with commercial tree species, in which case there is no net loss in forest cover and, therefore, no deforestation, which was the case in Burundi and Rwanda during the 1980s and 1990s. For the rural, subsistence farmers in the Nile Basin who depend on the land for their food and fuelwood, forests are susceptible to removal and subsequent conversion to croplands or grazing lands. Under these conditions, there is a net loss of forest cover. Unlike clear-cutting, fuelwood harvesting usually opens the canopy and can diminish the quality of the remaining trees as well as habitat for birds and wildlife, making it more or less destructive.

There has been significant deforestation in the Nile Basin, largely as a result of conversion to agricultural cropping. Deforestation has been particularly severe in the highlands of Ethiopia, the Democratic Republic of the Congo, and Uganda, but has been less severe in Kenya and Tanzania. From 1908 to 1995, total forest area actually increased in Burundi and Rwanda principally because of the establishment of plantations.

The net loss of natural forests has important environmental impacts. As populations grow, the demand for fuelwood increases. As forests become depleted under conditions of increasing demands, shortages of fuelwood can become severe. In some instances, people will burn animal dung when fuelwood is unavailable, thereby reducing organic fertilizer inputs to soils and potentially reducing land productivity. Other environmental impacts include the loss of habitat for birds and other wildlife, which can have a significantly adverse impact when natural forest reserves are already a very small percentages of overall land cover.

The hydrologic effects of deforestation can be significant, as when forest cover is replaced by annual crops or shallow rooted annuals and shrubs. The reduction in evapotranspiration that results can increase water yield and, thus, the quantity of streamflow from a watershed. These effects have been repeatedly documented. In addition, the reduced interception and

infiltration rates that often accompany deforestation can result in greater surface runoff (as opposed to subsurface flow) and will increase surface soil erosion. The consequences of increased flow often appear as increased annual peak flows and altered stream discharge-sediment relationships of stream and river channels. Reservoirs and wetlands then receive greater levels of sediment from uplands, and higher rates of sediment delivery and nutrient export begin to appear downstream in lakes and rivers that in turn can impact water quality, aquatic habitat, and fish populations.

As discussed later in this appendix within the respective sub-basins, the lack of resource tenure in many countries often limits the rural poor from actively engaging in reforestation or tree planting activities. If deforestation is to be reversed, and natural forests to be protected and sustained, policies will need to address issues of resource tenure, and incentives will have to be established that encourage good practices on the part of local watershed inhabitants.

Box A.1. Changes in Water Yield due to Deforestation: Implications for Downstream Effects on River Channels and Sediment Delivery

Widespread evidence exists that removal of forest cover or perennial shrubs (e.g., as would result from watershed degradation) and replacement with annual crops can increase stream flow discharge. The following relationships indicate expected increases in water yield caused by removal of the respective vegetative cover and are based on over 95 controlled experimental watersheds globally:

	Increase in annual water yield (mm) Per 10 % reduction in vegetative cover	
Original Vegetative Cover	Maximum	Minimum
Conifer and eucalypt forest	65 mm	20 mm
Deciduous forest	40 mm	6 mm
Perennial shrub	20 mm	1 mm

Therefore, 100 percent removal of a conifer or eucalyptus forest could increase annual water yield from 200 mm to 650 mm per year; higher responses would be expected in areas with higher rainfall regimes and lower responses from drier regimes.

Depending on the extent to which the soil surface is compacted through cultivation and/or overgrazing, much of the increase in water yield can be in the form of surface runoff, resulting in higher peak flows and greater surface soil erosion and sediment delivery downstream. The cumulative effects of widespread watershed degradation through loss of perennial vegetative cover and soil compaction across watersheds can affect the stability of river channels. Rivers adjust to increased peak flow discharges by entrenching; stream flow and sediment relationships become imbalanced, thereby accelerating sediment delivery downstream through channel degradation. Such effects are being documented in the United States and are particularly important because the resulting impacts can be felt some distance from upland watersheds. In short, increases in stream flow peaks from deforestation and subsequent conversion from perennial vegetation to annual crops on a watershed can affect stream channel stability and sediment delivery to downstream receiving waters, lakes, and reservoirs.

Source: Brooks and others (1997).

Mining

Artisanal mining, while not widespread in the basin, poses peculiar problems of both erosion and runoff pollution. Mining is an issue along the east and southern margins of Lake Victoria (in Burundi, the Democratic Republic of the Congo, Rwanda, and Tanzania) and along the Sudan-Ethiopia border. Deforestation has often preceded mining that then leads to increased surface soil erosion, gully erosion, and soil mass movement along hillsides, and it is known that mines in Kilembe, Uganda, release large quantities of copper and cobalt into streams and rivers that probably cause adverse effects in Lake George, a Ramsar site. In addition, the mines have spilled cobalt sulfide into streams and threaten to spill more, causing severe environmental damage.

In the case of gold mining, toxic wastes, among them heavy metals, are released in large volumes. Because of the nature of mining activities, there is often a change in the water course, and in mining districts it is quite common to see adverse effects on plant and animal life because of indiscriminant land clearing. Policies are often inadequate to regulate mining impacts. Furthermore, there are seldom adequate safeguards or standards.

Wetlands Degradation

Wetlands can be degraded through direct drainage, overgrazing, and cultivation, or indirectly from the discharge of excessive pollutants and sediment from uplands or nearby urban areas. Plans to divert water from the Sudd wetland to reduce evaporative losses and thereby increase flows to the Lower Nile River are well known, as is the concept that any activity that dewaters wetlands will eventually destroy the wetland. Conversion of wetlands into agricultural land in Uganda is a major threat to the enormous number of the country's wetlands. This in turn threatens wildlife habitat (migratory waterfowl) and also affects the hydrologic functioning of these wetlands. In Egypt conversion of wetlands to agricultural use is evident in El Faiyum and the lakes in the Nile delta.

Wetlands behave hydrologically like shallow lakes or reservoirs. They are formed usually as a result of groundwater discharge or poor drainage in flat areas, and contrary to popular belief, they are not normally significant recharge areas for groundwater. Water tables in wetlands are always at or near the land surface. The combination of shallow water tables and low hydraulic gradients results in the slow movement of water and, consequently, high rates of evapotranspiration in wetlands. In comparison with adjacent upland areas, most wetlands lose considerably more water to evaporative losses and, as a result, are more often than not a sink rather than a source of stream flow discharge.

Table A.2. Forest Cover and Change, 1980–1995 (forest area in 000 ha; change in percent).

	Total forest					*Natural forest*				*Plantations*	
	Extent 1980	*Extent 1990*	*Extent 1995*	*Avg. annual change 1980-1990*	*Avg. annual change 1990-1995*	*Extent 1990*	*Extent 1995*	*Avg. annual change 1980-1990*	*Avg. annual change 1990-1995*	*Extent 1990*	*Avg. annual change 1980-1990*
Burundi	260	324	317	2.20	(0.40)	232	225	(0.60)	(0.60)	92	19
D.R. Congo	120,613	112,946	109,245	(0.70)	(0.70)	112,904	109,203	(0.70)	(0.70)	42	10
Egypt	28	34	34	1.80	0.00	--	--	0.00	0.00	34	2
Ethiopia	14,621	13,891	13,579	--	(0.50)	13,891	13,439	--	(0.50)	189	10
Kenya	1,358	1,309	1,292	(0.40)	(0.30)	1,191	1,174	(0.50)	(0.30)	118	1
Rwanda	213	252	250	1.70	(0.20)	164	162	(0.20)	(0.20)	88	7
Sudan	47	43	41,613	(1.00)	(0.80)	43,173	41,410	(1.00)	(0.80)	203	6
Tanzania	38,004	34,123	32,510	(1.10)	(1.00)	33,969	32,510	(1.10)	(1.00)	154	8
Uganda	7,011	6,400	6,104	(0.90)	(0.90)	6,380	6,084	(0.90)	(1.00)	20	--

Source: World Bank, *African Development Indicators 2000*. Dash indicates data unavailable.

As a result of the low velocity of throughflow, wetlands are efficient in trapping and storing the sediments that flow into them. As with lakes and reservoirs, streams entering a wetland will first deposit coarser material, such as sands, then silts and clays. Thus the upstream inflow area of a lake or wetland will often exhibit a delta formation of coarser sediments. As sediment fills in a wetland, its storage capacity is reduced, reducing the ability of the wetland to attenuate flood peaks.

Drainage of wetlands in the upper midwestern United States, and the subsequent loss of storage, has been shown to increase the magnitude of average annual peak flows. Peaks now occur with 20 to 50 year recurrence intervals. Such changes in flow regimes not only impact the frequency of flooding downstream, but they also create unstable stream channel conditions downstream, and accelerate stream bank erosion and sediment discharge. Significant reductions of wetlands in the Nile Basin would be expected to show similar adverse results.

Because wetlands in the past were viewed by many as wastelands, mosquito breeding areas, and generally areas of little value, they have been exploited. Policies in some instances have actually encouraged wetland drainage and conversion to create more economically productive agricultural lands. But the overall effects of such transformations must be fully understood, and it greatly helps to know that policies have been established in many parts of the world to protect wetlands that are deemed valuable for hydrologic, biodiversity, or wildlife habitat purposes. The value of wetlands needs to be understood in the Nile Basin so that rational decisions can be made regarding protection or exploitation. Environmental impact assessments of proposed development of wetlands would provide the necessary public dialogue to help understand the economic and environmental trade-offs involved.

Water Degradation

The principal environmental threats to the water resource include point and nonpoint pollution, eutrophication of lakes, wetland and watershed degradation, and the resulting down-

stream siltation. In some parts of the Basin infestations of exotic species—especially water hyacinth—are an issue. Waterborne diseases (malaria, dysentery, Bilharzia, and other parasites) pose serious problems throughout the Basin, as does kidney disorders caused by polluted drinking water.

Pollution

Although water quality throughout the Basin is often said to be declining, with the exception of water pollution in the Lower Nile north of Aswan and eutrophication of Lake Victoria, the evidence for declining water quality is poorly documented. For example, water quality entering Egypt at Wadi Halfa is thought by Egyptian officials to be quite good, meeting all applicable standards. This points to the fact that a more comprehensive system of environmental data monitoring is needed within the Basin. Such monitoring can help riparian countries identify areas of water quality deterioration and target areas in need of remediation (one reach of river where water quality is systematically monitored is the Lower Nile in Egypt; see table A.3). Until then, care must be used in interpreting the existing water quality information.

Table A.3. Water Quality of the Nile in Egypt (1998)

Site	*COD < 10 mg/l*	*BOD < 6 mg/l*	*TSS mg/l*	*Oil, grease 0.1 mg/l*	*NO_3 mg/l*
1	7	1.2	10	0.3	1.7
2	4	0.8	9	0.36	1.6
3	22	2	6	1.2	1.6
4	17	1.6	12	0.27	1.7
5	6	1.4	12	0.46	2.1
6	5	1.6	9	0.45	2
7	3	1.9	8	0.46	1.9
8	21	1.2	12	1.1	1.6
9	14	1.4	14	0.27	1.3
10	6	1.2	13	0.27	1.5
11	2	1.6	13	0.45	1.8
12	17	1.7	14	0.35	1.3
13	2	1.5	14	0.46	1.4
14	9	2	15	0.41	1.2
15	6	1.6	18	1.5	1.3

Source: Abdelbary, Heikal, and Yousry (1999).

Another consideration in the analysis and interpretation of inputs (i.e., nutrients, runoff, pollutants, etc.) is that we must understand the nutrient cycles of these tropical lakes and rivers. Seasonal influx of nutrients is more often correlated with sporadic storm events or with rainy season flushing of floodplains (Gaudet 1992) than with the "spring flush" associated with snow melt events in the Northern Hemisphere. Moreover, tropical lakes typically have higher rates of production and are often comparable only with polluted or naturally eutrophic lakes of temperate regions (Beadle 1974). As a result, high levels of nutrients (e.g., phosphorus, sulphate, etc.) may be tied up in circulation because of the high rates of recycling in these lakes. These effects must be considered when setting standards for water use and/or ecosystem management plans.

The media constitutes another source of confusion regarding water quality. For example, Lake Victoria is often referred to as polluted when in fact it should more properly be described as undergoing the process of eutrophication, which can be caused by natural as well as artificial means. In this regard, there is no longer a question of deoxygenation of the deeper water of Lake Victoria. Studies such as that by Hecky and others (1995) have confirmed that anoxia has set in and eutrophication is a fact. This is a sobering and unexpected development, and it does not bode well for the future of Lake Victoria. The question is, however, where are the nutrients coming from that have caused this accelerated eutrophication. In areas close to the influent rivers, and along the lakeside on the Ugandan and Kenyan sides, where commercial fertilizers are used and mechanized agriculture is a fact, monitoring is needed to identify source areas. Intensive agriculture in these lakeside areas will probably increase with time because of the availability of water. An example can already be seen in the flower production region surrounding Lake Naivasha in Kenya, where fertilizer use has reached high levels.

In addition to fertilizer and sediment in runoff during storm events, sewage and industrial effluent from cities and towns, such as Kampala, Entebbe, Jinja, Mwanza, Bukoba, and Kisumu, enter Lake Victoria untreated, along with effluents from sugar and paper mills. According to a report of the government of Uganda, the wastes include brewery waste (caustic soda, yeast, alcohol, fermenting barley, etc.) at a rate estimated at 500 m^3/day, tannery waste (including DDT, dichlorobenzines, BOD –700 mg/l) at a rate of 420 m^3/day (GOU 1994), and 2.1tBOD/day from industrial influents at Mwanza (Scheren 1995). The average daily input from municipal and domestic sewage varies with an estimated 1.7 t/day of BOD from the leachate at Kisumu (Akech, Calamari, and Ochumba 1992) to 9.5t/day from municipal and domestic sewage at Mwanza (Scheren 1995).

Thus point-source pollution is occurring, but the overall effect on lake metabolism is unknown. A complicating feature in Lake Victoria is the change in nutrient status of the water due to the reduction in herbivorous fish. Such fish are the principle component in the diet of the carnivorous Nile perch, which is a recent introduction into the Lake. Furthermore, diatom algal flora have been replaced with nitrogen-fixing blue green algae. This last has resulted in a higher algal biomass, which in turn creates a higher oxygen demand and a reduction in lake transparency and clarity. It appears, therefore, that the eutrophication now evident in Lake Victoria may eventually be traced to the above-mentioned sources of pollution and/or changes in the biology and food web structure within the lake. Until more information is gathered and analyzed, the immediate causes for the overall decline in water quality in Lake Victoria remain unknown.

Table A.4. Fertilizer Use in Nile Basin Initiative Countries (1996)

	Use in 1000 m.t.	*Imports 1000 m.t.*	*Use in kg/ha*
Burundi	6	6	3
D.R. Congo	10	10	1
Egypt	1,194	66	264
Eritrea	5	6	0
Ethiopia	154	215	14
Kenya	120	120	31
Rwanda	0	0	0
Sudan	92	97	3
Tanzania	38	38	10
Uganda	3	3	0

Source: World Bank, *African Development Indicators 2000*.

Box A.2. Fertilizer Use in Sub-Saharan Africa

The soils of Africa, which are largely derived from metamorphic rock, require the application of fertilizers to reach their productive potential. The low consumption of fertilizer in Sub-Saharan Africa has long been a concern to the world community. While a reliance on rain-fed agriculture rather than irrigated agriculture explains a part of the low fertilizer use, requiring the importation of fertilizer, fertilizer cost, poor roads, and lack of information also play a role.

From the mid-1970s to the mid-1980s, most Sub-Saharan governments subsidized fertilizer in an effort to boost food production. The subsidies were large and placed a strain on government budgets. Since the late 1980s, governments have adopted structural reforms that reduced or eliminated fertilizer subsidies, tariff and nontariff barriers on all fertilizers were removed, and foreign donors increasingly provided subsidized fertilizer to the private sector. Despite these subsidy programs, fertilizer use has barely changed over the past 20 years. Gains in agricultural output over the past three decades in Sub-Saharan Africa are explained by increases in cultivated areas, not by yields per ha.

Source: Townsend (1999).

Such lack of definitive knowledge applies throughout the Basin, where information is desperately needed to uncover systematic causes for decline in water quality. Presumably such causes would include point discharge and nonpoint runoff of industrial wastes, agricultural chemicals, fertilizers and other nutrients, and untreated sanitary waste. At present, however, industrial pollutants, heavy metals, sulphides, etc., still seem low within the Basin. Despite subsidies for agricultural fertilizers, their use remains low in the Basin, a promising fact since many of these pollutants could presumably be recycled and, in any event, they will not often require conventional (and costly) treatment facilities. Thus the control measures will be easier to deal with at present than in the near future when industrial expansion is expected to accompany

the development of the Basin. Then the same problem will require more drastic measures and, consequently, more expense.

Table A.5. Major Industrial Activities in the Nile Basin

Country	*Industrial activity*
Burundi	Light industries such as food processing, shoes, soap, clothing
D.R. Congo	Mineral processing, textiles, food processing, cement, beverages
Egypt	Heavy industries: cement, ferrous and nonferrous metals, tire manufacturing, petroleum refining, petrochemicals, cotton textiles
Eritrea	Food processing, beverages, clothing, textiles
Ethiopia	Food processing, beverages, textiles, chemicals, metal processing, cement
Kenya	Small-scale manufacture of consumer goods, cigarettes, cement, oil refining, food, and other agricultural processing
Rwanda	Agricultural processing, beverages, soap, shoes, furniture, textiles, cigarettes, cement
Sudan	Food and agricultural processing, cotton ginning, edible oils, sugar, distilling, soap, shoes, cement, petroleum refining
Tanzania	Agricultural processing, mining, oil refining, cement, fertilizer
Uganda	Sugar, brewing, tobacco, cotton textiles, cement, mining, and mineral processing

Siltation

Declining water quality is further affected by siltation caused by the cumulative effects of overgrazing and inappropriate cultivation practices, such as on hill slopes. Additionally, deforestation and loss of wetlands contribute to higher levels of sediment deposition (siltation) in stream channels, rivers, lakes, and reservoirs. This problem is particularly apparent where agricultural practices are rudimentary, where appropriate soil and water conservation measures are not in effect, and where the topography is steep or uneven. Thus siltation is a particular problem in the eastern highlands, but it is also a serious problem in parts of Kenya and Tanzania and in coastal areas of the Egyptian delta. Some level of concern over erosion and siltation exists in all the sub-basins.

The immediate impacts of siltation are degradation of river beds, increased flooding due to channel changes, reduction in reservoir storage behind dams and other waterworks, loss of wetlands, degradation in water quality, and loss of biodiversity. There are two approaches to dealing with the problems of siltation: (i) attempt to fix the root causes, that is, the basic cause of poor agricultural practice, deforestation, and erosion within the region and (ii) deal with sediments in an engineering fashion once they enter the stream network, which involves such interventions as sediment routing, sediment basins, and dredging (Morris and Fan 1998).

Eutrophication and Water Weed Infestation

Accelerated eutrophication in lakes and still waters presents a problem in portions of the Basin. Eutrophication manifests itself in high nutrient levels, algal blooms, and invasion of exotic species, primarily water hyacinth and other water weeds. Although eutrophication can

come about by natural means, it is currently often caused by the improper discharge of nutrients from domestic sanitary sources and nonpoint-source runoff of agricultural chemicals, principally fertilizers. Often the underlying cause is a general degradation of agricultural land quality and loss of vegetative cover, which would otherwise capture and use nutrients. Poor farming practices with a corresponding overuse of agrochemicals plays an important role in the Lower Nile, as do nutrient and chemical discharges from urban and industrial areas throughout the Basin.

Eutrophication in Lake Victoria and its surrounding wetlands is thought to have encouraged the introduction and spread of water hyacinth and other exotic weed species from outside the Basin, which today has forced the lake basin countries to devote a great deal of attention and financial resources to deal with weed control. In some cases there have been delays in mobilizing those resources, and disagreements persist over best practices for controlling weed infestations; however, the notion of complete eradication of water hyacinth from the Basin now seems to many people to be unattainable, so that a program of continuing control is now being put into place and in the future must be meticulously executed.

Waterborne Disease

Waterborne diseases have long been endemic in the Nile Basin. Among others, these include malaria, dysentery, Bilharzia, intestinal worms, and other parasites. The problem of waterborne disease is everywhere in the Basin and relates to the lack of safe water supply (e.g., kidney disorders). According to the United Nations Development Program, 80 percent of ill-nesses and half the infant mortality in Africa are attributed to polluted water and poor sanitation (Rasheed 1998). In the Nile Basin, on a weighted average basis, only about 49 percent the people have access to safe water supply, and only 39 percent have access to adequate sanitation.

Biodiversity

The Nile Basin hosts a rich diversity of flora and fauna. The Basin straddles the equator and lies within and among several major biogeographical areas and biomes. Consequently, it has a diverse and important flora, fauna, and range of ecosystems, which are transboundary. Several Basin countries are making progress identifying and cataloging wetland resources under national wetlands programs. Recent publications of the World Conservation Union (IUCN) Wetlands Program illustrate the progress being made on a regional and national level (Hughes, Hughes, and Bernacsek 1992; Crafter, Njuguna, and Howard 1991; Kamukala and Crafter 1993). Yet such research also reveals degradation in major African wetlands. Among these, for example, the Lorian Swamp of eastern Kenya has shrunk from 150 km^2 in 1913 to 39 km^2 in 1960, to 8 km^2 in 1991.

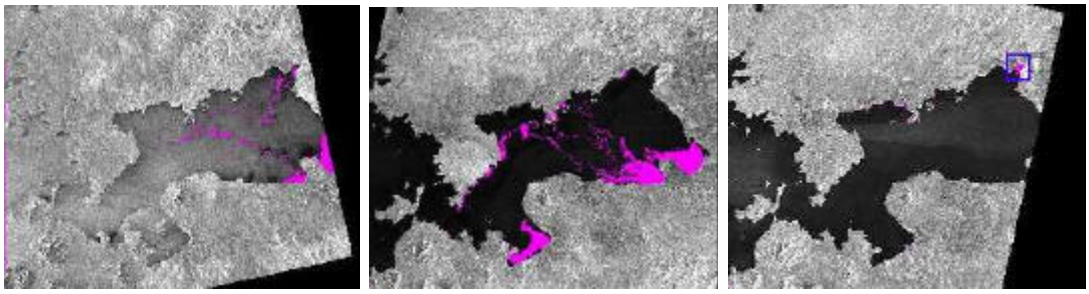
Figure A.1a (left). Severe Water Hyacinth Infestation at Owen Falls Dam, May 1996.
Figure A.1b (right). Water Intake at Murchison Bay, Uganda

Sources: (a) Photo by Clean Lakes, Inc./Aquatics; retrieved June 1, 2000, from the U.S. Geological Survey website at http://edcintl.cr.usgs.gov/ip/hyacinth/owen.html; (b). Photo by International Program staff, January 2000, available at http://edcintl.cr.usgs.gov/ip/hyacinth/intake.html.

Figure A.2. Winam Gulf on the Kenyan Shore of Lake Victoria

Note: In the 1990s, Winam Gulf experienced severe water hyacinth infestation. Particularly hard hit was the city of Kisumu on the northeastern edge of the Gulf. Large mats of water hyacinth were responsible for rendering the port inoperable, limiting fishing and blocking a municipal water intake.

Figure A.3. Recent Radarsat Images of the Winam Gulf Indicating Significant Regression of Water Hyacinth Infestation



Note: Photos taken May 29, 1998; Nov. 6, 1998; and Feb 12, 2000; received by Canada Centre for Remote Sensing, and processed and distributed by RADARSAT International. Image width is approximately 80 km.

Source: Retrieved June 1, 2000, from the U.S. Geological Survey website at http://edcintl.cr.usgs.gov/ip/hyacinth/winam1.html.

Box A.3. Lake Victoria and the Water Hyacinth

Eutrophication is now considered to be the greatest threat to Lake Victoria and seems to have provided an opportunity for the well-publicized invasion of water hyacinth (Eichhornia crassipes), a floating water plant and opportunistic weed with a striking blue-purple flower with yellow markings. It was first introduced from its native Central and South America, and has been recorded in the Nile Basin for at least a century. It established itself as a pest in the Upper and Lower Nile valleys in Sudan and Egypt decades ago. Most recently it entered the Lake Victoria Basin where it has expanded steadily, spread around the entire shoreline, and settled in sheltered bays. In this environment it grows fast and tall, forming dense growths near the shore, often rooted in the mud, which grow outwards to form large mats that float away to further infest the lake. In the open waters of the lake, the plant barely survives, as it is susceptible to wave and wind action.

Most recent estimates (see, for example, Ong'anga and Munyrwa 1998) suggest that possibly 1 percent of the Lake Victoria's area is occupied by water hyacinth. While this appears to be an insignificant proportion, most of that occupancy is in the bays of the lake where many human activities occur and where biodiversity is at its densest. Since it is a flowering plant, it produces seeds in-shore that may germinate in years to come and cause future infestations. The main problem with water hyacinth is that it forms dense mats of entangled plants that impede light penetration to the waters below, thereby denying the growth of other plants and reducing oxygen for other organisms in the lake. The effects on fish are important both from a commercial and biodiversity standpoint. It also increases eutrophication due to the abundance of rotting plants and increases evapotranspiration so that more water is lost from an open water surface than would be the case otherwise. Impacts on end-users include reduction of the small in-shore fisheries and interference with fisheries' operations in general; disruption of water transport; denial of access to water for domestic, industrial, and agricultural purposes; enhancement of water-related human disease; and obstruction of waterways, dams, and hydropower generation, as well as threats to many lakeshore activities. One interesting and positive development has been the sudden decrease in hyacinth coverage in Kisumu (Winam Gulf, Kenya) and along the shore in the Entebbe and Kampala region. The cause of the decrease is still under discussion, but the biological control (Neochetina beetles) and local climate may have had real effects. Such dramatic changes indicate the need for continuous monitoring of the lake's environment and the value of the new remote sensing techniques employed by the U.S. Geological Survey to record changes in floating weed coverage on Lake Victoria (see the Radarsat images at http://edcsnw4.cr.usgs.gov/ip/hyacinth/winam1.html).

How important is biodiversity in this region? The Nile River system of watercourses and wetlands is a major flyway for migratory birds transiting between Europe and the Mediterranean to the north and the equatorial district of Lake Victoria and the Rift Valley lakes to the south. As pointed out in the Government of the Sudan (1983a,b) report on the Sudd region, at least 125 species use the Nile Valley as a flyway between tropical Africa and Eurasia, where they breed during the northern summer. As Africa's largest wetland, the Nile floodplain is of immense importance to these migrants, particularly the water birds. The arid areas of the Basin are home to their own unique varieties of flora and fauna, particularly draught- and saline-insensitive species.

Table A.6. Social Indicators 1990–1996: Percentage of Population with Access to Safe Water, Adequate Sanitation, and Health Services

	Access to safe drinking water (%)			*Access to adequate sanitation (%)*			*Access to health services (%)*		
	Urban	*Rural*	*Total*	*Urban*	*Rural*	*Total*	*Urban*	*Rural*	*Total*
Burundi	93	54	59	60	51	51	100	79	80
D.R. Congo	89	26	42	53	6	18	40	17	26
Egypt	x	x	79	x	x	32	100	99	99
Ethiopia	91	19	25	97	7	19	x	x	46
Kenya	67	49	53	69	81	77	x	x	77
Rwanda	x	79	x	x	85	x	x	x	80
Sudan	84	41	60	79	4	22	x	x	70
Tanzania	73	29	38	96	84	86	x	x	42
Uganda	60	35	38	96	47	64	99	42	49

Source: World Bank, *African Development Indicators 2000.*

Whereas many millions of birds pass through or fly over the Basin twice a year, there are also many more for which the Basin wetlands are a major wintering ground. Because of the great seasonal variations in water and the many organisms that inhabit it, especially the seasonal flowering and fruiting of plants, the bird populations are highly variable in the Basin. In addition to major changes due to migration, there are local seasonal movements; thus a typical wading species, such as the saddlebill stork, which normally occurs singly or in pairs, will tend to aggregate as their food supply (and predators) become increasingly concentrated at the end of the dry season. Other species quit the Basin wetlands entirely during flood periods to reappear during the dry season.

On a worldwide scale, the most important areas for plant species diversity in the Basin are the high-altitude areas of Ethiopia and the Lake Victoria Basin (Mount Elgon and the Rwenzori Mountains). The next most important is the rest of the Lake Victoria Basin, where endemism is low (around 3 percent of species), but plant species diversity is high. There are elements of both the East and West African floras and faunas in a complex of forests, woodlands, shrublands, grasslands, wetlands, and agricultural areas. The lower altitude watershed and part of the White Nile region are in an area where endemism is high at 35 percent of species but diversity is lower. The remainder of the Nile Valley lies within the Sahel and Sahara zones where both endemism and diversity are low and most plants and animals are associated with the river channel.

Ethiopia is considered to be a world center of genetic diversity for several domesticated plant species that are regionally and globally important for agriculture (Demissie 1999). These plants include barley, sorghum, wheat, teff, chickpeas, and coffee. The genetic resources of native Ethiopian plants provide important gene reservoirs for plant breeding programs and thus

are the basis for food security and sustainable agriculture. There is concern about genetic erosion because of land degradation and exploitation of native plants. The conservation of plants across the landscape of the country is deemed to be of critical importance.

There are about 115 species of fish in the Nile River system, 26 of which are endemic to the river downstream of Lake Victoria (Groomridge 1992). This is not a great assemblage compared to the Zaire River with around 650 species (Lowe-McConnell 1993), or the much smaller Rufiji River in Tanzania with 122 species and 25 endemics, unless one adds the statistics from Lake Victoria and its associated wetlands. Here more than 430 species of fishes have been recorded of which possibly 350 are endemic to the lake and its satellites (see, for example, Kaufman and Ochumba 1993). Adding the fish species recorded from Lake Victoria and its associated wetlands with those of all the river fishes of the basin produces a staggering total of more than 540 species, which is only rivaled by the Zaire and Lake Malawi systems in Africa (Lowe-McConnell 1993).

The difference in species composition between the Zaire and Nile is said by Greenwood (1976) to be the result of different geological histories of the two basins in addition to the greater variety of habitats on the Zaire. Climatic factors are also involved; thus the Zaire does not pass through an arid region and exhibits much less seasonal variation than the Nile.

In the last 20 years, many species of Lake Victoria fish have disappeared due to exotic fish introduced into the lake–Nile perch from Lake Albert and Lake Turkana, and several tilapias. These exotic species have changed the nature of fish communities in the lake and downstream, while Nile perch has become the source of a significant export industry.

The rich flora and fauna of the Nile Basin are under environmental stress from poor land-use practices, reductions in water quantity and quality, and weak economic and environmental policies. Poverty and a high reliance on primary natural resources are root causes of the ongoing losses of biodiversity. When combined with inadequate management capacity and a lack of sufficient monitoring, these factors explain why biodiversity in the Basin is threatened. At the same time, there is a lack of full appreciation of the importance of biodiversity and the maintenance of habitat among the populace, especially in rural and riparian areas where much of the degradation is ongoing.

The immediate consequences of loss of biodiversity are the disappearance of endemic animal, bird, fish, and plant species—for example, the loss of native eastern highland grasses, or the increasing dominance of Nile perch over other fish species in Lake Victoria. This has an economic consequence in decreasing the variety of locally produced crops, fish production, and animal products, as well as an increasing reliance on exotic seeds and breeds. Decreasing diversity in forests has led to decreases in habitat and unknown effects on the production of fuelwood, lumber, fodder, and shelter. Ultimately, declining biodiversity in the Basin will affect tourist revenues, as the great biological reservoir of species and landscapes at the heart of the East African tourist industry declines.

Table A.7. Globally Threatened Species

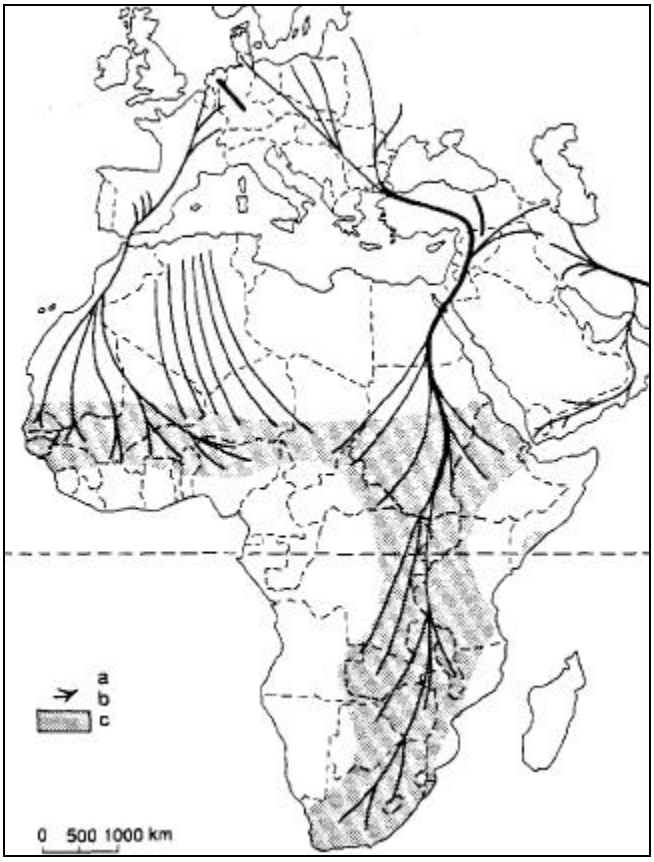
	Mammal species			*Bird species*			*Higher plant species*		
	All	*Threatened*	*Species per 10,000 km²*	*Breeding*	*Threatened*	*Species per 10,000 km²*	*All*	*Threatened*	*Species per 10,000 km²*
Burundi	107	5	76	451	6	322	2,500	1	1,783
D.R. Congo	415	38	69	929	26	153	11,000	7	1,817
Egypt	98	15	21	153	11	33	2,066	84	452
Ethiopia	255	35	54	626	20	133	6,500	153	1,378
Kenya	359	43	94	844	24	221	6,000	158	1,571
Rwanda	151	9	110	513	6	373	2,288	0	1,662
Sudan	267	21	43	680	9	110	3,132	8	506
Tanzania	316	33	70	822	30	183	10,000	406	2,229
Uganda	338	18	118	830	10	290	5,000	6	1,762

Source: World Conservation Union

Box A.4. Ramsar Sites: Wetlands of International Importance

The Nile Basin contains only two wetlands of international importance under the Ramsar Convention on Wetlands, but the Basin is related to several others that are part of the flyways of East Africa. There are two Ramsar sites in northern Egypt, **Lake Bardawil,** which is east of the Delta in the Sinai and a saline lake that serves as a temporary stopover for aquatic birds (some species use both saline and freshwater areas for multiple purposes). Whether or not it is considered a site within the Basin, it clearly is a site related to transboundary flyways. The second Egyptian site, **Lake Burullus,** is located near Rosetta on the Nile delta, and serves the same purpose, but is clearly within the lower Nile Basin. Of the two Kenyan sites, **Lakes Nakuru and Naivasha**, neither is directly connected with the Nile, but each serves as an important stopover point for aquatic birds going to and from the Basin. Thus, they too are included as sites related to flyways. **Lake George**, in Uganda, is a Ramsar site connected by the Kazinga Channel to Lake Edward; it is thus within the Basin. **Lake Nabugabo**, though separated from Lake Victoria, is close enough to the lake itself to serve as a stopover for aquatic birds and is in the process of becoming a Ramsar site. Uganda has indicated it is considering two additional sites for designation as Ramsar sites: **Lake Opeta** in eastern Uganda. and **Lutembe Bay** on the shores of Lake Victoria (http://ramsar.org/cop7_nr_uganda.htm).

Figure A.4. Schematic Representation of the Two Main Migration Routes of the White Stork (Ciconia Ciconia)



Source: Berthold (1993).

Table A.8. Matrix of Population Groups, Ecosystem Components, and Threats

Population groups	*Equatorial lakes*	*Lower altitude watershed*	*White Nile*	*Lower Nile*	*Eastern highlands*
Rain-fed agriculture and agropastoralism	- Refugees - Biodiversity - Deforestation - Disease - Eutrophication - Erosion	- Disease	- Biodiversity - Disease - Siltation - Pollution - Wetlands	- Biodiversity - Disease - Siltation - Pollution - Wetlands	- Drought-flood - Deforestation - Disease - Erosion - Siltation - Wetlands
Pastoralism and livestock production	- Deforestation - Overgrazing - Disease - Pollution - Wetlands - Erosion	- Disease - Wetlands	- Disease - Siltation - Pollution - Wetlands		- Deforestation - Overgrazing - Siltation - Wetlands - Erosion
Irrigated agriculture	-	-	- Salinization - Cropping practices - Sedimentation - Disease - Eutrophication - Wetlands	- Salinization - Cropping practices - Sedimentation - Disease - Eutrophication - Wetlands	-
Fishing communities	- Spills - Sanitation - Biodiversity - Eutrophication - Weed - Pollution	- Biodiversity	- Biodiversity - Siltation - Eutrophication - Pollution	- Biodiversity - Siltation - Eutrophication - Pollution	- Biodiversity - Siltation - Eutrophication - Pollution
Urban dwellers	- Sanitation - Pollution	-	- Pollution	- Pollution	- Flood - Pollution

Transboundary Environmental Issues

The previous sections discuss a variety of environmental threats, most shared by the riparian countries of the Nile Basin, yet many confined to national boundaries. Taking action against such threats on one level is mostly a matter for national governments. However, many of these threats have transboundary aspects that cannot be addressed by nations acting alone. These inherently transboundary environmental issues do not respect national borders and, thus, need to be addressed by regional or basinwide action. Waste discharges, for example, acid rain and river pollution, from one nation into circulating air or water systems that are carried into other nations create transboundary environmental issues. Waste discharges into a commonly held resource, such as a boundary wetland, lake, or sea, similarly create transboundary environmental issues. Solutions to transboundary issues require bilateral or multilateral cooperation.

Box A.5. Main Environmental Threats

To summarize the discussion of this section on environmental threats, the principal issues of concern in each country might be highlighted as follows. Although these are not the only environmental concerns in each country, they represent the most urgent threats. Several common themes can be seen—deforestation in seven countries ands soil erosion in every country. Uganda and Egypt stand out with respect to draining and filling of wetlands and attendant loss of habitat and potential adverse impacts on water quality. Only Egypt is experiencing a threat to soil productivity from increasing groundwater tables and rising soil salinity.

Country	*Principal threats*
Burundi	Deforestation, soil erosion, habitat loss, farming on marginal lands.
D.R. Congo	Water pollution, deforestation, soil erosion, wildlife poaching.
Egypt	Water pollution, air pollution, filling of wetlands, desertification, waterlogging and soil salinity.
Ethiopia	Deforestation, overgrazing, soil erosion, desertification.
Kenya	Water pollution, nonpoint pollution from farms, deforestation, desertification, soil erosion, sedimentation, encroachment on wet lands and lakesides.
Rwanda	Soil erosion, desertification, poaching, overgrazing, degradation from human resettlement.
Sudan	Soil erosion, desertification, shortages of potable water, wildlife hunting.
Tanzania	Deforestation, soil degradation, desertification, water pollution, poaching, shortage of potable water.
Uganda	Draining of wetlands, deforestation, soil erosion, encroachment into marginal lakeshore and riverine ecosystems, and protected areas point and nonpoint pollution.

For the purposes of this report, transboundary environmental issues are defined as those that have immediate proximity or impact on neighboring states or on shared water or natural resources, as well as issues common to the Nile riparians, or those linked to the management of shared water or natural resources.

Pearce and Warford (1993) classify transboundary environmental issues by the externalities they impose. An externality occurs when one economic agent imposes a cost on another economic agent without appropriate compensation. In principle, an externality can also create a benefit, but this is less of an issue. An externality can be unidirectional or reciprocal. A unidirectional externality is imposed by one nation on another, for example, when economic agents in the upstream nation dump wastes into a river that flows into a downstream nation. Costs of environmental degradation accrue to economic agents in the downstream nation by the action of agents in the upstream nation. A reciprocal externality is caused mutually between nations, for example, when a resource such as a lake or aquifer is shared by nations whose factories and municipalities each dump wastes into it. Costs of environmental degradation accrue to all the riparians by the actions of all the other riparians. Unidirectional and reciprocal

externalities are the simple extreme conditions; transboundary environmental issues of the real world tend to be a mixture of types.

Table A.9. Transboundary Environmental Issues as Externalities

Externality direction	*Generator and sufferer*	*Example*
Unidirectional	one → one	Downstream siltation
	one → few	Upstream discharges into multinational river
	few → one	Disposal of hazardous wastes
	few → few	
	few → many	Deforestation
Reciprocal	few ←→ few	Pollution of a border lake
	many ←→ many	Global biodiversity loss

Source: Adapted from Pearce and Warford (1993).

In the Nile Basin, the principal transboundary environmental issues include (i) river pollution transiting from upstream to downstream countries; (ii) siltation originating from eroding land and depositing in wetlands, lakes, or reservoirs downstream; (iii) degradation of shared resources, such as lakes, wetlands, and protected areas; (iv) adverse impacts on migrating species through habitat destruction, particularly of bird populations; and (v) population migration caused by weather variability, civil strife, and other factors. River pollution in the Nile appears to be a minor threat at present, although there are some pollution hot spots, and siltation is important in several parts of the Basin. Degradation of shared resources is important in the Lake Victoria region but less so elsewhere. Impacts on bird populations are important throughout the Basin as wetland habitat shrinks. Air pollution, which is a common transboundary environmental issue in other parts of the world, has yet to become a significant transboundary issue in the Nile Basin.

River Pollution

Transboundary river pollution in much of the Nile Basin appears not to be a serious issue as yet, at least to the extent documented in limited environmental monitoring data. For example, water quality entering the Sudan upstream of Juba and entering Egypt at Wadi Halfa is judged by Sudan and Egypt, respectively, to be good. Water quality entering Sudan from the eastern highlands is similarly judged to be free of significant biological and chemical contamination, although silt loads in the eastern tributaries have been high throughout recorded history, and may be increasing. Given the long transit times for water flowing from the equatorial lake district to reach population centers along the main Nile in Sudan and Egypt, the threat of pollution from sanitary runoff seems remote. In recent periods the outbreak of deadly hostilities in upstream countries has raised the specter of pathogenic contamination to downstream riparians, but there seems to be little scientific evidence to substantiate these fears.

Siltation

Siltation caused by high rates of soil erosion has persisted in the eastern highlands since the end of the last ice age, about 12,000 years ago, but is thought to be increasing. This siltation has caused loss of riparian habitat downstream and loss of reservoir storage behind dams. To a great extent, the issue of siltation from the eastern highlands was well known before the construction of modern downstream dams in Sudan and Egypt, and thus was neither unexpected nor unplanned for. For example, the High Dam was planned to accommodate 500 years of predicted sediment accumulation in reservoir dead storage. Rates of reservoir siltation are thought to be increasing, at least in Lake Nubia/Nasser, but empirical data appear to be limited. Siltation in the equatorial lakes district is less intense than in the eastern highlands, but it has the potential to affect unique and valuable wetland habitats. Only part of this threat is transboundary, but the issue of siltation and loss of wetland habitat is common to all the riparian countries, and from that view is of Basin-wide concern.

Shared Resources: Lakes, Wetlands, and Protected Areas

Under the East African Cross-Border Biodiversity Project, Kenya, Tanzania, and Uganda are cooperating to reduce biodiversity loss in the transboundary ecosystems of Rakai/Mbarara and Moroto/Kotido. Ethiopia and Sudan are considering the potential for transboundary protected areas at Dinder to preserve an established migratory corridor for large animals, and at Alatish to protect rare and endangered bird species. Burundi, Rwanda, the Democratic Republic of the Congo, and Uganda similarly share transboundary protected areas and national parklands of unique environmental importance. These are environmentally protected lands and associated flora and fauna that overlap borders and thus fall under the joint responsibility of more than one riparian country.

Among the most noteworthy activities aimed at managing transboundary environmental resources in the Nile Basin is the Lake Victoria Environmental Management Program, involving Kenya, Tanzania, and Uganda. Lake Edward, Lake Albert, the Kagera River, and the Semliki River are also transboundary waterways of bilateral or multilateral concern to their riparian nations.

Habitat Destruction and Migrating Species

The Nile Basin is one of the principal flyways of the world for species migrating from Europe and the Mediterranean to tropical Africa. Changes in wetland extent or water quality anywhere within the Basin affect the viability of these migrations and of the species involved throughout the Nile—and even of Europe and the Middle East. Until recently, Uganda had a national policy favoring the conversion of wetlands to agricultural and other uses. Egypt has filled most of the wetlands of the Nile delta. As noted elsewhere in this report, completion of the Jonglei canal would have an adverse impact on wetland habitat.

Population Migration

Population migrations caused by drought, war, and civil strife are an unfortunate fact of life in the White Nile Basin and take a huge toll on the environment. With their existence

threatened, migrating people naturally think about survival to the exclusion of the natural resources in the territory through which they pass.

Exotic Species

In parts of the Nile Basin, species introduced from one region to another have become important environmental issues. Well-known examples include the Nile perch and water hyacinth that were introduced into Lake Victoria.

Air Pollution

Air pollution, which is a common transboundary environmental issue in other parts of the world, such as North America and Europe, has yet to become a transboundary issue in the Nile Basin.

Box A.6. Transboundary National Parks and Protected Areas

Dinder NP (Sudan): Alatish Area (Ethiopia)
Garabela NP (Sudan)
Omo NP (Sudan/Kenya)
Nimule NP (Sudan/Uganda)
Karamoja Turkana (Uganda/Kenya)
Mount Elgon NP (Kenya on Uganda border)
Lake George (Uganda)
Ruvubu NP (Burundi)
Lake Rwihinda NR (Burundi)
Virunja Conservation Area: Virungas (D.R. Congo), Mgahinga (Uganda), Volcan (Rwanda)
Kibira (Burundi): Nyungwe NP (Rwanda)
Lake Rwihinda (Burundi)
Kagera NP (Rwanda)
Ibana Game Reserve
Rumanyika Game Reserve (Tanzania)
Minziro Sango Bay Swamp-Forest (Uganda/ Tanzania)
Masai Mara Natural Reserve (Kenya): Serengeti NP (Tanzania)
Lake Tana (Ethiopia)
Seminin Mountain NP (Ethiopia at Eritrea)

Table A.10. Transboundary Analysis: Common Concerns by Subregion

Common concerns	*Equatorial lakes*	*Lower altitude watershed*	*White Nile (Malakal to Khartoum)*	*Lower Nile (Khartoum to Med.)*	*Eastern highland*	*Basin-wide*
1. Land degradation						
Deforestation						
Soil erosion						
Wetland degradation						
Riverbank and lakeshore degradation						
Mining impacts						
2. Water quality degradation						
Pollution (point and nonpoint source)						
Eutrophication						
Water weeds infestation						
Waterborne diseases						
Siltation						
Sewerage discharge from boats					?	
3. Urban and industrial issues						
Sanitation concerns (runoff, sewerage)						
Urbanization and industrialization on lakeshores and riverbanks						
Waterborne diseases						
4. Disaster preparedness						
Navigation risks, aids, and mapping						
Oil spills						
Floods and droughts						
Refugee problems						
Uncertain impacts of climate change						
5. Biodiversity loss						
Biodiversity – Loss and destruction of valuable species and habitats						

=high =medium =low

Source: World Bank/United Nations Development Program National Experts Group Consolidated Report (**Draft 2000)**

Appendix B. Stakeholders Consulted during the Study

Burundi
INECN
NILE-COM Representative
NILE-TAC Representative
UNDP-Burundi
USAID-Burundi, Office of U.S. Foreign Disaster Assistance

Democratic Republic of Congo
Ministry of Environment and Nature Conservation
NILE-COM Representative
NILE-TAC Representative
UNDP, DRC
US Embassy, DRC
USAID, DRC

Egypt
Ain Shamps University, Water Resource Department
Archeological Engineering Department, Cairo University
Construction Research Institute, National Water Research Center
Drainage Research Institute, National Water Research Center
Egyptian Environmental Affairs Agency
EIA Central Department, Egypt Environmental Affairs Agency
Embassy of the United States of America-Egypt
Environment and Climate Change Research Institute, National Water Research Center
Environmental Management and Technology Component, Egypt Environmental Initiatives Fund
Environmental Research Institute, National Water Research Center
EPIQ Water Policy Team, Ministry of Water Resources and Irrigation
European Union-Egypt
Groundwater Research Institute, National Water Research Center
Higher Education Program, UNESCO
Hydraulics Research Center, Cairo University,
Hydraulics Research Institute, National Water Research Center
Institute for International Law, Cairo University
Ministry of Environment and Natural Resources, National Environmental Secretariat
Ministry of Public Works and Water Resources, Planning Sector
National Water Quality and Availability Project
Nile Basin Forecasting Center, Ministry of Water Resources and Irrigation
Nile Research Institute, Ministry of Public Works and Water Resources
NILE-COM Representative
NILE-TAC Representative
Planning, Follow Up, and Technical Cooperation, Egyptian Environmental Affairs Agency
River Nile Institute, National Water Research Center
Shared Water Resources Program, Cairo University,

UNDP-Egypt
US Embassy-Egypt
USAID-Egypt
World Bank-Egypt

Ethiopia
Catholic Relief Services
CIDA-Ethiopia
Environmental Protection Authority
Ministry of Foreign Affairs
Ministry of Water Resources
NILE-COM Representative
NILE-TAC Representative
SIDA-Ethiopia
UNDP-Ethiopia
US Embassy Addis Ababa
USAID-Ethiopia

Kenya
Africover, FAO
Belgian Administration for Development Cooperation
Kenyatta University
Lake Victoria Environmental Management Program-Kenya
Min of Environment and Natural Resources
Min of Environment and Natural Resources, Department of Water Resources
Ministry of Water Resources
NILE-COM Representative
NILE-TAC Representative
Office of the VP and Ministry of Planning and National Development, Department of Resources Survey and Remote Sensing
UNEP, Africa Bureau
USAID, REDSO
USAID-Kenya

Rwanda
Ministry of Energy, Water and Natural Resources
Ministry of Human Resettlement and Environment
NILE-COM Representative
NILE-TAC Representative
UNDP-Rwanda
US Embassy-Rwanda
USAID-Rwanda

Sudan
NILE-COM Representative
NILE-TAC Representative

Tanzania
CIDA
DANIDA
European Union
Institute of Resource Assessment, University of Dar Es Salaam
Lake Victoria Environmental Management Program-Tanzania
NILE-COM Representative
NILE-TAC Representative
UNDP, Water Group
University of Dar Es Salaam, Water Resources Institute
USAID, Tanzania
Vice President's Office, Environment
Vice President's Office, Environment
Water Resources Institute, Water Resources Department

Uganda
Africa Water
Aquatics, Lake Victoria Environmental Management Program, Water Hyacinth Control Program
EC Natural Forest Mgt and Conservation Project, Commissioner of Forestry Office
European Union Mission
Forest Department, Min of Lands Water and Environment
German Development Cooperation, Uganda Wildlife Authority
IUCN Wetlands Program
Lake Victoria Environmental Management Program-Uganda
Makerere University, Institute of Environment and Natural Resources RS & GIS Lab
Ministry of Water Lands and Environment
National Environmental Management Agency, EIA Unit
National Wetlands Program
NBI Secretariat
NILE-COM Representative
NILE-TAC Representative
UNDP-Uganda
US Embassy Uganda
USAID Conservation of Biological Diversity Program
USAID-Uganda
Water Resource Management Department, Directorate of Water Development
World Bank-Uganda

NILE-TAC
Burundi, Manasse Nduwayo
D.R.Congo,Kayembe Ditanta
Egypt, Ahmed M. Fahmy
Ethiopia, Kidane Assefa
Kenya, George K. Chesang
Rwanda, Emmanuel Nsanzumuganwa
Sudan, Osman El Tom Hamad
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UNDP/GEF National Expert Consultants
Burundi, Hakizimana Gabriel, INECN
DR Congo, Kilala Katsuva
Egypt, Hesham El Badry, Ain Shamps University and Egyptian Environmental Affairs Agency
Ethiopia, Tesfamariam Tequam, Environmental Protection Authority
Kenya, Sylvester P.M. Kiai, Ministry of Environment and Natural Resources
Rwanda, Tharcisse Urayeneza,
Sudan, Badiker Ibrahim, Higher Council for Environment and Natural Resources
Tanzania, Francis Gumbo, Ministry of Water
Uganda, Justin Ecaat, National Environmental Management Authority

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