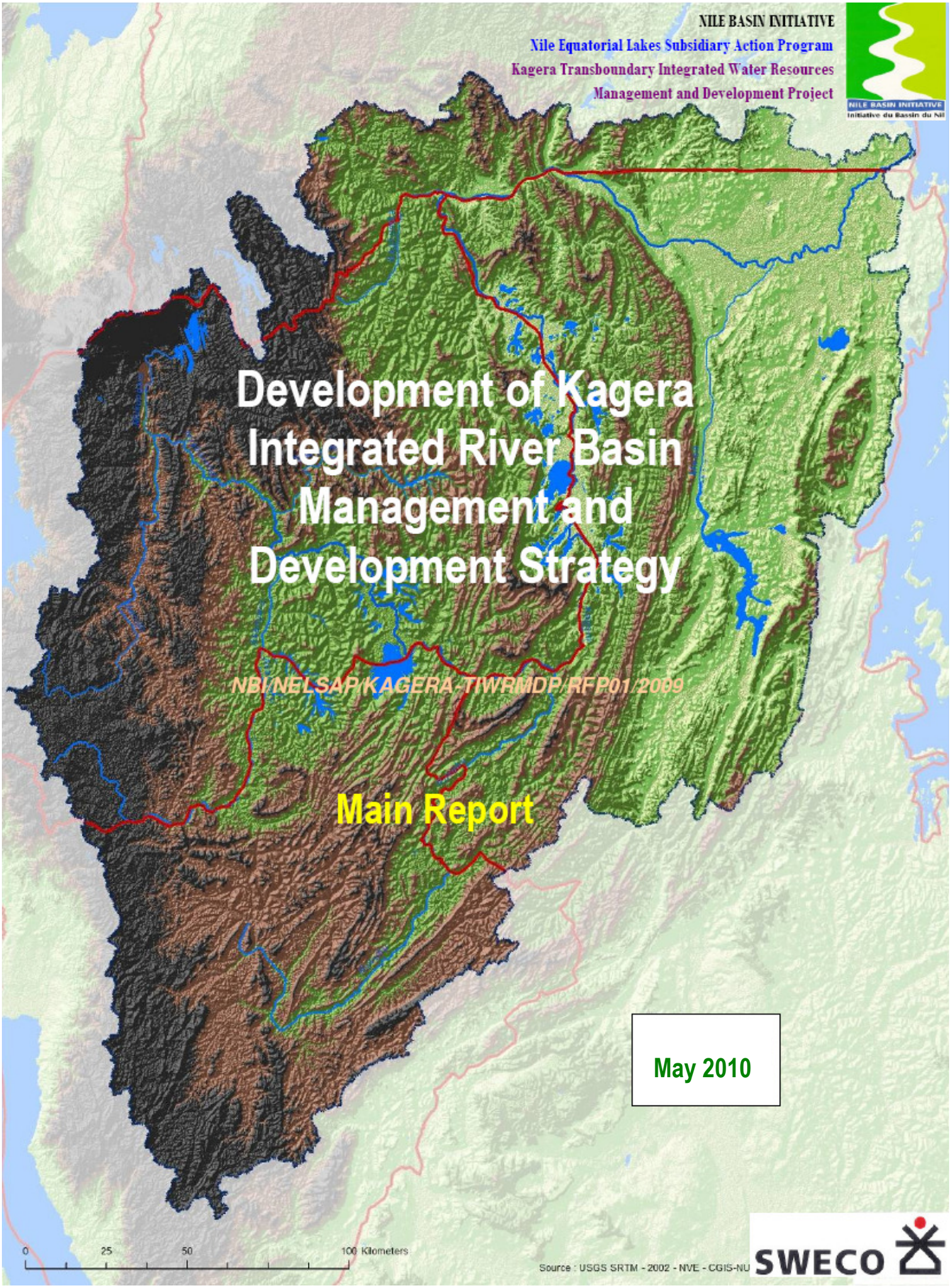
NILE BASIN INITIATIVE
Nile Equatorial Lakes Subsidiary Action Program
Kagera Transboundary Integrated Water Resources
Management and Development Project
NILE BASIN INITIATIVE
Initiative du Bassin du Nil
Development of Kagera Integrated River Basin Management and Development Strategy
NBI/NELSAP/KAGERA-TIWRMDP/RFP01/2009
Main Report
May 2010
0
25
50
100 Kilometers
Source : USGS SRTM - 2002 - NVE - CGIS-NU
SWECO

NILE BASIN INITIATIVE

NILE EQUATORIAL LAKES SUBSIDIARY ACTION PROGRAM

KAGERA TRANSBOUNDARY INTEGRATED WATER RESOURCES MANAGEMENT AND DEVELOPMENT PROJECT

Development of Kagera Integrated River Basin Management and Development Strategy

NBI/NELSAP/KAGERA-TIWRMDP/RFP01/2009

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Abbreviations and Acronyms

ACP	Awareness creation program
ATCB	Associated technical cooperation budget
ADB	African Development Bank
B/C	Benefit/Cost ratio
BDP	Basin Development Plan
BDPP	Basin Development Plan Program
BFP	Basin Focal Project
BOD	Biological oxygen demand
BRLi	BRL Ingénerie
CBSI	Confidence Building and Stakeholders Involvement Project (NBI)
CEO	Chief Executive Officer
CITES	Convention on International Trade on Endangered Species
CGIAR	Consultative Group on International Agricultural Research
CGISNUR	Geographic Information Systems and Remote Sensing Training and Research Centre, University of Rwanda, Butare
COM	Council of Ministers
DAC	Development Assistance Committee (of the OECD)
DANIDA	Danish International Development Agency
DEM	Digital elevation maps
DFID	UK Department for International Development
DHDP	Dams & Hydropower Development Program
DRC	Democratic Republic of Congo
DMMP	Disaster Management and Mitigation Program
DSF	Decision support framework
DSS	Decision Support System – numerical computer-based modeling tool(s)
EBRD	European Bank for Reconstruction & Development
ECA	Economic Commission for Africa
EDSP	Environmental Decision Support Program
EGZ	Economic Growth Zone
EIA	Environmental Impact Assessment
EMAP	Environmental Monitoring and Assessment
ENSAP	Eastern Nile Subsidiary Action Program
ENTRO	Eastern Nile Technical Regional Office, NBI, Addis Ababa
ETO	Reference Evapotranspiration
EU	European Union
EVD	Environment Division
FAO	Food and Agriculture Organization of the United Nations, Rome
FOs	Farmers' Organizations
GCOs	Grassroots Community Organizations

GDP	Gross Domestic Product – estimate of the size of a national economy – usually expressed in USD
GEF	Global Environment Facility
GNI	Gross National Income – estimate of the size of a national economy – a GDP calculation method favored by the World Bank – usually expressed in USD
GIS	Geographic Information System
GWP	Global Water Partnership
HDI	Human Development Index
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immuno-Deficiency Syndrome
HRD	Human resource development
HYDROMET	WMO/UNDP Hydrometeorological Survey. 1967. Egypt, Kenya, Sudan, Tanzania and Uganda. Rwanda and Uganda joined 1977. Ethiopia was not involved.
IBFM	Integrated Basin Flow Management
ICBP	Integrated Capacity Building Program
ICCON	International Consortium for the Cooperation on the Nile (donor consultative group)
ICID	International Commission on Irrigation and Drainage
ICOLD	International Commission on Large dams
ICRAF	International Centre for Research in Agroforestry
IDDP	Irrigation & Drainage Development Program
IDIS	Integrated Database Information System
IEC	Information, Education and Communication
IFAD	International Fund for Agricultural Development, Rome
IFC	International Finance Corporation
IGEBU	Institut Géographique du Burundi, Gitega
IKMP	Information & Knowledge Management Program
ILM	Integrated Land Management
IRR	Internal rate of return
ISABU	Institut des Sciences Agronomiques du Burundi
ISAR	Institut des Sciences Agronomiques du Rwanda
IUCN	International Union for Conservation of Nature and Natural Resources
IWMI	International Water Management Institute, Colombo, Sri Lanka
IWRM	Integrated Water Resources Management
IWRMD	Integrated Water Resource Management and Development
JKRBO	Joint Kagera River Basin Organization
JRBO	Joint River Basin Organization
KBMP	Kagera River Basin Trans-boundary Integrated Water Resources Management & Development Project
KIRBMDS	Kagera Integrated River Basin Management & Development Strategy
KBO	Organization for the Management and Development of the Kagera River Basin
KICA	Korea International Cooperation Agency
km^3	1 km^3 = 1 billion m^3 = 1000 Mm^3 = 1,000 Gigaliters (Gl) = 1 million Megaliters (Ml)
KWRC	Korea Water Resources Corporation
LVBC	Lake Victoria Basin Commission

LVDSS	Lake Victoria Decision Support System
LVEMP	Lake Victoria Environmental Management Programme
m amsl	meters (elevation) above mean sea level – ground surface elevation
MDGs	Millennium Development Goals of the United Nations
M&E	Monitoring and evaluation
MFI	Multilateral financial institution
MIGA	Multilateral Investment Guarantee Agency
NBCBN	Nile Basin Capacity Building Network
NBI	Nile Basin Initiative, 1999
NEL-CU	NELSAP Coordination Unit (NBI)
NELSAP	Nile Equatorial Lakes Subsidiary Action Program (NBI)
NEMA	National Environment Management Authorities
NGO	Non-Governmental Organization
NHDR	National Human Development Report
Nile-DSS	Nile Decision Support System – numerical modeling tools presently under development by the Water Resources Planning and Management Project, NBI
Nile-DST	Nile Decision Support Tool – numerical modeling tools developed with FAO support
NKCs	National Kagera Committees
NPV	Net present value
NORAD	Norwegian Agency for Development Cooperation
NTEAP	Nile Trans-boundary Environmental Action Project
O&M	Operation and maintenance
OCEO	Office of Chief Executive Officer
ODA	Official development assistance
OEB	Operating expense budget
OECD	Organization for Economic Cooperation and Development
OPD	Operations Division
ORTPN	Office Rwandais du Tourisme et des Parcs Nationaux
PAIGELAC	Le Projet d'Appui à l'Installation Intégrée et à la Gestion des Lacs Intérieurs - Integrated Installation and Interior Lakes Management Support Project, Rwanda
PGNRE	Projet de Gestion National des Ressources en Eau - National Water Resources Management Project, Rwanda
PMU	Project Management Unit
PRSP	Poverty Reduction Strategy Paper
PTSD	Planning and Technical Support Division
RBM	River basin management
R&D	Research and development
RPSC	Regional Project Steering Committee
Sida	Swedish International Development Cooperation Agency
SJEC	Standing Joint Executive Committee
SMT	Senior Management Team
SWC	Soil and water conservation

SWCP	Soil & Water Conservation Program
SWOT	Strengths, Weaknesses, Opportunities, Threats
TBM	Tunnel boring machines
TECCONILE	Technical Committee for the Promotion of the Nile Basin, 1992. Egypt, Sudan, Rwanda, Tanzania, Uganda and Congo. Ethiopia, Kenya and Burundi were observers
ToR	Terms of Reference
UNDP	United Nations Development Program
UNDUGU	*Brotherhood* in Swahili: an early (1983) collaborative effort on the Nile involving Burundi, the CAR, Egypt, Rwanda, Sudan, Uganda and Zaire
USD	United States Dollars
WC&WDM	Water Conservation and Water Demand Management
WHO	World Health Organization
WRMD	Water Resources Management Development
WSS	Water supply and sanitation
WSSP	Water Supply and Sanitation Program
WUA	Water users association
WUP	Water Utilization Program
WWAP	United Nations World Water Assessment Program
WWC	World Water Council

Acknowledgements

The Consultant Team would like to express its gratitude to all parties who have contributed and provided valuable input and comments during the Consultant assignment to jointly prepare the Kagera Management and Development Strategy, a process oriented task where the active contribution has been a necessity.

The Client, NBI through NELSAP and the Kagera PMU has willingly geared the Consultant via active advice and decisions throughout the assignment. All other stakeholders of the riparian countries Burundi, Rwanda, Tanzania and Uganda from government offices to NGOs have also actively contributed to the development of the Strategy, and this Final Report is the final delivery connected to the contract agreement between NBI and SWECO.

Stockholm and Kigali May 2010

SWECO International AB

Per-Olof Seman
Senior Vice President, and
Consultant Project Director

I. Introduction

I.1 Nile Basin Initiative

The Nile Basin Initiative (NBI) is a partnership of the riparian states [1] that seeks to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security through its shared vision of "sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources".

The primary objectives of the NBI are:

- to develop the water resources of the Nile Basin in a sustainable and equitable way to ensure prosperity, security and peace for all its peoples;
- to ensure efficient water management and the optimal use of the resources;
- to ensure cooperation and joint action between the riparian countries, seeking win-win gains;
- to target poverty eradication and promote economic integration; and
- To ensure that the program results in a move from planning to action.

The NBI's *Strategic Action Program* is made up of two complementary programs: the basin wide *Shared Vision Program* to build confidence and capacity across the basin, and *Subsidiary Action Programs* to initiate concrete investments and action on the ground in the *Eastern Nile and Nile Equatorial Lakes sub-basins.* The programs are reinforcing in nature. The Shared Vision Program focuses on building regional institutions, capacity, and trust, to lay the foundation for unlocking the development potential of the Nile, which can be realized through concrete investments carried out under the subsidiary action programs.

The "Draft" Nile River Basin Cooperative Framework

The most recent draft Agreement on the Nile River Basin Cooperative Framework ("the Framework Agreement") is that presented and considered by the Nile River Basin Council of Ministers ("Nile-COM") at its annual general meeting held at Entebbe, Uganda during 22nd – 25th June 2007. The key provisions of the Framework Agreement are summarized below.

Scope of the Nile Basin Cooperative Framework Agreement: The Framework Agreement will, when adopted, regulate the use, development, protection, conservation and management of the entire Nile River Basin and its resources. It proposes to establish a basin wide legal and institutional framework for cooperation among the Nile River Basin states. The key terms under the Framework Agreement are the "Nile River Basin" and the "Nile River System". Both are defined widely in accordance with accepted international law principles in terms of the geographical area determined by

[1] Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda. Eritrea is participating actively in the NBI as an observer.

the watershed limits of the surface and ground waters related to the Nile River. It is clear from Articles 1 and 2 of the Framework Agreement that the Kagera River Basin forms part of the "Nile River System" and so constitutes part of the wider "Nile River Basin". The Framework Agreement will, therefore, when concluded and adopted by the NBI member states regulate the use, development, protection, conservation and management of the Kagera River Basin.

General Principles: The Framework Agreement sets out fifteen general principles that will guide the protection, use, conservation and development of the Nile River Basin. These include the following:

- co-operation on the basis of sovereign equality, territorial integrity, mutual benefit and good faith;
- sustainable development;
- subsidiarity whereby development and protection of the River Nile Basin is planned and implemented at the lowest appropriate level;
- equitable and reasonable utilization of waters of the Nile River System;
- the right of each Nile Basin State to use, within its territory , the waters of the Nile River Basin;
- each state to take appropriate measures individually, and where appropriate jointly for the protection and conservation of the Nile River Basin and its ecosystem;
- exchange of information on planned measures through the Nile Basin Commission;
- regular and reciprocal exchange of relevant data and information; and
- Environmental impact assessment and audits.

Rights and Obligations: Articles 4 – 14 of the Framework Agreement set out the rights and obligations of the Nile River Basin states. Each Nile River Basin state will have the following rights and obligations in relation to national projects utilizing the Nile River waters:

- the right to utilize water resources of the Nile River System and Basin in its territory in an equitable and reasonable manner;
- an obligation not to cause significant harm to other basin states;
- an obligation to take appropriate measures to protect, conserve and where necessary to rehabilitate the Nile River Basin and its eco systems;
- an obligation to exchange on a regular basis readily available and relevant data and information on existing measures and on the condition of water resources of the Basin;
- an obligation to exchange information on planned measures through the Nile Basin Commission;
- an obligation to undertake environmental impact assessments for any planned measures that have significant adverse environmental impacts – applies to both national and transboundary projects;
- an obligation to allow affected stakeholders to participate in the planning and implementation of projects consistent with the basin – wide framework;
- an obligation to take all appropriate measures to prevent or mitigate conditions harmful to other basin states such as floods, invasive weeds, water-borne diseases, siltation, erosion, drought or desertification;

- an obligation to promptly notify other potentially affected and competent basin states of any emergency situations originating in its territory and to take all practicable measures to prevent, mitigate and eliminate harmful effects of the emergency; and
- An obligation to protect Nile River Basin and related installations in times of armed conflict.

I.2 Nile Equatorial Lakes Subsidiary Action Program

The countries of the Nile Equatorial Lakes Subsidiary Action Program[2] have identified a number of projects to promote poverty alleviation, economic growth, and the reversal of environmental degradation in the sub-basin. The projects are grouped into two major areas: *Natural Resources Management and the Environment* and *Hydropower Development and Trade*, and target investments in agricultural development, fisheries development, water resources management, water hyacinth control, hydropower development and transmission interconnection. A small NELSAP Coordination Unit (NELSAP-CU) based in Kigali, Rwanda, in collaboration with the NBI Secretariat in Entebbe, Uganda, coordinates and facilitates the activities of the program.

I.3 The Lake Victoria Basin Commission

The Lake Victoria Basin Commission (LVBC) is one of the key organizations with regard to Kagera Basin management and development. LVBC derives its mandate from the East African Community (EAC) and, as a means of setting the background, a review of the LVBC is preceded here by a review of the EAC treaty.

The East African Community (EAC) is a regional group of countries in the East African region comprising Tanzania, Kenya, Uganda, Rwanda and Burundi. The EAC was set up under the Treaty for the Establishment of the East African Community ("the EAC Treaty") which was signed on 30th November 1999 and came into force on 7th July 2000. It re-established the East African Community, the earlier treaty having collapsed in 1977. The EAC was originally established by and comprised of Tanzania, Kenya and Uganda, but on the 18th June 2007, Burundi and Rwanda signed treaties of accession to the EAC and became full members of the EAC effective from 1st July 2007. Both Rwanda and Burundi are now bound by the EAC Treaty, EAC legislation, EAC protocols and instruments and memoranda of understanding.

One of the key objectives of the EAC is the development of policies and programs aimed at the widening and deepening of regional co-operation in political, economic, social and cultural fields, research and technology, defence, security and legal and judicial affairs. For purposes of implementing its objectives, the EAC is required to ensure, amongst other areas of cooperation, the "*promotion of sustainable utilization of natural resources of the EAC member states and the taking of measures that would effectively protect the natural environment*" (see Article 15.3 {c}).

[2] Burundi, D.R. Congo, Egypt, Kenya, Rwanda, Sudan, Tanzania and Uganda

Protocol for Sustainable Development of Lake Victoria Basin

EAC partner states agreed (under Article 114 of the EAC Treaty) to establish a body for the management of Lake Victoria. This was implemented by the EAC through the adoption of the Protocol for Sustainable Development of Lake Victoria Basin on 29th November 2003 ("the LVBC Protocol"). Since 2006 the Secretariat has been based in Kisumu, Kenya.

The LVBC Protocol sets out in Article 4 the general principles to guide the management of the Lake Victoria Basin. These principles are drawn from accepted rules of international law regarding waterways. Key principles include:

- equitable and reasonable utilization of water resources;
- sustainable development;
- prevention to cause harm to EAC members which oblige EAC partner states to individually and jointly take appropriate measures to prevent environmental harm;
- environmental impact assessment and audit;
- prevention, minimization and control of pollution of water courses so as to minimize adverse effects on fresh water resources and their ecosystems and on human health;
- the protection and preservation of the ecosystems of international water courses whereby ecosystems are treated as units, all of whose components are necessary to their proper functioning;
- the principle of community of interests in an international watercourse whereby all states sharing an international watercourse system have an interest in the unitary whole of the system;
- water is a social and economic good and a finite resource; and
- The principle of subsidiarity.

Article 5 of the Protocol obliges all EAC partner states to utilize the water resources of the Basin in an equitable and reasonable manner.

I.4 The Kagera TIWR Management and Development Project

The Kagera Transboundary Integrated Water Resource Management and Development Project (KTIWRMDP) is one of the three river basin projects implemented under the NELSAP. Others include the Mara River basin Project and the Sio-Malaba-Malakisi Transboundary IWRM Projects located in Kenya, Tanzania and Uganda respectively. The Kagera region contains some of the world's poorest countries and is marred by conflict and civil strife. The basin is characterized by low productive peasant agriculture and endemic poverty. There is continuing land degradation and loss of soil fertility caused by population pressure and primitive farming methods. There is ongoing deforestation and an almost total absence of reforestation activities. Virtually the only source of energy is biomass, contributing to the deforestation. The soil erosion results in an increased nutrient load in the river and also in Lake Victoria, leading to problems with water hyacinth and eutrophication. In the basin area there is also insufficient water for household use and for grazing. Wetlands are exploited and degraded, and there are

unplanned migrations across borders of pastoralists with their cattle causing friction in the border zone.

I.5 Highlights of Activities

The primary objective of this consultancy is to develop an integrated river basin management and development strategy for the Kagera basin. (The entire Terms of Reference for the assignment is presented as Annex G). The specific objectives of this consultancy include the following:

- To develop scenarios for water resources development in the Kagera basin based on review of the *Kagera River Basin Monograph* and Information database.
- To develop a simple model to support integrated planning and management of the Kagera River Basin; and conduct training on the simple model.
- To develop a Kagera Basin Integrated River Basin Management and Development Strategy based on international best practice in IWRM.
- To prepare Terms of Reference for pre-feasibility and feasibility studies for viable investment opportunities arising from the development strategy.

The total input to the consultancy is 20 man months and the distribution among the specialist consultants is as follows:

- Water Resources Management Expert/Team Leader (6 man-months)
- River Basin Modeller (3 man-months)
- Hydrologist (5 man-months)
- Natural Resources Economist (3 man-months)
- Environmental Management Specialist (2man-months)
- Rural Sociologist/ Social Economist (1 man-month)

The Consultant undertook the following activities during the Kagera Integrated River Basin Management and Development (KIRBMD) Strategy Report preparation process.

- **Mobilization of Project team** – The commencement date of the consultancy service was on June 15th 2009. The Consultant mobilized and brought together a team of experts who immediately embarked on implementation of the inception phase activities.

- **Identification of Data and Information Sources** – The *Kagera River Basin Monograph* and several other potential data and information sources were visited and the nature, quality and accessibility of relevant data ascertained. As part of this activity, relevant reference documents were retrieved where possible and useful contacts established for easy follow up during the main phase of the study. In general, the Kagera Monograph served as a baseline assessment of key water resources and development issues and provided a good basis for identifying and prioritizing water challenges and objectives.

- **Field Visits** – Field visits were conducted to several parts of the basin to have an on-site assessment of the different socioeconomic activities taking place in the basin. Areas visited included agricultural farms, settlements, hydropower

station, lakes and rivers within the Kagera Basin. The visits cover important sites in Burundi, Rwanda, Tanzania and Uganda.

- **Stakeholders Workshop on Inception Report** – The workshop was conducted on 13th and 14th of August 2009 in Kigali. The workshop participants contributed valuable suggestions and recommendations that are the basis for revising the Initial Inception report and guidance for the preparation of the Draft Report.

- **Training on the Kagera River Basin Simple Model** – The training was held from October 12th to 16th of 2009. Most of the discussions during the training were on Integrated Water resource Management and Development. This forum gave an opportunity to identify problems and the desirable solutions to them. The training was facilitated by a manual on the "Kagera River Basin Simple Model".

- **Questionnaires** – Three questionnaires were designed and forwarded to the stakeholders. Copies of these questionnaires are presented as Annex E. The responses of the stakeholders to the questions provided very useful information on: (a) the existing situation prevailing in the Kagera Basin with regard to water infrastructures and institutions; and (b) clear indication on the interests of the stakeholders.

- **Stakeholders Workshop on the Draft Final Report** – The workshop was conducted on 18th and 19th of February 2010 in Kigali. The workshop participants contributed valuable suggestions and recommendations that are the basis for revising the Draft Final Report and guidance for the preparation of the Final Report.

- **Preparation of Terms of Reference (ToR)** – TORs for (a) a team formulating integrated capacity building program, (b) the feasibility study of Kanyaru multipurpose project; and (c) the feasibility study of Nsongyezi hydropower project have been prepared and submitted separately.

- **National Consultation Workshops** – National consultation workshop were conducted on 1st of April (Bugesera, Rwanda), 6th of April (Dar Es Salaam, Tanzania), 9th of April (Kampala, Uganda), and 12th of April (Bujumbura, Burundi). The workshop participants contributed valuable suggestions and recommendations.

I.6 Structure of the Report

This is Final Report on Integrated Water Resources Management and Development Strategy for the Kagera River Basin. Consistent with IWRM and the principle of Nile Basin Initiative and LVBC Protocol, reasonable and equitable use, the monograph also puts forward the approach to benefits-sharing of the uses of water and related resources in a transboundary and multi-sectoral context. The Kagera Integrated River Basin Management and Development (KIRBMD) Strategy Report is therefore structured into Executive Summary and Main Report. The Main Report consists of main body in two Parts and and one set of Annexes.

Part I: Kagera River Basin Development Scenarios

Part I presents a brief discussion on bio-physical setting, peoples of the Kagera river basin and macroeconomic trends of the Kagera river basin. In addition, it consists of a brief discussion on hydrometeorology, potable water and sanitation, soil and water conservation, irrigation and drainage, hydropower as well as fisheries and aquaculture. It describes hydrological analysis, water demand analysis, identification of large-scale water resource projects, rapid environmental assessment of dam and reservoir sites, simulation study, approximate cost estimates of water resource projects and economic analysis of selected large scale projects. In addition, Part I presents an observation report on assessment approach, scenarios that are modeled, consideration of climate change, key indicators performance and assessment of outputs. Over all estimated infrastructure and management investment costs for the coming 20 years (2010-2030) in the Kagera Basin are presented.

Part II: Integrated Water Resource Management and Development Strategy

Part II presents strategies for protection of water resources, water conservation and water demand management, water pricing and financial assistance, water management institutions, water monitoring and information, water disaster management, water anticipated program of implementation activities and complementary strategies. It also discusses the nature of River Basin organizations and outlines the desirable role of Kagera River Basin Organization in the implementation of the Strategy. In addition, strategies for resources mobilization and funding for KRBO are presented.

Annexes:

Annexes consist of, partial results from the scenario analysis, estimated investment costs and disbursements, Kagera River Basin institutional framework, questionnaire related to the development of KIRBMD strategy and others.

Part I: KAGERA RIVER BASIN DEVELOPMENT SCENARIOS

1. Setting of the Kagera River Basin

1.1 Bio-Physical Setting

The Kagera River basin covers the territories of Burundi, Rwanda, Uganda and Tanzania. The total catchment area of the Kagera River basin is some 60,000 km² (see Figure 1.1). Table 1.1 presents the distribution of Kagera basin amongst the riparian countries. The Kagera is the largest of the 23 rivers that drain into Lake Victoria and it carries 34% of the annual river inflow to the lake.

Table 1.1: Kagera River basin – area and coverage amongst riparian countries

Country	*Country Area Total*	*Land area in Kagera River Basin*	*National basin area/ national area*	*National basin area/ total basin area*
	(km²)	(km²)	(%)	(%)
Burundi	27,834	13,69	53%	23%
Rwanda	26,338	21,43	85%	36%
Tanzania	945,087	20,48	2%	34%
Uganda	241,038	4,40	2%	7%
Basin		**60,00**		**100%**

Source: *Kagera River Basin Monograph: Basin Development Report* (BRLi, 2008)

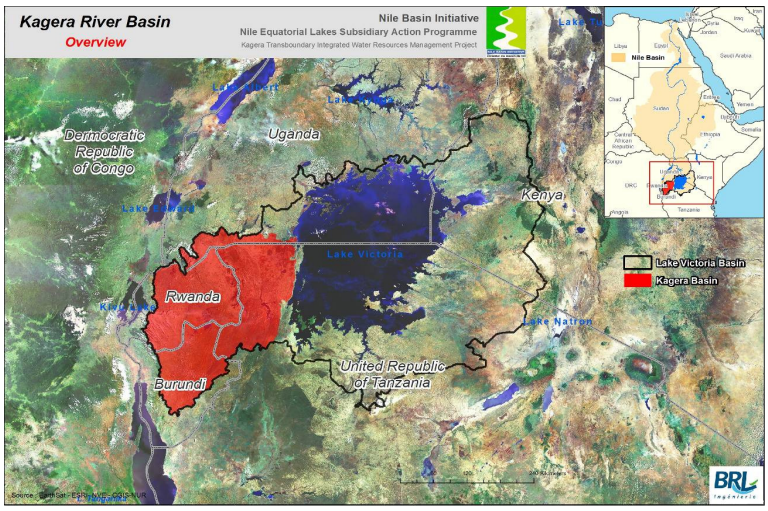


Figure 1.1: Location map of Kagera Basin

Climatic regime

The weather pattern of the Kagera River basin is characterized by a wide range of climatic variations due to topography, latitudinal position and the presence of water bodies.

There are two rainfall seasons, with the longer south-easterly monsoon bringing rain between about February and May, and the shorter north-easterly monsoon from about September to November. The months of June, July, and August are generally dry. Daily precipitation is commonly patchy, with some stations within a general area of rainfall having none.

Average rainfall over the basin amounts to some 1,000 to 1,200 mm per year, characterized by significant spatial and temporal variability. The zoning of annual rainfall is approximately vertical, with high average rainfall up to 1,800 mm per year in the western mountain ranges in Rwanda and Burundi, with a descending gradient towards the east down to 800 mm per year. Rainfall increases again in the vicinity of Lake Victoria in the Ngono river sub-basin, which however represents only a minor part of the total drainage area.

Being near the equator temperatures are very constant. The average annual temperatures are lower in the westernmost and north-western mountain range at 15 to 18^{o}C, and up to an average of 22^{o}C in the central part. The mean minimum reaches 14.5^{o}C and a mean maximum reaches 27.5^{o}C. The average evapotranspiration is some 1200 mm per year.

Hydrogeology

Based on the overview of the physical setting of the Kagera basin, a summary has been made of descriptions of all discussed aspects and typical parameter values for the different hydro-geographic zones (see Table 1.2).

The greater majority of the Kagera River Basin is made up of *Precambrian Basement* rocks, characterized by localized discontinuous aquifers. Groundwater in Basement formations generally occurs in the weathered rock, and in the fractured rock. The weathered rock may have a good transmissivity and storage abilities to provide some yield; generally, however, the better aquifers are found in the contact zone between the overburden and the fresh rock. Ultimately, the higher yielding aquifers can be expected in the fractured bedrock. Large and deep, fractured aquifers may be recharged through an interconnected system of fractured zones. The recharge of shallow aquifers, found in the overburden or in the fractured upper part of the bedrock is generally dependent on the size of the catchment area and the lithological character of the overburden.

Alluvial infills in major valleys and the lake sediments in the extreme north-eastern corner of the basin provide continuous aquifers of higher potential than boreholes drilled in the Precambrian Basement. Another high-potential area for groundwater is constituted by the volcanic formations.

Table 1.2: Kagera Basin Hydro-geographic Zones – physical characteristics

Development Zone / Description	Zone I *Congo-Nile Divide*	Zone II *Hills and mountain foot ridges*	Zone III *Swamp and lake terrain*	Zone IV *Western lake region*
Altitude (m amsl)	1900 – 4500	1500 – 1900	< 1300 – 1500	1134 – 1300 in alluvial plains; 1300 – 1700 in plateaux
Relief	Steep	Rolling	Flat	Flat to rolling
Dominant lithology	Gneiss, phyllites	Phyllites	Alluvial and collucial deposits / phyllites and quartzites	Alluvial and lacustrine deposits / quartzites and phyllites
Soils	Cambisols, Leptosols	Ferralsols	Histosols, Ferrasols	Various
Soils erodibility	high	medium	Low	Low
Average temperature (°C)	15 -18	18 -22	22	20 -30
Average rainfall (mm)	1400 – 4000	1000 – 1400	< 800 – 1000	800 – 1000 in alluvial plains; > 1000 on plateaux
Surface water availability	High (springs)	Medium - High (springs)	High (swamps)	Low (apart from Kagera river)
Representative hydrometric station	Nyabarongo (Mwaka) Ruvubu (Gitega)	Nyabarongo (Kanzenze) Ruvubu (Mwendo Ferry)	Kagera (Rusumo Falls)	Ngono Kagera (Kyaka Ferry)
Runoff coefficient	0.26	0.17	0.16	0.09 – 0.15
Groundwater potential	Low	Low	Medium – High	Medium – High

(ref: Maps presented in Kagera Monograph: BRLi, 2008)

The big number of springs in Zones I and II in Rwanda and Burundi, though individually low-yielding is a good indicator of the shallow (perched) groundwater potential.

The groundwater potential of the different geological formations can be described according to their lithological characteristics as occurring in the four identified zones. Apart from in Zone IV, mainly discontinuous aquifers exist in the Kagera basin, in the lower part of the overburden and in locally fractured bedrock. Numerous springs occur especially in the steeper Zones I and II, where the groundwater exits at the contact of an impermeable layer and the ground surface. Typical yields of the springs are in the range of 0.9 m^3/hr.

The small percentage of continuous aquifers in Zones I, II, and III are:

- the small unit of volcanic deposits in the NW corner of the Basin in Zone I,
- the sandy sections of the alluvial deposits situated in the valley bottoms of the main tributaries in Zones II and III, and
- Pockets of colluvial deposits on the lower foothills.

Based on the baseflow of the rivers, the total groundwater recharge in Rwanda is 66 m^3/s, of which 9 m^3/s is released through springs (PGNRE, Composante B, 2005).

Too few boreholes have been drilled in the basin to give reliable information on sustainable yields. For example, the first boreholes in Rwanda were drilled in 1985, and data are available for 404 boreholes only. However, indications of characteristic yields based on these data are given below.

Aquifers in the Precambrian schists have yields of 1 up to 8 m^3/hr, depending on the degree of fracturation, whereas the quartzites occurring in the same formation, when fractured have higher typical yields of 2 to 25 m^3/hr. Granite formations are characterized by low yields of 0 to 3 m^3/hr. Aquifers in the volcanic formation in the extreme north-western corner of the basin are characterized by high yields; 10 boreholes were drilled in this formation with yields of 110 m^3/hr (PGNRE, Composante B, 2005).

Zone IV has a substantial unit of alluvial infills and lacustrine deposits. These deposits produce an almost continuous aquifer, whereas the yield depends on the transmissivity of the sediments. Fluvial beds within the lacustrine deposits present the best yields. Typical sustainable yields are expected to be in the range of 0.5 to 6 m^3/hr. This unit is also characterized by the presence of numerous springs. The rest of the area consists of Precambrian rocks with discontinuous aquifers as described above.

Hydrology

The density of the drainage patterns (ref: Kagera Monograph) reflects the underlying geological formation. The drainage density in the catchment areas of the Nyabarongo, Kanyaru and Ruvubu is very high, particularly on the eastern part of the Congo-Nile Crest. On the other hand, the drainage density is low in the central and eastern part of the Basin. The foothills of the volcanoes are also characterized by little runoff.

The upper tributaries, Kanyaru and Nyabarongo are generally steep but include flatter reaches where swamps have formed. The middle course of the river including its tributaries above Rusumo Falls is extremely convoluted, this reach reflecting regional warping and drainage reversal, with some tributaries retaining the appearance of flowing towards the Congo. Several side valleys enter the river with their courses filled either with lakes or swamps. At Kigali, the valley is some 500 m wide. The valley widens downstream of Kigali before narrowing again above Rusumo Falls. Between Kigali and Rusumo Falls the river slope diminishes from about 0.3 m/km to 0.05 m/km, and the valley is filled with papyrus swamps. Below the falls, the Kagera flows north for 150 km flanked by a zone of lakes and swamps up to 15 km wide. The river meanders through extensive areas of swamps and lakes both upstream and downstream of Rusumo Falls. The river turns east where the borders of Uganda, Tanzania and

Rwanda converge and flows across a plain in an incised channel before entering Lake Victoria through papyrus swamps, the so-called Sango Bay.

The Kagera Basin is thus characterized by the existence of many lakes and swamps. Most of the lakes are very shallow (3-7 m deep). Exceptions are the Rwandan lakes Burera, Ruhondo and Muhazi with depths of 165, 68 and 14 m, respectively (Atlas Geo - demographique du Rwanda, 2002). The river flows are attenuated by these lakes and in particular by the two sets of swamps and associated lakes above and below Rusumo Falls.

The Kagera River basin drains the headwaters of the White Nile, and is a sub-basin of the Lake Victoria basin and the larger Nile River basin. The Kagera River is indisputably the single largest in the Lake Victoria basin. The Kagera contributes roughly 34% of the total river inflow (Sutcliffe, 1999; and WSP International Sweden AB, ERM and BCEOM, 2003). According to Phillips et al (2006), rainfall constitutes 85% of the total volume entering Lake Victoria, whereas of the remaining 15%, 40% is contributed by the Kagera River. 85% of the total outflow of Lake Victoria is constituted by evapotranspiration from the Lake. It follows that differences in Lake Victoria are attributed mainly to rainfall and runoff in the upper catchments, of which the Kagera Basin has the largest contribution. The variability of tributary inflow is much greater than that of direct rainfall on Lake Victoria, which is therefore the main explanation of historical Lake level variations (Sutcliffe, 1999).

The *Kagera River* is fed by three main tributaries: the Nyabarongo River, the Kanyaru River, and the Ruvubu River. All three rivers rise on the Congo-Nile Divide (Zone I), and then run through the hills and mountain foothills of Zone II. The Kagera River basically commences in the *Swamps and Lakes* area (Zone III), although the change in name from the Nyabarongo to Kagera occurs at the outlet of Lake Rweru.

The *Ruvubu River* rises in the southern high mountains of the Congo-Nile Divide in the tropical rain forest of Burundi in the province of Kayanza. Its head lies in the Kibira National Park at about 2,000 m of altitude and traverses about 350 km to its confluence with the Kagera River on the border between Rwanda and Tanzania. The Ruvubu River watershed area is around 12,200 km². It traverses some slopes of about 150 cm/km upstream and less than 20 cm/km downstream at its confluence with the Kagera. The main tributary of Ruvubu River is the Ruvyironza which runs from southern part of Burundi. Ruvubu is navigable towards the north in its downstream part.

The *Nyabarongo River* flows over 300 km from its source in western Rwanda South-eastwards to its outlet to Lake Rweru in south-eastern Rwanda along the border with Burundi. The source of Nyabarongo is Rukarara and is situated in the highlands of Nyungwe National Park on the Congo-Nile Divide along the border between Rwanda and Burundi at an elevation of 2,700 m. The most important tributary of Nyabarongo is *Kanyaru River* that flows also from Nyungwe National Park, but flows in south-eastern, and then in north direction until the junction with Nyabarongo at about 50 km south of Kigali (approximately 1500 m altitude).

From the confluence (Kanzenze station), the Nyabarongo River flows eastwards through swampy valleys and small lakes in south-eastern Rwanda. The confluence

marks the boundary between Zones II and III. From the Lake Rugweru outlet, the Nyabarongo River changes the name to Kagera and meanders through a swampy terrain for about 60 km and meets the Ruvubu River flowing through the Tanzanian plateaus. At about 2 km downstream from the Kagera-Ruvubu confluence, the Kagera River enters into the gorge of Rusumo Falls and drops about 30 m over a distance of less than one kilometer, marking the end of the comparatively steeper upper reach of the river. The Kagera sub-basin at the location of Rusumo Falls measures some 30,114 km^2, representing 52 percent of the total Kagera River basin.

Below the water falls, the valley widens and the Kagera River is again enclosed by papyrus swamps. For the next 230 km, to within a few kilometers upstream of the junction with the Kagitumba/Muvumba River, the Kagera waters flow northwards through lakes and swampy terrain of the Kagera National Park along the Rwandan – Tanzanian border. Downstream the Kagitumba/Muvumba junction (which marks the border between Uganda and Tanzania), the Kagera changes direction and trends eastwards for 260 km to Lake Victoria. The major streams contributing to the Kagera River downstream of Kagitumba/Muvumba confluence, i.e. Mwisa and Ngono are in Zone IV, the West Lake Region.

The Ngono River joins the Kagera from its mouth. The West Ngono and the Rubare are the two main tributaries. The catchment is well-defined by steep hills which parallel the west shore of Lake Victoria. The river flows south to north for a distance of about 125 km. Over most of its course it flows on a very flat gradient through swamp and lake terrain. The Kishanda valley system drains the central part of the district, including country as far as south-west of Nyaishozi. It traverses the swamps below Nkwenda, where it is joined by tributaries draining the Kayanga, Kituntu and Rwambaizi areas. Further north, it crosses the swamps of the Kishanda valley, where the tributaries from Mabira join, and enters the Kagera in the north, just east of Murongo. All land east of the hill-range that runs from Kibare in the very north to beyond Kimisi into Ngara, is drained by the Mwisa valley. The Mwisa river runs north, bending to the northeast, crossing the Kitengure plains, and enters the Kagera near Kyaka. Going southward, the Mwisa enters Lake Burigi.

The runoff in the Kagera River basin responds to seasonal rainfall; the peak flow occurs in April in the upper tributaries, in May at Kigali and Rusumo Falls, where the stream flow is the resultant of half of the total catchment area, and is delayed to July at Kyaka Ferry on the lower Kagera, close to the outlet into Lake Victoria. A comparison of mean monthly flows at Rusumo Falls, marking the boundary between the upper and lower reach of the swamp and lake area, and Kyaka Ferry shows a difference in timing in the peak flow at Kigali of about one month, whereas the period of the peak increases from 1 to 3 months. The lake levels in the lower half of the swamp area experience a mean seasonal difference of 1 meter between peak flow and low flow. The Kagera River flow regime is different from other tributaries to Lake Victoria, mainly because of this wetland attenuation. The monthly flow series of the Kagera River at Kyaka Ferry shows the high baseflow component of the Kagera flow, resulting from the storage in lakes and swamps (Sutcliffe, 1999).

The tributaries to the Kagera in Zones I and II of the basin have a strong response to rainfall, resulting in a monthly average annual level oscillation of 2.08 m for the

Nyabarongo River at Kanzenze, and 2.61 m for the Ruvubu River at Muyinga. At Rusumo Falls in Zone III the average level difference has reduced to 0.93 m as a result of the attenuation of flows in the swamps downstream of Kanzenze.

Every year, in the two peak rainfall months of April and May, the stream flow surplus overflows the river banks and floods the marshy valley and the lakes. The river levels of the tributaries reduce between June to September, with annually the lowest levels experienced from August to October (Hakizimana, and Bahama, 2005).

Almost all runoff is generated in the upper half of the catchment, referred to as the Congo-Nile including its related mountains and foot slopes and the hills east to it (Zones I and II). This follows from stream flow data of the stations of the Nyabarongo at Kanzenze (before the commencement of the lakes and swamps situated in the central part of the Basin), the Kagera at Rusumo Falls and Mumwendo Ferry in Ruvubu river, where the average stream flow volumes at Kanzenze station added to these of Ruvubu station are approximately the same as the mean stream flow at Rusumo Falls. This implies that on an annual basis, precipitation in the sub-catchments downstream of Kanzenze and Mumwendo Ferry equals evapotranspiration losses.

The hydrology of Zone III, the swamp and lake terrain was studied in Norconsult and Electrowatt (1975). The river, swamps, lakes and open water are closely related. Water levels in these elements follow roughly the same cycle with extreme levels occurring more or less simultaneously. Maximum levels in the upper reach (between Kanzenze and Rusumo Falls) are attained in May and minimum levels occur between mid-August and mid-October. Throughout the Lower Reach (between Rusumo Falls to just upstream of the Kagitumba/Muvumba junction) maxima occur in June and minima in January demonstrating the much longer recession period. But the absolute annual fluctuations differ greatly, especially for the Lakes of the Upper Reach, where vegetation barriers and catchment area play dominant roles. At Lake Mugesera in the Upper Reach, papyrus barriers are sometimes breached causing great variations of levels. The maximum range of levels in the lakes is 3.5 m and average annual fluctuation is 1 m. On the Nyabarongo River the range of levels reduces downstream from a maximum of 4.10 m at Kanzenze and 1.20 m at Rusumo Falls. In the Lower Reach the annual range of levels on Lake Ihema varies from 1.0 to 1.8 m. The system is very dynamic, and owing to the growth and disappearance of vegetation the local conditions are constantly changing. The two reaches behave in the same manner, but in the Lower Reach the swamps and lakes are more intimately interconnected with each other and with the Kagera River.

Downstream of Rusumo, only one perennial river exists, the Kagitumba/Muvumba, which contributes to a small extent to the Kagera flow. The Kagitumba/Muvumba River drains the extreme SW area of Uganda (after Norconsult & Electrowatt, 1975). Near the western shore of Lake Victoria is a belt with rainfall of over 2,000 mm. The Ngono River, draining this area of heavy rainfall, contributes a highly seasonal flow to the lower Kagera (WSP International Sweden AB, ERM and BCEOM, 2003).

For the whole Kagera River basin, it may be assumed that the groundwater inflow is negligible.

In the upper half the basin, rainfall and runoff are strongly related and dominant as compared to evapotranspiration, whereas in the lower half of the basin, the dominant hydrological factors are rainfall, evapotranspiration and the storage in, as well as release from wetlands. Sango Bay, the area around the Kagera Bay of Lake Victoria, has been studied by Haskoning et al (2002). Here, rainfall and evapotranspiration are about 10 times the absolute value of the runoff. For modeling purposes, the wetland catchment was subdivided in drylands, seasonal wetlands and permanent wetlands. The increase in precipitation and evapotranspiration is about double from the dryer lands towards the permanent wetlands. The wetlands prove to be effective in reducing the amount of water entering Lake Victoria. The dry lands are sensitive to changes in total rainfall, whereas the riverine and permanent wetlands are little sensitive for changes in rainfall quantities, but depend on the water quantities coming from upstream.

On an annual basis, the flow recorded at the mouth (7.5 km^3/year) is not much more than that recorded at Rusumo Falls (7.2 or 7.3 km^3/year). However, one should be cautious about this conclusion. The flow data from Kagera River mouth come from a different source (Sutcliffe, 1999) than the other stations, which are from the PGNRE Rwanda database (2005). The Consultant was informally informed by various sources that the hydrometric station at the Kagera mouth is poorly positioned, and the rating curves and water levels are affected by growth of papyrus plants and backwater effects from Lake Victoria. However, no documentation could be found on this subject. Upstream of the Kagera mouth, before the confluence of the Kagera with the Ngono River, the hydrometric station Kyaka Ferry is positioned in the Kagera River. Theoretically, the annual flow at the Kagera mouth should be close to the sum of the flows at Kyaka Ferry (8.3 km^3/year) and on the Ngono River (0.7 km^3/year), and therefore amount to about 9.0 km^3/year. The fact that the observed annual flow at the mouth is much less (7.5 km^3/year), less than the flow determined for Kyaka Ferry, is an indication, along with the possible sources for error noted above, of the doubtful validity of the data-series of the Kagera mouth station.

Water quality

Physico-chemical quality

Very little information is available on the water quality of the surface water in the basin. In Rwanda, one study has been carried out by the national university of Rwanda in 2002 (described in PGNRE, Composante B, SHER, 2005). It follows that the Kagera River is generally of good quality, and that the differences in conductivity and the different lithologies of the sub-catchments influence the water quality.

Sekamana (1989) found that the surface water in Burundi has fecal contamination. The water quality suits all water uses. The stream waters are generally warm (between 19 and 26ºC), acid, of relatively low conductivity (< 100 µS/cm), very soft and rich in dissolved oxygen. For 30% of cases, the Fe and Mn contents are above the water potability limits. Nitrogen and phosphorous increase with increasing discharge as a result of leaching of agricultural soils so that, contrary to the dilution effect, their contents increase during the rain events.

Groundwater quality has been analyzed to examine potability in a non-systematical manner by analyzing spring water and to a lesser extent borehole water samples on 948 samples. The mineralogical water quality is generally within the norms of the World Health Organization apart from nitrate in 2.5% of the samples taken. However, bacteriological analyses carried out revealed that 44% of the sources, including even boreholes are bacteriologically contaminated.

Sediment transport

For the Hydromet Program (described in Norconsult & Electrowatt, 1975), about 15 samples each were collected from 3 locations within the basin between March 1971 and August 1972. The locations were Mumwendo Ferry (Ruvubu River), Nyakanyasi (lower end of the Kagera River), and Kyaka Road (Ngono River). The results indicate in the first place that the water is slightly to moderately-mineralized and is suitable for unrestricted use for irrigation, domestic and livestock supply.

Secondly, it was established that the sediment load is low throughout the basin, and that it diminishes downstream. The mean measured annual sediment load was 25 ton/km² for the Ruvubu catchment, 10 ton/km² for the Kagera catchment at Nyakanyasi and 8 ton/km² for the Ngono catchment. Then 10 ton/km² can be assumed to have entered Lake Victoria on a yearly basis.

Although the western part of the basin is partly forested, much of the basin has become intensively cultivated and even fragile lands located on steep slopes are cultivated. This has resulted in erosion and sediment load from the high rainfall areas (Sutcliffe, 1999). From the data collected by LVEMP from 2000 to 2005, it was estimated that 4,905 kilo tons per year of suspended sediments load is ultimately deposited in the Lake, of which Kagera catchment contributes 26.1%, equivalent to a basin sediment yield of 21.4 ton/km²/year (Myanza et al, 2005, quoted by Lugomela and Sanga, 2007). These data suggest that the sediment load of the Kagera has doubled since Hydromet's measurements, which is over the last 30 years.

This is however only a fraction of the soil loss due to erosion. Data on erosion rates are scarce, but studies conducted in the mid-1980s found that the average loss of surface soil due to erosion is 10.1 ton/ha/year, or 1000 ton/ km²/year. Soil losses range from 21.5 ton/ha/year in the Congo-Nile Divide to 2.6 ton/ha/year in the Bugesera area (World Bank, 2005). The explanation for the big difference between soil losses and sediment outflow may be that the larger part of the sediment load is deposited within the basin where the valley slope becomes less and/or sediments are retained in the swamp vegetation. This would explain also that the sediment load diminishes towards the outlet.

The content of suspended matter was estimated at 200 mg/l for Ruvubu (Sinarinzi, 2000, in Hakizimana and Bahama, 2005). The suspended sediment load and consequently the water turbidity are very high, notably in rainy seasons, with the highest values after rainfall events.

Major pressures and pollution hot spots

The industry sector is little developed in the Kagera basin, and no major pollution hot spots can be mentioned. Rwanda is expected to be relatively the most industrialized country within the basin. The industries in Rwanda are farm produce plants, and (para) chemical industries, as well as mining industries. The main point-source of pollution is Kigali, the capital of Rwanda, where 70% of the industrial activities in Rwanda take place. A sample study on 11 industries in Kigali revealed that the industries do not treat their wastewater at all before discharge in the Nyabugogo River. It is expected that the industrial sector in Rwanda will increase some five-fold by year 2020. This will have a major impact on the surface water quality downstream of Kigali, if the ongoing practice of direct discharge of untreated wastewater will continue.

Water samples of surface water in Rwanda were analyzed for several parameters. Fluoride (1.8 mg/l) and copper (1.3 mg/l) are indicative of the pollution by industries located in Kigali; their polluting effects in the Nyabugogo River quickly reduce downstream. Unfortunately, other parameters typical for pollution including arsenic, heavy metals, hydrocarbons, pesticides and fungicides have not been tested (PGNRE, Composante B, SHER, 2005).

The main water quality study carried out in Burundi was done during the hydrological year 1988-1989 through GTZ funding (Sekamana, 1989). The water courses and their water quality are mainly influenced by human activities, including farming without erosion control measures, mining activities, and cultivation of wetlands. The study revealed that the industrial pollution of streams is still insignificant, because of the weak industrialization development and the utilization of chemical inorganic fertilizers. Industrial development in the Burundian part of the Basin is limited to farm-produce plants, including coffee shelling and washing and palm oil manufacture. Some streams receiving urban and farm-produce wastewater are becoming polluted. The pollution consists generally of high suspended sediments load, organic and bacteriological pollution, and high contents of nutrients (nitrogen and phosphorus).

Within the framework of LVEMP, in the period 2000 – 2005 samples were collected from 19 urban centers and 31 industries in the Lake Victoria basin which were considered to be relatively large enough to cause significant pollution. It followed that there are no main urban point sources of pollution in the Kagera basin. Myanza *et al.* (2005) reported that atmospheric deposition is by far the major contributor of nutrients to the lake whereby 84% and 75% of nitrogen and phosphorus respectively are deposited this way (Lugomela and Sanga, 2007).

In NBI's regional water quality report (2005), it is reported that in Burundi, mining causes pollution by heavy metals, toxic substances including arsenic such as the mine of Kabarore, which pollutes Nwogere, a tributary of Kanyaru.

Role of wetlands for water quality improvement

In the lower reaches of Kagera river different types of swamps are encountered. Permanent swamps are mostly found at the river mouths of Kagera and Ngono river systems in the Western part of the lake. Seasonal swamps exist along the Kagera River

and its main tributaries, including also the upper reaches of Mwisa River, the middle reaches of the Ngono River and Ruzinga swamp associated with lower reaches of Kagera River.

Most of the tree swamps are found particularly along the Kagera River and its tributaries. Open waters are also mostly found in Kagera Region. These include among others, the Lakes of Ikimba and Burigi (Lugomela and Sanga, 2007).

The buffering capacity of wetlands has been studied using a model called DUFLOW which describes the cycling of nutrients and fate of behavior of heavy metals in wetlands (LVEMP, Vol 1 & 2, 2001). The study revealed that Ngono wetland has a retention capacity of 50-80% for suspended solids and total phosphorus, and 40-60% for total nitrogen.

Environmental degradation

The Kagera River Basin's existing environmental resources, especially in the protected areas are currently under threat due to encroachment by human activities, which are resulting in water pollution and land degradation, with significant loss to the biological biodiversity in the basin and ultimately in the receiving trans-boundary ecosystems (Lake Victoria and Nile basin). The continued transfer of sediments and nutrients loads in the river is creating a potential negative impact on other infrastructure development projects, such as hydropower and irrigation schemes.

Apart from continued depletion of the existing environmental resources the basin is characterized by few exploitable mineral resources, poor soil nutrients, limited irrigation and scarce water resources for majority of households. In addition, the existing forests outside the protected areas do not provide sufficient timber for the local communities; hence in most cases the local people tend to exploit them illegally from the existing forest reserves.

There is no study conducted on the erosion hazard potential in the Kagera River basin. However, a study conducted on Lake Victoria basin shows erosion hazard potential in some Kagera basin districts of Bukoba, Biharamulo, Karagwe and Ngara (Yanda, 2001). The erosion hazard potential has been associated with high population density, encroachment into forest reserves by farmers and charcoal makers. Another cause of soil erosion has been attributed to cultural beliefs that lead to poor cultivation practices that promote soil erosion. The problem of high rainfall in combination with cultivation along slopes and deforestation due to fish smoking has been identified to be another cause of soil erosion. Finally, over-grazing has been a major cause of soil erosion in areas like Misenyi Division. The study conducted in some basin districts (Kabale, Rakai, Mbarara) on the Ugandan side has attributed causes of soil erosion to be steep slopes, population pressure, deforestation, poor farming, vulnerable soils, bush burning and overgrazing (NEMA, 2000) . These findings are also in agreement with those from Tanzania.

Urbanization in basin districts of Mbale and Ntungamo has been found to be another problem that contributes to deforestation in the basin through increased demand for charcoal and fire wood and timber for construction purpose. The conversion of wetland

areas to other uses is also common in the Kagera River basin. These include agriculture, sand mining, brick making, dumping of solid wastes and hunting, whereby hunters usually set fires. Extraction of wood and hand crafts products, especially in the Sango Bay Swamp in Rakai District is another example of destructive uses of wetlands (NEMA, 2000).

In general the ranking of environmental threats for the Nile basin countries shows land degradation, water quality degradation, loss of biodiversity and wetland are the major issues of environmental concern for the four riparian countries. The causes and extent of land degradation, loss of biodiversity, wetland degradation and water quality degradation shall be discussed in the proceeding sub-sections.

Land Degradation

Land degradation has been defined as physical, chemical and biological impairment of the attributes of land (Lal, 1987). The problem of land degradation in the Kagera basin could be associated with high rate of deforestation on the upland watershed and cultivation on steep slopes (up to 80%), soil fragility and high rainfalls – which contributes to soil erosion. The land degradation in turn is having significant downstream impacts, including water quality degradation in the rivers, lakes and wetland areas due to sedimentation and pollution from both point source and non-point sources. It also contributes to disruption of water flow, flooding and alteration in the micro-climatic conditions in the basin (loss of humidity and misting).

Some studies conducted in the 1980s in Rwanda have shown that average loss of soil due to erosion is 10.1 tons/ha/year (World Bank, 2005). The highest rate was recorded in the Congo-Nile Divide area (21.5 tons/ha/year) and the minimum was in the Bugesera area (2.6 tons / ha /year). Again, it is estimated that water erosion alone can resulted into total annual losses of about 945,200 tons of organic matter, 41,210 tons of organic nitrogen, 280 tons of phosphorus and 3,055 tons of potash for the whole country due to poor soil cover and lack of erosion control (BRLi, 2008).

The problem of land degradation is also the result of exploitation/harvesting of forest products, mainly trees for fuel wood and/or construction, land clearing for agriculture. This is also leading into encroachment into protected areas and conversion of wetland areas into agricultural lands and human settlement. As a result land and forest clearing has now exceeded sustainable limits, especially in Burundi and Rwanda sides. Soil erosion is significant and widespread in upper catchments due to intensive cultivation and farming and livestock-keeping.

Wetland Degradation

Most of the wetland areas in the basin are threatened by conversion to agricultural lands and creation of human settlements, filling for solid waste disposal and road construction. Wetland degradation leads into loss in groundwater recharge, decreased buffering capacity of wetland against floods, loss of filter functions to absorb and degrade pollutants and decrease in water quality, destruction of natural habitat for wetland related organisms and loss of biodiversity. The wetland areas in many parts of the basin are exploited and degraded because these areas are treated as not belonging to

anybody (public property). There is no enforcement of laws or by-laws to restrict development activities like cultivation, construction of houses, sand/clay mining on wetland areas.

The increasing population pressure is also resulting into cultivation of larger areas of wetlands. The cultivation on wetlands is being done haphazardly without consideration of ecological balance, hence leading into negative environmental impacts.

Water Resources Degradation

The upper watersheds are the key sources of surface and ground water resources, hence degradation of these areas creates significant impact on water quality and quantify due to siltation, sedimentation and pollution from agricultural run-off (pesticides and fertilizers).

Overflowing pit latrines and septic tanks as well as contaminated storm waters pollute the river and its tributaries, hence increasing the incidence of water borne diseases among the local communities in the Kagera basin. Eutrophication is now considered to be one of the greatest threats to the Kagera River basin – as indicated by the proliferation of aquatic weeds, including the water hyacinth, elephant grass and algal blooms in the Kagera River. Eutrophication can also result in decreased water quality and reduction in fish stock.

The major factors that contribute to water resource degradation include discharge of untreated domestic, urban and industrial waste waters. Other potential threat is discharge from non-point source pollutants from agricultural activities (pesticides and fertilizer residues), increased sediment / silts loads and increased salinity. Sedimentation is closely related to soil erosion from the upper catchments. Siltation can impose direct economic costs by reducing the efficiency of irrigation schemes as it can necessitate expensive de-silting operations.

The degradation of wetlands is also associated with water resource depletion. For example, many wetland areas and valley bottoms in the basin are being cultivated for rice production. This has led into decrease in the ground water resource in the wetland areas. Also, clearing of natural vegetation has resulted into changes in micro-climates (loss of humidity and misting), hence negatively affecting the hydrological cycle in those areas.

Biodiversity Loss

Biodiversity can be provided by a variety of plants and animals that can be used in many ways including domestication and direct harvesting from natural ecosystems. The diverse wildlife has valuable recreational and aesthetic environmental beneficial uses. The wild variety of plants can also be used as a source of genetic material to produce resistant strains of cultivated crops.

Despite their importance the biodiversity of natural ecosystems continue to be threatened in the basin due to over-exploitation of certain type of plants and animal species.

Introduction of new varieties with ability to out compete indigenous and traditional varieties is also a biodiversity concern. The introduction of alien species can also cause biodiversity loss and attract disease transmitting vectors.

Another potential threat to biodiversity in the basin is from pollutants discharged from industrial effluents, domestic waste waters and agrochemicals. The biodiversity can also indirectly affected by macro and micro-economic policies such as agricultural modernization, which favors the use of agrochemicals as agricultural inputs, apart from clearing large areas of land due agricultural mechanization (use of tractors).

The loss of natural habitat is another form of biodiversity loss at ecosystem level due to encroachment by human activities such as creation of settlements, cultivation. The resultant effect of habitat loss is invasion of wildlife into human settlements by wild animals with potential to crossbreed with domestic types, and transmission of diseases - for example, hybridization of the Ethiopian wolf with domestic dogs (NEMA, 2000). The destruction of natural habitats can also result into invasion of cultivated crops by insect pests that use to depend on related wild varieties of plants (e.g. coffee family plants).

1.2 Socio-Economic Setting

Demographics

Very high population density

Current situation: As shown on the two following tables, in the Kagera River basin the mean annual demographic growth rate is 2.7% (ref: Table 1.3) and the fertility rate per woman is 6 (ref: Table 1.4). These rates are higher than in Sub-Saharan where the mean population growth rate is 2.5% and the mean fertility rate is 5.4 [World Bank Health, Nutrition and Population indicators, 2007]. Those basin figures have to be used with caution as they are estimated from comparisons between national censuses of population more or less recent.

Table 1.3: Kagera River basin population density and growth rate

Projection July 2007	Kagera River Basin Population (million)	Kagera River Basin Population Density (p/km²)	Mean annual growth rate (%)
Burundi	4.6	337	2.75
Rwanda	7.8	363	2.75
Tanzania	1.6	79	2.5
Uganda	0.8	191	2.5
Basin	**15.0**	**247**	**2.7**

Sources: Kagera Monograph

Table 1.4: Kagera River basin fertility rate

2004	Total fertility rate (per woman)
Burundi	6.8
Rwanda	5.6
Tanzania	4.9
Uganda	7.1
Basin	**6.0**

Sources: Kagera Monograph

The mean estimated population density is 248 peoples/km² in June 2007, which is more than 8 times the 28 peoples/km² average for Sub-Saharan Africa. According to the demographic growth rate, this gap is even getting bigger every year). However, this density is not equally shared on the Kagera River basin: the population density is 4 times higher in Burundian and Rwandan hills (those two countries share the highest population density in Africa) than in Tanzanian lowlands.

For the many reasons (climate, water related diseases, soil fertility, etc.) people have always preferred to settle in the upper Kagera River basin (ref: Kagera Monograph). There is also some density variances inside the upper basin also linked to the soil fertility, to polygamy practice (e.g. Ruhengeri or Byumba district) or to urbanization (for instance, Kigali city district, the Rwandan capital, has more than 1000 inhabitants/km²).

A very young population: Children under 15 represent 45.6% of the Kagera River basin's population. If the 3.5% representing the over 65 age group are added, the community burden is 49.1% of the population. The young and the old indeed represent a heavy burden in terms of basic needs, including education and health. The young generation would have to carry on the development of the Kagera River basin. But this population class is particularly concerned by threats such as HIV, agricultural land fragmentation, illiteracy and lack of professional qualifications. One of the challenges

of the young generation will be to get professional qualification out from the agriculture, where lands can not be fragmented anymore.

More women than men: There are more women than men but they are economically weaker than men. The majority of the population lives in the rural world where agriculture and livestock rearing are extensive and where women are neither landowners nor livestock owners. In urban areas, they are in the minority among salaried workers and their jobs are usually the least paid ones.

A rurally rooted population: The country with the least urbanized population in Sub-Saharan Africa is Burundi, at 11 percent. The urban population represents around 18% of the basin population, which is by far less than Tanzania and entire Africa, both at 38%. This urbanization rate is however increasing and, for instance, it should be 30% in 2020 in Rwanda [governmental statistics].

The average proportion of urbanization is around 18% in the Kagera River basin. With urbanization, the basic socio-economic infrastructure has developed: water and sewerage, health services, education, communications, energy, markets, administrative authorities, etc. There are also more economic opportunities in towns. Consequently, the low rate of urbanization in the river basin is a synonym of poor access to various services especially in the rural areas. This means that living standards between urban and rural areas are not balanced at all.

Social development in the Kagera River basin

Human Development Index: The four countries in the Kagera River basin are among the world's poorest countries. Uganda is No. 145, Rwanda 158, Tanzania 162 and Burundi 169 (out of 177 countries listed by the UNDP in 2006). Their situation is roughly the same as the average situation in sub-Saharan Africa (though the per capita GDP is much lower in the Kagera River basin countries).

Subsistence agriculture and nutritional requirements: The per capita GDP in the Kagera River basin is very low since agriculture there is mainly subsistence farming. The small mean cultivable area per household (0.8 ha) and the low agricultural productivity means that there is not even enough food to satisfy the basic nutritional needs of most of the households, so that in most of the case, no monetary surplus from off-farm sales are possible.

Low life expectancy at birth: health issues

Life expectancy of about 45 years in the Kagera River basin is low, ranging from 44.1 to 50.0 for Rwanda and Uganda respectively. It is slightly below 46 years which is the average for sub-Saharan Africa and well below the world average of 67 years. In the last decade Rwanda and Uganda have made the greatest gains in life expectancy: 12 and 7 years respectively (World Bank, 2007). The children, adult and maternal mortality rates are high in the Kagera riparian countries, especially in Rwanda and Burundi, whereas the figures are lower in Uganda. The situation is close to the WHO African region ones.

There is a difference in the infant mortality rate in urban zones and rural zones. Among others, this reflects the inequality of access to health care, drinking water and sanitation and to the other basic services. Sanitary structures with qualified personnel are rare in rural areas.

In addition to what has already been said, ignorance is also a factor which prevents pregnant women from understanding the need to consult health care providers. This is partly due to barriers and traditional beliefs, the importance of customs and the absence of decisional and economic power for women.

As is the case on average in Sub-Saharan Africa, living until the age of 15 does not mean one is sure to live until the age of 65. Even after 15, the chances are about fifty-fifty that a person will live longer than 65 years. This is because after the age of 15 years, people are particularly exposed to HIV/AIDS, there are always wars and malaria is a constant threat…

Disease: Disease is the top life-expectancy reducing factor in the Kagera River basin. Disease is prevalent as health and hygiene conditions are not satisfactory and cause numerous diarrhoeal diseases, malaria and cholera. HIV/AIDS is the top cause of death in the Kagera River basin. Many deaths are due to water-related factors. Diarrhoea and malaria are the main water-borne diseases in the Kagera River basin.

Malaria: In the Kagera River basin, malaria is endemic in the plains. On the upper plateaus, it is more often found in epidemics [Vermylen, 1967; Ivorra, 1967]. An estimated 80% of the population is exposed to the risk of catching malaria [The World Bank, 2005]. Malaria is still a major public health concern in the Kagera River basin, especially among pregnant women and children under five years of age. It is a leading cause of morbidity and mortality in the Kagera River basin in both outpatient attendance and inpatient admissions, accounting for more than 40 percent of overall outpatient attendances (MOH, 2002). Most parts of the basin, including uplands have reported malaria transmission throughout the year, though it increases during and soon after the rainy season.

Health care: The lack of health care is particularly flagrant in rural areas, which partly explains the high effect of certain diseases in the Kagera River basin. Sanitary infrastructure is insufficient, often lacking equipment and understaffed with under-qualified personnel. This is particularly the case in the rural areas, where purchasing power is very low and general living standards (basic socio-economic infrastructure such as drinking water, energy, markets, schools, health care centers and leisure centers, etc.) do not encourage health professionals to settle there.

Access to safe drinking water and sanitation: The lack of water, especially safe potable water is responsible for many of the precarious health conditions in the basin. The important links between water and sanitation, and poverty alleviation, including proposed programs and investment scenarios for the Kagera basin are fully discussed in Section 10the Monograph Report.

Low adult literacy rate: Education

In the Kagera River basin countries, the literacy rate is approximately the same as the average for sub-Saharan Africa: ranging from 58.9 % in Burundi to 69.4 % in Tanzania. Women's literacy is of crucial importance in addressing wider issues of gender inequality. Yet, women still account for the majority of the Kagera River basin adult illiterates, with only around 80 literate women for every 100 literate men.

Among the difficulties encountered in the education system, some of the most notable are the lack of teachers, the lack of school books and the lack of infrastructure. There are not enough schools, especially in the rural parts of the basin. In towns and large enough urban communities, even schools for the very young exist, while in rural areas all types of schools are rare. Some children start primary school only at the age of 7 because of the distance they have to travel to attend school. The fact that housing is so scattered does not make geographical access to schools an easy matter. The lack of infrastructure partly explains the low rate of transition to the next level of schooling, as shown in the following figure on Rwanda. For 100 pupils starting at primary school, only 30 finish primary school and only 17 go on to secondary school.

Some regions further away from urban areas, i.e. without basic socio-economic infrastructure such as drinking water, roads, communications facilities, electricity, book shops, libraries, leisure activities, etc., find it difficult to attract competent, well-trained teachers.

However, primary education seems to be improving (about 70% enrolment in the river basin) and the gap between the number of boys and girls attending school has narrowed, even if it is still very high for tertiary education.

Other basic socio-economic services

Electricity: There is a serious lack of electricity availability in the equatorial lakes region in general and the Kagera basin in particular. It is estimated that access to electricity is between 2% and 7%. Improving the access to electricity at a reasonable cost is essential for poverty alleviation.

Gender

*Historical inequality***:** The people in the Kagera River basin all had the same mode of social organization: patriarchy. Marriage was a contract and the future husband was expected to pay a dowry. The dowry gave a man the right to be the head of the household and the family and an absolute right over the children born of the marriage. Women did not inherit, even if they were widowed. Male children were the inheritors and it was an inherited duty to look after their mother and sisters. Traditionally, polygamy meant a comfortable existence, enough land and livestock, and usually, integration into the spheres of power. This and the need to have enough labor, combined with the high mortality rate, forced most men to take several wives, and obliged women to compete to have the most children, preferably boys.

The pre-defined roles of men and women are always different, as the way they are put across as part of the education or socialization:

- The supreme role of a woman is to give birth. She must also take care of her children, her husband and his kin. Having children and looking after a household are not really part of what is taught at school.
- The supreme role of a man is to meet all the needs of his family, mainly to feed his children and to honor his kin.

So, since women are in charge of running the household, they were kept from school, while men (even if there is a difference between urban and rural areas) usually went to school and broadened their outlook so that they could better adjust to the modern world.

Disease - HIV/AIDS: There are also differences between men and women in terms of rates of infection with HIV/AIDS among other diseases. The factors which make women more vulnerable to HIV/AIDS infection can be summarized as follows: A combination of biological, social, cultural and economic factors contributes to women's increased vulnerability. In particular, gender inequalities prevent women from asserting power over their own lives and controlling the circumstances that increase their vulnerability to infection.

Water resources: Water fetching for domestic use is generally a duty for women and children; once again, girls rather than boys. The lack of water or the distance of homes from sources of water make women's lives difficult, have a strong influence on their availabilities for other tasks and limit their ability to take part in other activities. It is such a serious problem that some women don't go to antenatal appointments and don't give birth at health centers. *"They can't be seen in public, they can't go to meetings, etc. if they haven't done their washing and they won't dare go to any healthcare appointments…"* said one 76 year-old lady who lives near Rusumo.

Water fetching also affects girls' schooling: if it is a long way to fetch water, water supply is incompatible with school attendance. Women would tend to school too late and be punished. Children would rather avoid this, so absenteeism is high.

Boys are usually in charge of small livestock grazing and sometimes gathering fuel-wood. Both of these activities can be done in the afternoon after school. Boys usually find it harder to attend school regularly when they have to look after livestock or when they are older pupils and are chosen to go fishing, drive the livestock to their pastures or take products to market.

Today all the countries in the Kagera River basin have expressed their agreement with the conclusions of 1) the 1995 international conference on women held in Beijing and 2) the Millennium Development Goals. Emancipating women is one of their fundamental priorities for sustainable development. Traditional community culture and women's own lack of self-confidence are severe impediments to initiatives targeting an improvement in women's living conditions and greater female participation in the development process.

Social water-related opportunities

This report is oriented towards water resources management, so that it is therefore focusing on development opportunities linked to water use and management. As we have seen above, there are direct links between water and socioeconomic aspects, such as health, which should be addressed in any future water resources management plan of the Kagera River basin, which should not only be oriented towards revenue increase.

Health

Water related diseases may often be avoided or their impact reduced through better education or improvement of heath services (financial and geographical access). Rwanda, for instance, has recently introduced community private health insurance systems even in rural spheres: community-based health insurance schemes were introduced in 1999 in Rwanda; in 2007 27% of the population had coverage under these systems. In general, they cover a minimum amount of care and health services and indicators now show that their influence is positive: more women are attending ante-natal consultations and giving birth in health centers or hospitals; and fewer people are consulting unrecognized traditional practitioners.

Water related diseases may also be avoided through better wetlands management. On the Kagera River basin, populations living close to marshlands (marshlands are used for irrigation or brickworks) are the most affected by malaria or other water related diseases. Drainage infrastructure development, as proposed in the “agriculture” section, could lead to a noticeable decrease of these diseases.

Education

Education is the first step in improving water resources management. Illiteracy is a barrier to dissemination through written information. Teaching adults to read and write enables them to share their own knowledge and to gain access to written information. This would bring some relief to social isolation. Schooling is now a driving force for socialization and education. Schools are potential partners and players who can promote good use of water "management" because the concept can be integrated in the learning process from a very early age: respecting water, learning about hygiene and how to use water properly.

Schools should also be some of the first infrastructures to benefit from rain water collection systems, taps, so that they can teach children to wash their hands frequently and toilets that are up to modern sanitary standards.

Gender and water

Women are first in line when it comes to making water available for their families. They are the key targets to be involved in potable water supply related activities. The promotion of women's rights and their integration at different decisional levels (from water committees to higher levels) must therefore be consolidated.

Men are above all concerned when it comes to provision of agricultural water for crops and animals, but also the related land and water resources conservation problems resulting from deforestation for charcoal production among others uses. It is essential for men to understand their responsibilities in terms of sound management of water and land resources under their control.

Macroeconomic Situations

The economies of the Kagera River basin countries are predominantly based on agriculture. According to the UN Human Development Report the four countries of Kagera River basin, Burundi, Rwanda, Tanzania and Uganda, were ranked in the last 30 of 173 countries of the world[3]. The general features of the macro-economy of the countries of Kagera Basin are marked by the following:

- Steady growth of economy
- Small size of the Gross National Product (GNP)
- Low Gross National Income per capita (GNI/capita)
- Predominance of the agricultural sector in the economy
- A slowly growing industrial sector
- A persistent deficit in the trade balance
- Lack of economic diversification
- High inflation rates

The recent economic growth of all of the four countries of the Kagera basin was due to several factors of different nature in each country. Positive factors that have influenced these economies include the following:

- Macro-economic policies that are promoting investments
- Medium and short term development plans that focus on poverty reduction and community participation
- Improved governance and political stability providing an enabling institutional framework
- Favorable weather for agricultural production
- Increasing industrial and agricultural productivity and the evolution of regional markets

Factors that caused a negative impact on the economies include the following:

- Political and social crisis – from time-to-time - in all countries
- Unfavorable terms of trade
- Volatile agricultural prices
- Inadequate investment funds
- Insufficient participation of the private sector
- Insufficient information about local, regional and international markets
- Limitations in available technologies
- Limited personal savings

The economies of the countries of the basin have been growing, albeit unequally, because of differences in geographic size, endowment of natural resources, investment

[3] UNDP. 2006. Human Development Report.

capability, economic policies, governance and social stability. Detailed discussion and assessment of the macro-economy and trends for the Kagera River basin are presented by Kagera Monograph (BRLi, 2008).

1.3 Current Water Resource Development Situation[4]

Potable water and sanitation: Potable water is derived from protected springs, boreholes and shallow wells with hand pumps, and treated surface water. On average, the safe water coverage is 48%, meaning that more than half of the population uses unsafe water. More information on water supply and sanitation coverage is presented in the Kagera Monograph.

Irrigation and drainage: There are an estimated 2,200,000 ha of cultivated land for agricultural production in the Kagera River basin. Water for production on these lands is provided as follows (BRLi, 2008):

- rainfed-only agriculture (more than 94% of the agricultural area);
- marshlands agriculture without any infrastructure (around 5%);
- marshlands irrigation with at least drainage infrastructure (1%);
- Plains irrigation schemes, with reservoir or river water intakes (less than 1%).

Hydropower: Information on hydropower potentials and studies carried out are presented in the Kagera Monograph including brief discussions on:

- Rusumo Falls Hydropower Project
- Kakono Dam Hydropower Project
- Kishanda Valley Hydropower Project
- Nyaborongo Hydropower Project
- Small, mini and micro hydropower potential

More about future hydropower development potential are presented in the coming Chapters.

Fisheries and aquaculture: Despite the fact the capture fishery is threatened by environmental degradation and over-exploitation, no significant attempt has been made to promote aquaculture in the Kagera River basin. However, aquaculture provides a high potential for sustainable fish production due to the fact that the basin contains many areas of small lakes / wetlands where fish ponds could be established.

[4] Information and discussion on this topic is available in the Kagera River Basin Monograph. (*Kagera River Basin Monograph: Basin Development Report, BRL Engénierie, 15 July 2008)*

2. Water Resource Developments in the Future

2.1 Driving Forces

Before proceeding with the nature and distribution of future water resource development, the following clusters of *driving forces* were identified:

- *Demographic* (population growth; migration pressures; urbanization).
- *Economic* (water works investments).
- *Technological* (water use efficiency).
- *Social* (poverty; inequity, health, education).
- *Governance* (power structure; level of conflict; globalization).
- *Environmental* (water-related diseases; soil salinization; water pollution; ecosystem health).
- *Climate change* (temperature increase resulting in increased evapo-transpiration/ evaporation, change in precipitation, increased frequency of droughts and floods).

Demographic issues

Even though all the listed driving forces are critical, the demographic factor is main/major deriving force providing both *opportunities* and *threats* underlying the demands placed on water and related resources. Most of the other driving forces are highly related to the demographic factor.

The high population density and population growth rate of the peoples of the Kagera basin are amongst the highest in the world. This places significant pressures on the sustainable utilization of the water and related resources. Population pressures in the region are further compounded by large numbers of displaced peoples and the resultant internal population movements of migrants and refugees, presently continuing, and the move towards *urbanization* for those seeking improved economic opportunities in the more urbanized cities and towns in the basin. These conditions suggest that demand for water will be increasing in the future.

Many studies indicate that the majority of the rural people in the basin are very poor (few tools, poor housing, small land area, little disposable income); they are unable to invest in improved resources management or education. They have limited access to improved technologies, information and services (research, credit, reliable markets, inputs and dispensaries). In upland areas, water is scarce both for domestic use and livestock as wells and watering points are mostly in lowland areas, or is sold from kiosks at prices most people cannot afford. In large areas of the basin, fuel-wood is also in increasing short supply and alternatives such as paraffin or electricity are only accessible in the few urban centers.

The increasing human and animal pressures in the Kagera basin have led to intensification of land use and the adoption of unsustainable practices. Population

pressures, insecurity and the struggle to meet short term needs have compromised the capacity of farming communities to sustain the land resources even though it is in their best interests.

Resource degradation

The resulting degradation problems affecting the sustainability of livelihoods in the Kagera River Basin include:

- extreme deforestation and loss of woody biomass, timber and non-wood forest products;
- extensive, pervasive land areas subject to severe soil erosion, nutrient mining and declining soil quality affecting land potential and productivity of crop, pasture/range and forest lands;
- pervasive biomass burning, through bush fires, burning of crop residues, cooking with firewood, reducing vegetative cover and soil organic matter;
- Siltation of rivers and lakes.

Soil erosion is extensive across the diverse farming systems and terrain units, with overall moderate sheet and rill erosion; and severe erosion (some gullies) on hilltops and steep slopes. *Deforestation* is also caused by encroachment of agriculture and increasing demands of the growing population for fuel-wood, charcoal, timber and construction purposes. Currently, the majority of the basin's population depends on locally gathered fuel-wood for their energy. Wood is also used for cooking in schools and other public institutions and for brick making and agro-processing. Erosion and deforestation has been extremely severe over the last few decades, especially in Rwanda and Burundi and it will be worse unless the problem is averted.

Access to water and sanitation services

Expanding access to water and sanitation and extending the services to all including to the poor households would largely contribute to promoting them. The following are indicators of the benefits from water supply and sanitation services:

Improving the health of the community

- Safe drinking water and basic sanitation is of crucial importance to the preservation of human health, especially among children.
- Water-related diseases are the most common cause of illness and death especially among the poor.

Generating economic benefits

- Better services resulting from the relocation of a well or borehole to a site closer to user communities, the installation of piped water supply in houses, and latrines closer to home yield significant time savings.
- Girls and women have better educational and productive opportunities when they have water and sanitation facilities nearby, because they can safeguard their privacy in school and save time fetching water.

Currently 8 million (52%) people lack access to safe drinking water, 10 million (67%) people lack adequate sanitation, 1.5 million (10%) people die every year from diarrhoeal diseases and the rate is nearly double (18%) for children under 5. This situation is no longer bearable.

Irrigation

The Kagera river system has its headwaters in high rainfall areas and flows are relatively insensitive to droughts in agricultural areas downstream. In other areas such as Bugesera they are subject to repeated and prolonged droughts. In these and other similar drought prone areas rainfed agriculture will not be reliable to the desirable level and therefore irrigation can provide insurance against drought as far as the location of the farms are along the banks of the river channels. However, it should be realized that irrigation development costs will only be justified by high value crops (such as rice).

2.2 Priority Areas of Development

The identification the nature and type of problems and the possible direction to get out of the complex problems suggest that the development of widely distributed accessible infrastructures need to be in place. Such moves require participation of all stakeholders with full responsibility and authority.

Clean drinking water and sanitation is a basic necessity of life. Supply of clean drinking water in the rural areas has always been one of the highest priorities of the riparian Governments. In these regard, according to the policies of the Kagera riparian governments at all levels (from central as to local) of their administration aim at:

- Providing safe drinking water to all villages, and
- Assisting local communities to maintain sources of safe drinking water in good condition.

To achieve the objectives the riparian Governments supplement the efforts of the people by providing financial and technical support. The strategy to achieve the objectives can be briefly summarized as:

- Accelerating coverage of the remaining not-covered and partially-covered habitations.
- To tackle problems of water quality in affected habitations and to institutionalize water quality monitoring and surveillance systems.
- To promote sustainability, both of systems and sources, to ensure continued supply of safe drinking water in covered habitations

Table 1.5 presents administrative area and corresponding indication of expected future levels of priorities of development and Table 1.6 presents lists of maps given in the Kagera Monograph (BRLi, 2008) that are used in the process of classifying administrative distribution of measures to be taken in the future.

Table 1.5: Administrations and Corresponding Priority Areas of Development

No.	Administration	Water Supply and Sanitation	Soil and Water Conservation	Irrigation and Drainage	Fisheries	Flood Mitigation	Drought Mitigation
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Burundi						
1	Kirundo	H	H	H	H	H	H
2	Ngozi	H	H	H	L	H	M
3	Kayanza	H	H	M	L	M	M
4	Muramvya	H	H	L	X	L	M
5	Bujumbra R.	H	H	X	X	X	L
6	Mwaro	H	H	L	X	L	M
7	Bururi	H	H	X	X	X	L
8	Rutana	H	H	X	X	X	M
9	Gitega	H	H	H	L	H	M
10	Ruyigi	H	H	L	L	L	M
11	Karuzi	H	H	M	L	M	H
12	Cankuzo	H	M	L	L	L	M
13	Muyinga	H	M	M	L	M	H
	Tanzania						
1	Ngara	H	M	L	L	L	H
2	Biharamulo	H	M	L	L	L	H
3	Karagwe	H	M	H	H	H	H
4	Muleba	H	L	L	H	L	H
5	Bukoba	H	L	H	H	H	M
	Uganda						
1	Rakai	H	M	L	X	L	H
2	Isingiro	H	H	M	L	M	H
3	Mbarara	H	H	L	X	L	H
4	Ntungamo	H	H	M	X	M	H
5	Kabale	H	H	L	X	L	M
6	Kisoro	H	H	X	X	X	H

H = *high* M = *medium* L = *low* X = *insignificant*

Table 1.5: (…. Continued 2/2)

No.	Administration	Water Supply and Sanitation	Soil and Water Conservation	Irrigation and Drainage	Fisheries	Flood Mitigation	Drought Mitigation
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Rwanda						
1	Musanzi	H	H	M	H	M	L
2	Gakenke	H	H	M	L	M	L
3	Rulindo	H	H	L	X	L	L
4	Gikumbi	H	H	L	X	L	L
5	Nyabihu	H	H	M	X	M	L
6	Ngororero	H	H	L	L	L	L
7	Rutsiro	H	H	X	X	X	L
8	Karologi	H	H	L	L	L	L
9	Nyamagabwe	H	H	L	X	L	M
10	Nyaroguru	H	H	H	X	H	M
11	Gisagara	H	H	H	L	H	H
12	Huye	H	H	L	X	L	H
13	Nyanza	H	H	H	L	H	H
14	Ruhango	H	H	H	L	H	H
15	Muhanga	H	H	H	M	H	M
16	Kamonyi	H	H	H	L	H	H
17	Nyarugenge	H	H	H	L	H	H
18	Kicukiro	H	H	H	L	H	H
19	Gasabo	H	H	M	X	M	H
20	Bugesera	H	H	H	H	H	H
21	Rwamagana	H	H	H	H	H	H
22	Ngoma	H	H	H	H	H	H
23	Kirehe	H	L	H	H	H	H
24	Kayonza	H	L	M	H	M	H
25	Gatsibo	H	L	M	H	M	H
26	Nyagatare	H	L	M	H	M	H

H = *high* M = *medium* L = *low* X = *insignificant*

Table 1.6: List of maps showing various situations in the Kagera Basin

(ref: Kagera Monograph: BRLi, 2008)

No.	Title of Map
1	Administrative Boundaries
2	Population Density (2002 – 2003)
3	Population Density (Projection 2025)
4	Precipitation
5	Drainage
6	Flow Distribution
7	Hydrogeographic Zones
8	Land Forms
9	Longitudinal Profiles
10	Lithology
11	Elevation
12	Soils
13	Land Cover – Land Use
14	Wetlands and Biodiversity
15	Water and Agriculture
16	Food Crop Density
17	Livestock Density and Cattle Proportion
18	Protected Areas
19	Potable Water Supply
20	Sanitation
21	Regional Power Options

Development of water resources and related resources requires integration in different ways including:

- ***Geographical integration*** using the hydrologic boundaries (that is, catchments and river basins rather than administrative boundaries) as the basic units for water resource management. It also means considering the catchments themselves and the interactions between land use and the water in rivers, streams and lakes, when making decisions about the development and management of all natural resources.

- ***Administrative integration*** that coordinate the water management responsibilities and activities at all levels of government, including national, state/provincial and local/community, and between those levels, and reduced effectiveness in managing water and other natural resources of any country.

- ***Economic, social and environmental integration*** that takes into account not only the financial and economic costs and benefits of water management decisions, but also the social and environmental costs and benefits.

- ***Donor integration*** that creates effective coordination among the many external support agencies in the development and implementation of projects and the provision of other assistance.

The following section briefly discusses an exemplary joint project that demonstrates the benefits of integration.

2.3 Bugesera Joint Project

Project Overview

The overall objective of the Bugesera Natural Region Rural Infrastructure Support Project (Bugesera PAIR)[5] is to help reduce poverty in its impact area. Its specific objective is to improve food security in Bugesera region by increasing agricultural production. PAIR activities will begin in 2010 and will span six years.

The Bugesera natural region suffers chronic food insecurity due to the scarcity of land and severe soil erosion. The situation is worsened by high population density and growth rate. To reverse the trend and create conditions for the cross-border region's sustainable development, it is necessary to develop rural infrastructure to boost agricultural production while preserving and conserving its natural resources. This can only be achieved through planned, coordinated and joint development actions by both countries. The Bugesera PAIR addresses such a need.

The project impact area is the cross-border region astride Rwanda and Burundi and particularly around Lakes Rweru and Cyohoha and Kanyaru marshlands which are shared by both countries, as well as their watersheds. The total project cost is estimated at US$ 45.8 million.

The population of the project area is estimated at 274,000 for the district of Bugesera in Rwanda and 560,000 for the Kirundo province in Burundi, which is a total of 834,000. The project will help to improve the food security for that population by building irrigation infrastructure, access roads and storage facilities, increasing agricultural production and conserving water and the soil.

The project will introduce a new hillside irrigation method and disseminate technical and organizational knowledge on that method to its beneficiaries. The development of the method will contribute to better mastery of water resource management and ensure greater profitability of farm holdings by increasing and securing farm output.

[5] The entire information about PAIR presented in this report is obtained from the Project Appraisal Report of Bugesera Natural Region Rural Infrastructure Support Project (PAIR): Multinational Rwanda – Burundi: African Development Fund ADF/BD/WP2009/112, 21 August 2009

Strategic Orientation and Justification

Bugesera region has suffered serious food insecurity for some years now. Due to galloping population growth and increasing need for arable land, natural forests have been partly destroyed leading to severe erosion. Soils washed from hillsides are deposited in lakes, silting them in the process. These three factors (deforestation, erosion and silting of lakes), combined with irregular and insufficient rainfall, contribute to falling agricultural output. Bugesera has witnessed chronic famine and the population's standard of living of the population has deteriorated sharply. Today, 60% of the population in Rwanda and about 90% of the population in Burundi within the project area live below the poverty line, compared to a national average poverty level of 56.9% and 67% in Rwanda and Burundi, respectively. This situation can worsen irreversibly if steps are not quickly taken to develop and protect the ecosystems.

To overcome the above constraints, the Governments of Rwanda and Burundi decided to design the Bugesera Rural Infrastructure Support Project. The multinational character of the project finds justification in:

a) The use of the shared water resources of Lakes *Cyohoha* and *Rweru* and of the *Kanyaru* marshland: since these are shared resources, they must be used in a concerted and joint manner;

b) The urgent need to protect the ecosystems of these zones: such protection should be done through water and soil conservation works which can only be efficient if they are carried out on all the watersheds concerned and thus on both sides of the border. In other words, the impact of ecosystem protection and conservation action can only be significant if such conservation works are conducted in a synchronized and concurrent manner by the two countries;

c) Both countries have prepared and will sign an agreement to implement the project, thus demonstrating their commitment to ensure joint and concerted use of cross-border waters. Project implementation will benefit both countries. Were the activities envisaged under the project to be carried out only in one of the countries, their impact would be limited in terms of the conservation of the Nile basin ecosystems, in general, and the shared waters between the two countries, in particular. Therefore, the project meets the eligibility criteria of the Bank's "Strategic and Operational Framework for Regional Projects".

Project Description

The project ***objective*** is to enhance food security in the Bugesera region through sustainable increase in agricultural production. The project will pursue its objective through components consisting of the following actions:

Table 1.7: Project Components

No	Components	Cost (Million US$)	Component Description
1	Irrigation Development	30.01	• Develop lake and marshland watersheds over a surface area of 8,000 ha (4 000 ha in each of the two countries); • Rehabilitate irrigation facilities over 3 500 ha of marshland (1,500 ha in Rwanda and 2 000 ha in Burundi); • Develop irrigation facilities in small hillside areas watered by lakes (500 ha in Burundi and 1 000 ha in Rwanda); • Develop production (distribution of selected seeds, integration of cattle and goat rearing with irrigated farming
2	Other Rural Infrastructure	8.38	• Rehabilitate 100 km of rural access roads (50 km in each of the two countries); • Set up storage and processing facilities, and construct buildings.
3	Project Coordination and Management	7.40	• Set up a Joint Project Coordination Unit • Strengthen already existing national structures in charge of implementing the project in the two countries.

Construction of lake-watered hillside irrigation facilities: based on the findings of studies to be launched under PPF advance payments granted to the two countries, the project envisages the development of a surface area of 1 000 ha around Lake Rweru for Rwanda and 500 ha around Lakes Cyohoha and/or Rweru in Burundi. The implementation of this activity will be supported by a technical assistance mission in the two countries.

Rehabilitation of land-locked marshland irrigation facilities: the project will develop an irrigation and drainage network on three land-locked marshlands in Burundi (2000 ha) and one marshland in Rwanda (1500 ha). To maximize returns from these marshlands, the size of irrigation networks will be such that the schemes would be put under cultivation both during the rainy and dry seasons.

Development of lake and marshland watersheds: the extent of soil and water quality deterioration and its adverse effect on marshlands and lakes have compounded land degradation due to poor water and soil conservation and the absence of upstream watershed erosion control. In that regard, the project will seek to protect watersheds over a total surface area of about 8 000 ha around Lakes Rweru and Cyohoha as well as marshlands. Developing the watersheds will further help to check erosion and allow for more intensive cultivation of graded terraces.

Adapting to Climate Change

With regard to climate change, the project will be implemented in a region that witnesses variations in climate, especially in rainfall, both in inter-annual terms and medium-term trends, leading to some severe droughts over the last decade. Considering that the project includes measures aimed at regulating irrigation water inputs and harvesting rainwater, it can be concluded that for the irrigated area, at least, the project is actually a vulnerability reduction initiative. Most of the project investments contribute to helping Rwanda and Burundi adapt to climate change. Hillside or marshland irrigation activities will protect the agricultural sector against periods of extreme drought. Project activities relating to rain and surface water management and, consequently, the management of underground water, are adequately consistent with the water strategy of the two Governments, which aims at guaranteeing the integrated and sustainable use of these resources.

Gender Issues

According to estimates, women account for up to 70% of agricultural workforce in the region. They play a key role in agricultural production, including stock rising, in the two countries. Women manage nearly 30% of the farms and are well represented (60%) in reforestation, soil and water conservation works. As such, women will be the key target of the project and will benefit from its positive spin-offs. The project will also carry out sensitization/training activities for women and youths aimed at promoting non-agricultural income-generating activities. Both women and youths will also receive training in management. To diversify sources of income and meet the food needs of the population, the project will promote income-generating activities such as market gardening and fruit tree farming. Women and children will benefit from improved nutrition thanks to increased availability of various foodstuffs. Women and youth communities will be involved in the management of infrastructure and will assume leadership positions in the running of, and cooperation with, local authorities and Grassroots Community Organizations (GCOs) as well as Farmers' Organizations (FOs), in order to promote participatory management in their localities.

Social Issues

An estimated 834 000 people will benefit directly or indirectly from the positive fallouts of this project. The increase in agricultural activities and output will help to create more job opportunities in rural areas, increase the income of the target population and reduce poverty. Women and children will benefit from improved nutrition status thanks to increased availability of various foodstuffs. The conduct of works (marshland development, rural access roads, etc.) and increased output will lead to the creation of new opportunities for the development of trade in farm produce and inputs, and hence to an overall improvement of the region's economy. The two Governments have also embarked on land reforms with the support of technical partners and donors (DFID, Belgian Cooperation, and IFAD). These reforms are aimed at clarifying the status of, and securing, land ownership through land registration and enabling women and other vulnerable groups to have access to land. The population of the project area will benefit from these reforms.

The project will entail neither the displacement nor resettlement of the population of the project area.

Implementation Arrangements

A project implementation will have the establishment of the following institutions:

a) A *Joint Coordination Unit* (UCM): this Unit will be responsible for implementing joint activities. It will particularly be in charge of planning, coordination, relations with the CRPP and organization of its meetings, administrative and financial management, auditing, project monitoring and evaluation, drafting of progress reports, supervision of national units and relations with the ADF. The UCM will comprise a Coordinator assisted by regional experts (director of administration and finance, monitoring and evaluation officer, an accountant, an accounting clerk, and support staff).

b) *A Regional Project Steering Committee* (CRPP*)* which will comprise the Governor of Kirundo (Burundi) and the Mayor of Bugesera (Rwanda), as well as two representatives of civil society. The CRPP will be presided over by the Ministers of Agriculture of the two countries. Its role will be to give the project the necessary orientations for achieving its objectives, approve annual work plans and budgets, validate progress reports, examine and solve any major problem that may arise during project implementation. The relevant departments of both countries will be represented on the CRPP which will meet quarterly. Administratively, the UCM will be attached to the CRPP and its Coordinator will sign a performance contract with the Regional Steering Committee.

In the two countries, project activities will be implemented by existing structures:

a) The Kirundo Provincial Department of Agriculture and Livestock (DPAE) for Burundi located in the project area. This structure will see its capacity strengthened with the recruitment, using ADF resources, of a national expert in charge of coordinating the project, an international expert with proven experience in project management and an international irrigation expert as well as national experts in various other fields (environment, procurement, monitoring and evaluation, accounting and administration);

b) For Rwanda, the implementation unit in charge of PADAB (Bugesera Agricultural Development Support Project), currently ongoing with ADF financing in the same area, will also be responsible for the implementation of the project in the country. It will be backed by national expertise in different fields (environment, monitoring and evaluation, gender and information technology). The two national coordinators will sign performance contracts with their respective Governments.

Monitoring and evaluation: The project intends to set up a results-based monitoring and evaluation system. A study of the baseline case comprising a socio-economic survey of the project area and the design of its monitoring and evaluation system will be financed under PPF advance payments (granted to both countries for project

preparation). The study findings will be available before effective project start-up. Two other surveys similar to the initial one will be undertaken at mid-term and at project completion. The monitoring and evaluation system will use the findings of these surveys. Monitoring and evaluation officers will be recruited by the UCM and National Units.

Governance: The conflict that rocked Burundi for more than fifteen years seriously disorganized the country's administration and weakened its capacity. Since 2004, the Government has been making efforts in collaboration with its partners, including the World Bank, to redress the situation and improve governance. Considerable progress has been made in terms of the legal and regulatory framework, development of management tools and setting up of audit institutions. Although significant efforts are still to be deployed in governance, there have been positive changes. The Government of Rwanda has developed a political and socio-economic governance action plan comprising decentralization, corruption control and public sector management reforms. To that end, good governance monitoring institutions have been put in place. A new procurement code has been adopted with the establishment of the Rwanda Public Contracts Regulatory Board (ARMPR). Budget monitoring and audit rules, both at the central and local levels, have been adopted. The decentralization reform will enable the population to participate in development and empower local communities in planning and managing project activities.

Sustainability

The project will enhance the experience both countries have acquired in managing marshlands by strengthening the capacity of government departments and farmers' cooperatives. Project sustainability is also contingent on the beneficiaries bearing irrigation costs (beneficiaries will be organized into associations). Members will make their contributions through annual levies set by the management committee of each association. Every year, each association will review its budget by including its actual maintenance and repair needs, which will enable it to fix the rate of levies paid by its members. These levies will be paid into the coffers of the association at the close of each farming season. Already entrenched in the management of marshlands, the project will strengthen this practice through specific training programs for association management committees of associations. This is a guarantee for ensuring the sustainability of the infrastructure. The project will closely monitor hillside pump irrigation, which is not widely used in the two countries. It will recruit an irrigation specialist in each of the two countries to support the authorities and beneficiaries for the proper management of irrigation networks and better organization of irrigators, including setting up a system for collection of levies to finance maintenance activities. The project will also organize a specific training program for the pump operator (irrigation network manager) of each association to strengthen their technical capacity especially in the maintenance of water pumping equipment. It should be noted that in schemes of this nature where productivity is quite high, maintenance costs will be moderate because the sites to be irrigated are near water and the difference in height between the water body and the plots to be irrigated is not much. The maintenance of rural access roads will be entrusted to the road maintenance program of each country especially since the stretch of road envisaged under this project is short (50 km per country).

3. Proposed Large-Scale Water Infrastructures

3.1 The Need of for Dams and Reservoirs

Water has been and will remain to be the vital resource to support all forms life in the Kagera Basin. At present, there is unused abundant water. However, much has to be done in the future in order to adjust the water resource distribution over the basin. Some parts of the basin are prone to drought making water a scarce and precious commodity, while in other parts of the basin it appears very much in abundant. As domestic water supply, irrigation and hydropower production increases, it will soon be prevail that there is a need to balance river flows with regard to seasonal and location distribution. It is already realized that dams and reservoirs have to be used in order to collect, store and manage water needed to sustain water resource developments successfully.

Water remains essential for the survival of the peoples of Kagera Basin and it will be more essential for the future development of the rural and urban communities by providing clean domestic and industrial water supply, irrigation water supply and water for hydropower generation.

As the population of the Kagera Basin continues to grow at the rate of half a million people each year, so does the demand for water. At the same time, there is a need to carefully use of the natural resources and prevent the environment from pollution. The fact that as the water available in the natural system decreases and becomes more sensitive contaminations makes domestic use situation very critical.

One of the most efficient ways to manage water resources for the needs of the people of Kagera Basin is by the construction of dams that create reservoirs for the storage and future distribution. Of the total rainfall, only one-tenth remains for runoff at Kagera mouth, the rest is lost to evaporation. This hydrological pattern has to taken into consideration in the process of utilizing the water resource of Kagera Basin. To accommodate the variations in the hydrologic cycle, dams and reservoirs are needed to store water and then provide consistent yearly supply (World Bank 2002, Admasu 2004 and 2006.a).

The primary benefit of dams (ICOLD, 1997) and reservoirs in the Basin is for *domestic water supply*. Other key purposes and benefits include:

- Irrigation for agriculture (food supply)
- Flood control
- Hydropower
- Recreation

Most dams will be built for several purposes. This produces a broad range of domestic and economic benefits from a single investment. An additional local benefit is the employment opportunities during the multiple year construction of a reservoir project.

Effective management of the water resource is essential to sustaining the existing and future population of the Basin. As the population continues to grow so does the need for more dams especially in drought prone areas. While dams provide significant benefits to the society it should also realized that their impacts on the surroundings have to be properly addressed. These include:

- Resettlement and relocation
- Socioeconomic impacts
- Environmental concerns
- Sedimentation issues
- Safety aspects

These concerns and impacts can be reduced or eliminated by careful planning, and the incorporation of a variety of mitigation measures. Besides, basin-wide planning for water management is the key element to providing optimum water supply and other benefits.

The Relationships between Dams and Hydropower

Hydropower potential can be estimated as a product of water flow rate (or discharge) and the amount of fall (or power head). Discharge is usually measured in cubic meters per second and head is measured in meters.

The drop or the head can be created by natural topographic situation (the gradient or slope). The other alternative is to build a dam and use its height to create fall. The gradients of the major rivers within the Kagera basin are as follows:

- *Ruvubu* has a gradient of 0.5 to 1.5 m/km throughout most of its course. In its lowest reach, below Mwendo Ferry, it has a gradient of less than 0.2 m/km.
- *Nyabarongo* has a gradient of 1.0 to 2.0 m/km for most of its upper course. Below Kigali the gradient reduces to less than 0.5 m/km and further downstream to less than 0.3 m/km and then to 0.05 m/km.
- *Kagera*, at Rusumo Falls, drops about 30 meter within a distance of less that 1.0 km. Below the fall, for the next 230 kms the gradient is about 0.08 m/km.
- *Kagera* downstream of the junction with Kagitumba River has gradient ranging from 0.7 to 1.7 m/km for a distance of 260 km.
- *Kagera* from the confluence of Mwisa River to the mouth, for the last 190 km has a gradient of 0.08 m/km.

It can be concluded that the natural river gradient of Kagera river system is not conducive for hydropower production. However, the discharge is relatively high. In other words, there is a significant amount of exploitable hydropower potential provided dams are built in order to create drops and balance river flows.

It should be clearly understood that ***electricity cannot be stored***, meeting the power demand at different times (short or long) depends on the water flow pattern that is

directly diverted or stored in reservoirs and create a balanced flow throughout the year by compensating the dry season low flows by the wet season excess flows.

In both cases, either to create power head or water flow, it can be concluded that the conditions prevailing in the Kagera Basin require building dams in order to develop hydropower potentials and also other benefits as discussed in the following paragraphs.

Benefits from Dams

Water Supply for domestic and industrial use: One of the fundamental requirements for socio-economic development in the Basin is the availability of adequate quantities of water with the appropriate quality. In the past and present, the main sources of domestic and industrial water have been aquifers. Today, many of these are now overused and their likely rate of recharge in the future is far less than what is extracted. Their supply must be augmented with additional water from reservoirs. Large urban areas are going to depend heavily on water stored in reservoirs during high flows (wet season) and used during low flows (dry season). Properly planned, designed and constructed and maintained dams will contribute significantly toward fulfilling the water supply requirements.

Meeting the agricultural demand for food supply: The land suitable for irrigated agriculture in limited by the topographical condition of the basin compared to water availability. However, irrigated agriculture will be the largest water user. Construction of more reservoir projects requires also improved irrigation technology.

Flood control: Dams and reservoirs can be effectively used to regulate river levels and flooding downstream of the dam by temporarily storing the flood volume and releasing it later. The most effective method of flood control can be accomplished by a number of multipurpose dams strategically located in the river basin. The dams have to be operated by a specific water control plan for routing floods through the basin without damage. This not only eliminates flooding, but provides other benefits such as water supply, irrigation, hydropower and water quality. The number of dams and their water control management plans are established by comprehensive planning for economic development and with public involvement. Flood control is a significant purpose for many of the dams and a main purpose for some of the major dams to be constructed.

Hydropower: The availability of energy is essential for the socio-economic development of the riparian countries. It is advantageous to use energy that is clean, efficient, dependable and renewable. Hydropower meets all of these requirements. Since a vast amount of development lies ahead, good conditions often exist for renewable energy sources. Hydropower projects produce energy with a high rate of efficiency and without burdening future generations with pollution or waste. Hydropower projects can be developed with very small capacities for local consumption or with very large projects as part of a regional or national system. As part of a multipurpose project, hydropower can also help to finance other functions of a reservoir or river, such as irrigation water for food supply, drinking water, flood protection, improved navigation or recreation.

Recreation: The attractiveness of reservoirs for tourism is often a significant benefit, in addition to the other purposes of a dam. This is very significant in areas where natural surface water is scarce or non-existent. Recreational benefits associated with lakes and reservoir, such as boating, swimming, fishing and bird-watching, should betaken into account early at the planning stage, along with other objectives achieve a balanced project. The operation of the dam and reservoir can enhance tourism.

Concerns Associated with Dams: Impacts and Mitigation

As is the case with any complex infrastructure project, dams have some impacts on their surroundings in the river basin. However, adverse effects can be reduced or eliminated by careful planning, public involvement and by incorporating a variety of mitigation measures. Some of the main concerns are as follows:

Safety aspects: To ensure the continued and dependable delivery of benefits from a dam, the owner must have a comprehensive plan for operation, maintenance and rehabilitation. Dam safety activities include monitoring structural performance, developing emergency action plans, training of dam operators, exercises involving the local officials and population and implementing risk reduction actions. As residential and commercial development expands in a river basin, the hydrologic characteristics of the basin also change. This requires a periodic and thorough review of the rainfall and runoff characteristics as well as the identification of other changes in the hydrology of the basin.

Socio-economic impacts: The local economic and social impacts of dam have to be adequately evaluated. One of the most important objectives of dams should be to ensure that appropriate share of the benefits go to the population directly affected. Resettlement programs must involve the identification of the affected population as well as the affected activities such as agriculture, irrigation, forestry, commercial and industrial. Educational programs and new activities such as crafts or other cottage industries should be developed wherever it is appropriate to do so. It should be clearly realized that reservoirs can create an environment which is favorable for the transmission of water-related diseases. The primary preventive measures that should be taken are sanitation and health-care programs for the population around the reservoir, in conjunction with appropriate operating rules such as fluctuating reservoir water level to discourage growth of disease carrying insects.

Environmental concerns: Managing water resources in a river basin has an impact on its natural water cycle. The scale of the impact depends on the actual size and natural condition of the area to be developed and the extent of development. Concerns about environmental issues and implementation of mitigation measures, are essential elements in the planning of a project. This includes: clearing of vegetation in the area to be flooded, multi-level outlet structures to optimize downstream water temperature and quality, provisions for the migration of fish and other aquatic organisms, and operational rules for regulating downstream flows at critical times to protect habitat for reproduction or migratory routes. Appropriate site selection, together with the implementation of these techniques, will result in both new and rehabilitated projects that minimize unacceptable environmental impacts. The planning and operation of dams should focus on combined technical, social, economical and environmental aspects. Full

consideration should be given to whether or not the projects are technically, socially, environmentally and economically justified, and whether the normal functions of the river will continue to be preserved. Only projects with acceptable impacts should be considered for constructed.

Sedimentation problems: Fast-flowing small tributary streams originating in the hilly and mountainous areas of Kagera Basin have the capacity to erode and transport soil, sand, gravel and stones as bed load and suspended material. When the fast flowing streams enter in to mild slope river channels and calm reservoirs, the solid materials will be deposited creating a process is known as sedimentation. There are two positive impacts of sedimentation:

- The deposits in the entry zone of the reservoir (inner delta) provide highly diversified habitats for wildlife.
- Following the removal or settling of suspended solids in the reservoir, the water released from the dam is less turbid and the water quality is improved.

A positive impact of sedimentation is the improved water quality downstream of the dam that makes water treatment easier and less costly. Additional downstream benefits are enhanced recreation, improved local living conditions and facilitating riparian and aquatic wildlife. The negative aspects of reservoir sedimentation are progressive loss of storage capacity, and increased erosion in downstream river channels.

Mitigating the negative impacts of reservoir sedimentation requires sediment control measures. Erosion control measures include fostering and safeguarding the natural vegetation cover through appropriate soil and water conservation techniques. The positive aspects of sedimentation can be accentuated and the negative impacts reduced by appropriate planning and operational regimes for reservoirs that are susceptible to sedimentation.

3.2 Identified Large Reservoirs Sites

The Consultant has identified seven relatively large-scale projects which that are briefly discussed within this section. The locations of large-scale projects are shown by Figure 1.2. Available preliminary information about these water resource projects is presented in Table 1.8. The results of the analysis were used in the analysis of scenarios to support the strategy formulation.

Nyabarongo Multipurpose Project (KWRC 2008) and Rusumo Falls Hydropower and Multipurpose Project (SNC-Lavalin 2008) have sufficiently detailed information. Whereas, in the case of the remaining projects, quite a lot of work has been carried out in order to create satisfactory information for the scenario analysis.

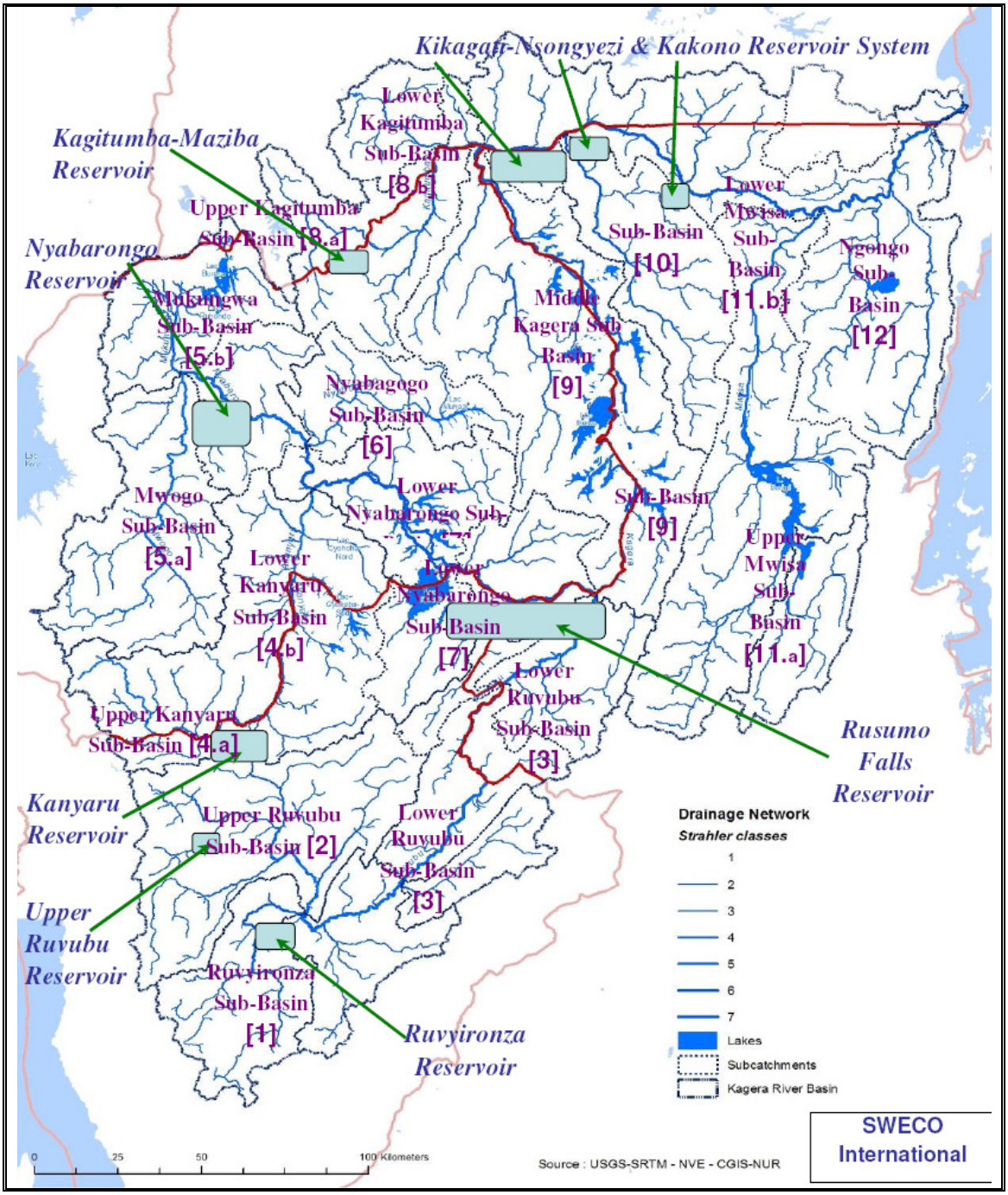


Figure 1.2: Location of Proposed Large Reservoirs Sites

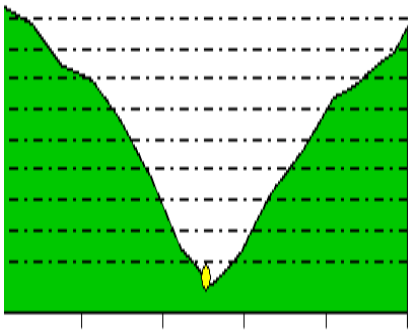
Table 1.8: Available information about the Identified Large-Scale Water Resource Projects

Description	Nyabarongo	Rusumo Falls	Lower Kagera Cascade Systems	Kanyaru	Upper-Ruvubu	Ruvyironza	Kagitumba-Maziba
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Catchment area of the dam site (km^2)	5750	30200	50300	1830	548	1850	856
Catchment area sharing countries	Rwanda	Burundi, Rwanda, Tanzania	Burundi, Rwanda, Tanzania Uganda	Burundi, Rwanda	Burundi	Burundi	Uganda
Dam site sharing countries	Rwanda	Rwanda, Tanzania	Tanzania and Uganda	Burundi, Rwanda	Burundi	Burundi	Uganda
Reservoir site sharing countries	Rwanda	Burundi, Rwanda, Tanzania	Tanzania and Uganda	Burundi, Rwanda	Burundi	Burundi	Uganda
Irrigation area sharing countries	Rwanda		Tanzania	Burundi, Rwanda	Burundi	Burundi	Uganda, Rwanda
Nearby urban center	Kigali	Rusumo	Kyaka	Butare, Ngozi	Gahombo	Gitega	Kabale, Maziba
Primary purpose	Municipal WS,	Hydropower	Hydropower	Irrigation	Irrigation	Hydropower	Hydropower
Secondary purpose	Hydropower and Irrigation	Irrigation	Irrigation	Hydropower	Hydropower	-	Irrigation
Nearby irrigable land availability	Sufficient	Limited	Sufficient	Sufficient	Sufficient	Not available	High
Hydropower Characteristics	Low head & high discharge	Low head & high discharge	Cascade low head & high discharge	Low head & medium discharge	Low head & low discharge	High head & medium discharge	Very high head & low discharge
Identified by	Previous studies	Previous studies	Previous studies	Current study	Current study	Current study	Current study
Information availability on dam characteristics	Complete and available	Complete and available	Partially available	Not available	Not available	Not available	Not available
Information availability on reservoir characteristics	Complete and available	Complete and available	Partially available	Not available	Not available	Not available	Not available
Hydrological analysis	Complete and available	Complete and available	Not available	Not available	Not available	Not available	Not available

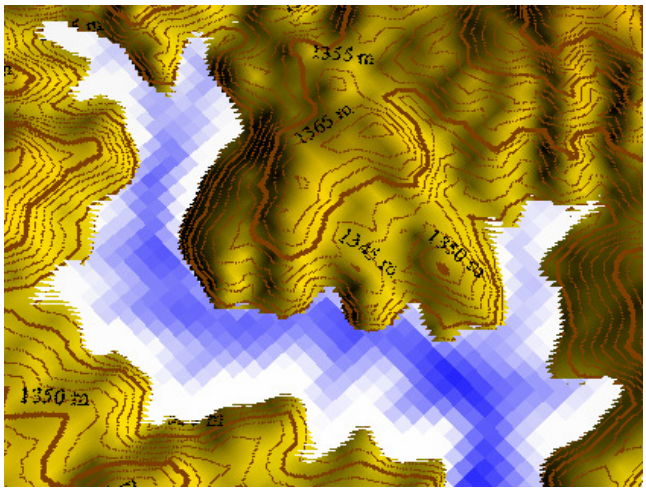
Identifying more likely feasible dam and reservoirs sites included at least the following key activities:

- Searching for existence of a relatively narrow valley to avoid unduly large embankments and inundates areas.
- Searching for appropriate size of catchment that balances production of adequate quantity of water for storage with less magnitudes of design floods magnitude in order to minimize the cost of spillway.
- Establishing preliminary relationships of elevation-area-capacity of reservoirs using digital elevation maps (DEM).
- Delineating the extent and characteristics of all lands within the extent and characteristics of all lands within the projected maximum flood levels (using DEM).
- Establishing dam sections (using DEM).
- Estimating the basic preliminary geometric dimensions of sizes (length, width, height and slope) and typical materials for constructing dams.
- Determining (at preliminary level) types, lengths and sizes of pipes required from dam site (and/or reservoir site) to the proposed treatment plant site.
- Estimating costs of all major components (such as dams, spillways and intakes)

Global Mapper software was applied in generating sufficiently detailed physical topographic information such as reservoir-elevation-area-capacity relationship, plan and sectional profiles for dam sites, plan and sectional profiles for dams and hydropower sites. Digital elevation maps (DEM) provides a regular grid of elevation points that allow the user to reproduce the topography in a variety of display formats and for computer analysis and manipulation as shown by Figure 1.3.



(a) Typical sectional view of a dam site



(b) Typical reservoir site

Figure 1.3: Display of Outputs from DEM Analysis of Dam and Reservoir Sits

3.3 Rusumo Falls Hydroelectric and Multipurpose Joint Project

Introduction

The Rusumo Falls Project[6] is the most centrally located of any potential hydropower development in the Kagera Basin. Rusumo Falls are located on the Kagera River, 2 km downstream from the confluence of the Kagera and Ruvubu rivers, where the Kagera River narrows abruptly to a width of about 25 m entering a gorge wherein the river drops about 31 m through two series of rapids in an 800 m reach. The energy capability of the Rusumo Falls Project, in an environmentally responsible configuration, has been previously evaluated at an average energy value of 403 GWh (capacity of 61.5 MW).

On March 22, 2005, the Ministers in charge of energy of Burundi, Rwanda and Tanzania pledged in a joint communiqué to implement the Rusumo Falls Project within the context of the overall Kagera Basin Integrated Development Framework, for generating hydroelectricity, and generating in turn multi-purpose and public goods benefits.

On March 31, 2006, the Energy Ministers of Burundi, Rwanda and Tanzania signed a Joint Project Development Agreement (JPDA) for the preparation stage of the Regional Rusumo Falls Hydroelectric and Multipurpose Project, which designated the Coordination Unit of the NELSAP as the Secretariat of the Project Implementation Unit.

Location and General Features of the Site

The Rusumo Falls are located on the Kagera River at the border between Rwanda on the left bank (Eastern Province, Kirehe District) and Tanzania on the right bank (Kagera Region, Ngara District).

At Rusumo Falls, the Kagera River narrows abruptly to a width of about 25 m entering a gorge wherein the river drops about 31 m through a series of rapids in an 800 m reach. The flanks of the gorge rise steeply from the floor of the valley at about 1319 m amsl at the head of the gorge to about 1345 m amsl, then moderately to about 1360 m amsl becoming steep again to the crest at 1425 m amsl.

The site of the proposed dam is located a few hundred meters upstream of the international bridge that crosses the Kagera River at Latitude 2.38 South and Longitude 30.78 East. From there, the flow of the Kagera River would be diverted to a powerhouse, bypassing the falls and the rapids. The powerhouse would be built in the rock cliff that overlooks the Mitako basin, where the water would be passed back to the river.

[6] The entire information on the Kagera Joint Project in this section is obtained from SNC-Lavalin International Inc. October 2008. Feasibility Study of the Generation Plant and Related Project Area. Regional Rusumo Falls Hydroelectric and Multipurpose Project. Nile Basin Initiative, Nile Equatorial Lakes Subsidiary Action Program.

The Project, with an installed capacity of 61.5 MW, is intended to supply power to Burundi, Rwanda and Western Tanzania, via interconnections with the national grids, as well as to provide rural electrification to the communities located within the Rusumo Falls vicinity. The figure below shows the location of the proposed civil and hydraulic structures on an Ikonos´satellite image background.

The Objectives and Components of the Project

The development objective of this regional Project is "to enhance economic and social development in the region through productive multipurpose use of water and energy resources along with investments in sustainable livelihoods in the project area". The Project supports the broader Kagera Basin development goal, which is to improve livelihoods in the region through sustainable development in the Basin.

The Project includes the following main elements:

- A hydroelectric power station over the Rusumo Falls of ca. 60-80 MW, to be shared between the three countries, and the multi-purpose/benefit sharing in the Project area;
- Transmission facilities connecting the hydroelectric power plant of Rusumo Falls to the national grids of Rwanda and Burundi, and supply electricity to the western mining provinces of Tanzania, which are currently not connected to the country's national grid;
- At the Project level a joint utility/institutional mechanism for the co-management of power generation and distribution to national utilities.

At the Project area, Project activities will focus on economic development in promising growth centers and improve access to electricity for Micro, Medium and Small Enterprises.

The Project will include environmental management programs, such as watershed management and restoration of water catchment areas, as well as programs to prevent waterborne diseases such as bilharzia and malaria.

In June 2007, the Nile Basin Initiative / NELSAP retained SNC-LAVALIN International Inc. to provide consultancy services to conduct the feasibility studies for the construction of hydroelectric installations, including the assessment of the Project's environmental and social impacts.

Previous Studies and Documentation

The most significant and best documented studies on the Rusumo Falls hydropower development were conducted for the KBO by Tractebel (formerly Tractionel/Electrobel) in 1979 (pre-feasibility), and over the years 1987 to 1992 (technical feasibility, economic feasibility, and final design and tender documents). Tractebel's studies concluded in 1992 that the Rusumo Falls Project at 61.5 MW was "attractive and favorably compared with any

other alternative for power generation in the region" to meet the power deficit faced by these countries (*i.e.*, Burundi, Rwanda, Eastern DRC, and Tanzania). Tractebel's studies also included institutional and tariff studies and feasibility studies of interconnecting power networks. Tractebel's studies were scheduled to be presented to donors for Project financing in 1995. However, they lacked a Social and Environmental Impact Assessment and a Resettlement Action Plan.

More recently, following the approval of the Project by the NBI's Council of Ministers and financing support by the African Development Bank, the World Bank, and Swedish and Norwegian bilateral cooperation agencies, key sectoral studies have been undertaken in order to investigate further aspects of the Rusumo Falls Project.

In 2003, Acres International Ltd. was appointed by the World Bank to perform a review of existing documents on the Rusumo Falls Hydroelectric Project in order to assess the status of the Project and determine next steps in preparing the Project. Acres' Final Review Report recommended performing an optimization study of the Rusumo Falls Project alternatives prior to undertaking in-depth engineering, environmental, social, economic and financial studies

The Strategic/Sectoral Social and Environmental Assessment of Power Development Options (SSEA) was undertaken by SNC-Lavalin over a three-year period (2004-2006) in two stages, within the framework of the NELSAP, to provide an overview analysis of all major regional power development options and regional transmission interconnections in the Nile Equatorial Lakes (NEL) Region in order to facilitate sound decision making by the NEL countries as they move forward with their power development program. The SSEA resulted in the recommendation that Rusumo Falls Hydroelectric Project is a power option that should be implemented in the short to mid-term as it is low cost and with acceptable environmental and social impacts.

In 2005, the World Bank commissioned a Study on Financing and Implementation Arrangements for Regional Hydro Power Generation and Multi-purpose Projects in the NEL Region, conducted by Manitoba Hydro, in which the Rusumo Falls Project was selected for specific analysis. The modeling and sensitivity studies demonstrated conclusively that Rusumo Falls is financially competitive and economically attractive. Finally, in 2006-2007, the Norwegian Water Resources and Energy Directorate (NVE) has carried out a review of earlier hydrological and sedimentological investigations in the Kagera River Basin and the catchment upstream of the Rusumo Falls in view of providing a hydrological expert opinion for evaluating the hydropower potential and related sediment transport issues of the proposed Regional Rusumo Falls Hydropower and Multipurpose Project.

Ongoing Study

Currently *SNC- Lavalin International* is carrying out a Feasibility Study which is divided into two phases:

(1) a preliminary design phase to explore three alternatives using the available head and water resource, and
(2) The full feasibility and basic design study phase assessing one preferred option based on a joint decision by the countries, and the independent Environmental Impact Social and Environmental Assessment phase.

This preliminary design study, referred in this Report, assesses three alternative options, including at least one run-of-the river option, to optimize the hydropower scheme from technical, economic, social and environmental points of view, to determine the economic viability of the Project. One of the selected options was studied during the next phase up to full feasibility including basic design.

The feasibilities studies undertaken by SNC-Lavalin aimed at validating and explaining the feasibility of the Rusumo Falls Hydroelectric Project by taking into account technical, economic, environmental and social issues. They also aimed at producing the documents that riparian countries, financial donors and other investors will need to make an informed decision regarding the implementation of the Project. The studies cover all aspects of the Project to help the authorities of the countries involved and the funding agencies to choose the best possible option.

3.4 Hydrological Analysis

Available information and data on evaporation in the Kagera Basin were collected and analysed to derive estimates of reservoir evaporation for all reservoirs included in the simulation model. The analysis was based on available data of pan evaporation measurements at Kigali airport, estimates of pan evaporation correction factors and reservoir evaporation from previous studies, and water balance calculations for existing reservoirs where sufficient data are available to close the reservoir water balance. Relationships were established to interpolate reservoir evaporation estimates from locations where reliable estimates can be obtained to all reservoirs included in the simulation model. As a minimum, monthly average values of evaporation were estimated for each reservoir and used as base input for the modelling.

The hydrological analysis included:

- Investigating the availability of surface water sources that could be converted into adequate quantity, reliability and quality with the provisions of storage reservoirs.
- Estimating and analyzing flows at control locations and dam sites to establish the dependable yields of reservoirs corresponding to different scenarios.

- Estimating and analyzing design floods for spillways and other large structures facing floods.

Basic procedure

Before using the hydrological data set obtained from PMU as input there were passed through data screening. The data screening procedure consists of four principal steps. These are:

(a) Doing a rough screening of the data and compute or verify the totals for the hydrological year or season;
(b) Plotting these totals according to the chosen time step (e.g. month, year, season) and noting any trends or discontinuities;
(c) Testing the time series for presence or absence of trend.

These steps form what is called the 'basic procedure'. Depending on the nature of the specific requirement of the specific hydrologic characteristics and length of record, the basic procedure can be expanded to include two additional steps. These are:

(a) Testing the time series for absence of presence of persistence by computing the first serial-correlation coefficient;
(b) Testing the time series for relative consistency and homogeneity with double-mass analysis.

Together, the two sets of steps form the complete data-screening procedure.

Regionalization approach and data transfer

Since there are no sufficient hydrological data at potential dam and reservoirs sites, a regionalization approach was used in order to transfer information from those nearby observation/gauging stations.

Estimation of evapo-transpiration

The FAO Penman-Monteith method was maintained as the sole standard method for the computation of crop reference evapotranspiration (ET_O) and open water evaporation from meteorological data. The monthly ET_O was determined from temperature, humidity, wind-speed and sunshine hours data collected at stations within and the nearby Project Area. In general, the Consultant has taken into consideration the evapo-transpiration and/or evaporation estimates obtained by the various previous studies within the Basin. Adjustments on the basis of latitude, longitude and temperature were made in the process of transferring and adopting estimates from their source to site of interest.

Estimated average evaporation at reservoirs is presented by Table 1.9. Evaporation as well as evapotranspiration rates increase as altitude decreases. In other words, the upper part of

Kagera Basin is associated with less water loss due to evaporation or evapotranspiration than the lower part.

Estimated average net evaporation at reservoirs is presented by Table 1.10. Net evaporation is defined as gain due to rainfall at the site minus loss due to evaporation. The net evapotranspiration rates increase as altitude decreases. The main reasons are that gain in rainfall in the upper part of Kagera is higher than the lower part while loss due to evaporation at the upper part of Kagera less than that of the lower part.

Estimation of design floods

Flood studies were undertaken to determine the flood peak magnitudes at potential development sites in order to design the necessary flood handling facilities. Estimating design floods at dam sites involved:

(a) computing mean maximum flood of the gauging stations in the vicinity of the projects area;
(b) transferring the mean maximum floods from the gauging stations to the points of interests taking cachment characteristics (area, slope, rainfall, etc.) into consideration; and
(c) Deriving frequency factors for the region using flood data set obtained from.

Estimated magnitudes of floods corresponding to various return periods are presented in Table 1.11.

Table 1.9: Estimated Average Evaporation at Reservoirs

(Unit: mm)

Name of Reservoir & Location	Upper Ruvubu Reservoir	Ruvyironza Reservoir	Kanyaru Reservoir	Nyabarongo Reservoir	Rusumo Falls Reservoir	Kagitumba-Maziba Reservoir	Lower Kagera Reservoir System
Avg. Runoff (MCM)	1245	1339	1339	1353	1393	1163	1488
January	101	108	108	109	113	94	120
February	91	97	97	98	101	85	108
March	98	105	105	106	110	92	117
April	89	96	96	97	100	83	106
May	96	103	103	104	107	89	114
June	104	111	111	113	116	97	124
July	122	132	132	133	137	114	146
August	136	146	146	148	152	127	163
September	114	122	122	124	127	106	136
October	106	114	114	116	119	99	127
November	92	99	99	100	103	86	110
December	98	105	105	106	110	91	117

3.5 Consideration of impacts of climate change

Evaporation from land surface includes evaporation from open water, soil, shallow groundwater, and water stored on vegetation, along with transpiration through plants. The rate of evaporation from land surface is driven essentially by meteorological controls, mediated by the characteristics of vegetation and soils, and constrained by the amount of water available. Climate change has the potential to affect all these factors. Vegetation cover, type, and properties play a very important role in evaporation and different vegetation types have different rates of transpiration. The actual rate of evaporation as well as transpiration is constrained by water availability. A reduction in soil moisture, for example, could lead to reduction in the rate of evaporation from catchment despite an increase in evaporative demands.

In the Kagera Basin, since there are many lakes and wetlands covering a large area, losses due to evaporation and evapotranspiration are significantly high (see Table 1.10).

Table 1.10: Estimated Average Net Evaporation at Reservoirs

(Unit: mm)

Name of Reservoir & Location	Upper Ruvubu Reservoir	Ruvyironza Reservoir	Kanyaru Reservoir	Nyabarongo Reservoir	Rusumo Falls Reservoir	Kagitumba-Maziba Reservoir	Lower Kagera Reservoirs
Net Annual Evaporation(mm)	-54	48	64	147	604	51	746
January	-105.6	-93.6	-94.1	-82.2	-12.5	-82.5	2.7
February	-58.5	-49.2	-48.9	-39.9	10.9	-43.1	23.0
March	59.2	64.9	67.4	70.3	86.1	58.5	95.1
April	71.0	75.5	77.9	79.9	88.5	67.6	95.8
May	47.5	53.5	55.6	59.4	77.9	48.0	86.9
June	-5.2	3.3	4.6	11.6	49.5	3.5	61.5
July	-3.7	6.1	7.9	15.5	60.1	6.3	73.9
August	-20.8	-9.2	-7.7	2.4	56.9	-7.1	72.8
September	-3.5	6.0	7.3	14.8	56.0	5.9	69.0
October	13.4	21.4	23.2	29.3	62.5	19.6	73.9
November	-14.5	-6.4	-5.5	1.1	38.2	-5.3	48.9
December	-33.1	-24.1	-23.4	-15.0	30.4	-20.7	42.5

Table 1.11: Estimated Magnitudes of Floods Corresponding to Various Return Periods

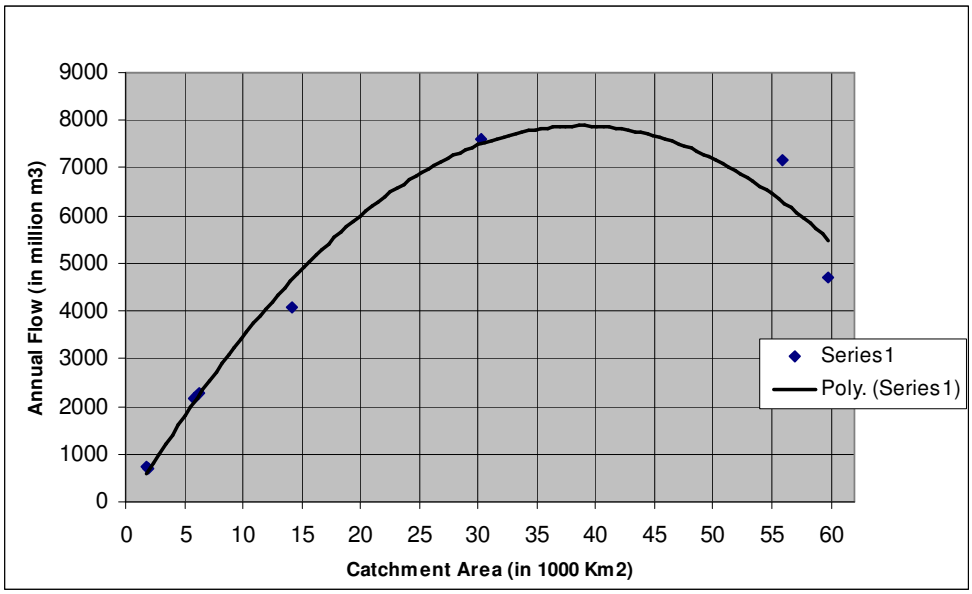
(Unit: m3/s)

Return period (Years)	Growth factor (Qi/Qavg)	Upper Ruvubu Dam Site	Ruvyironza Dam Site	Kanyaru Dam Site	Nyabarongo Dam Site	Rusumo Fall Dam Site	Kagitumba-Maziba Dam Site	Lower Kagera Cascade Dam Site
Average daily maximum flow (m3/s)		49	77	153	234	392	53	431
T(yrs)	XT							
5	1.22	60	94	187	287	480	65	528
10	1.39	68	107	212	324	544	73	598
20	1.55	76	119	237	362	606	82	667
50	1.77	87	136	270	414	693	94	762
100	1.94	95	150	297	455	762	103	838
200	2.13	104	164	326	498	835	113	919
500	2.39	117	184	366	560	939	127	1033
1000	2.61	128	201	399	611	1023	138	1126
2000	2.84	139	219	434	664	1113	150	1225
5000	3.17	155	244	484	741	1241	168	1366
10000	3.43	168	264	525	803	1345	182	1480

Table 1.12: Location and Surface Area of Lakes

Lakes	Sub-Basin No.	Elevation (m amsl)	Surface Area (Km^2)
1. Lake Burera – Rwanda	5.a	1860.0	54.0
2. Lake Ruhondo – Rwanda	5.a	1757.0	26.1
3. Lake Muhazi – Rwanda	6	1445.0	34.1
4. Lake Cyhoha – Burundi & Rwanda	4.b	1348.0	37.0
5. Lake Mugesera – Rwanda	7	1132.0	52.6
6. Lake Birara – Rwanda	7	1328.0	24.3
7. Lake Sake – Rwanda	7	1326.0	38.7
8. Other 5 lakes – Rwanda	7	1325-30	44.6
9. Lake Rweru - Burundi & Rwanda	7	1323.0	132.0
10. Lake Bisongo-Tanzania	9	1288.0	100.5
11. Lake Kazinga-Tanzania	9	1287.5	56.3
12. Lake Katabila-Tanzania	9	1287.0	28.0
13. Lake Cyambwe-Rwanda	9	1288.0	62.9
14. Lake Nasho-Rwanda	9	1289.0	54.9
15. Lake Mpanga-Rwanda	9	1286.5	38.9
16. Lake Rwakibali-Rwanda	9	1286.5	34.6
15. Lake Ihema – Rwanda	9	1286.0	187.6
16. Lake Majunju-Tanzania	9	1284.0	71.5
17. Lake Kivuba-Rwanda	9	1285.0	48.1
18. Lake Hago –Rwanda	9	1285.5	60.5
19. Lake Kisanju-Rwanda	9	1283.0	37.0
20. Lake Mihindi-Rwanda	9	1282.0	51.8
22. Other Lakes in Middle Kagera	9	1283.0	27.0
21. Lake Rwanyakzinga-Rwanda	9	1282.0	66.9
23. Lake Burigi – Tanzania	11	1172.0	166.9
21. Lake Ikimba – Tanzania	14	1154.0	48.8
Total			**1379.8**

Note: Surface elevation and surface areas of lakes were estimated from 90 m DEM



Note: The curve was established on the basis of hydrological data obtained form PMU

Figure 1.4: Relationship between Catchment and Area and Annual Flow

Soil moisture: The amount of water stored in the soil is fundamentally important to agriculture and is an influence on the rate of actual evaporation, groundwater recharge, and generation of runoff. The local effects of climate change on the soil moisture will vary not only with the degree of climate change but also with soil characteristics. The water-holding capacity of soil will affect possible changes in soil moisture deficits; the lower the capacity, the greater the sensitivity to Climate Change.

First, preliminary estimation of parameters of dam and reservoirs were carried out with the assumption that historic hydrological data such as average annual flow, annual variability of flow and seasonal distribution of flow are reliable guides to the future. However, climatic change forces a modification to traditional water resources planning, which is based on the assumption of a stationary long-term climate. In this regard, a *Climate Change* Scenario was analyzed in order to visualize the long-term possible outcomes if the anticipated impacts due to climate change occur.

In the case reservoir evaporation estimates associated with *Climate Change* Scenario, Penman Method has been used to transfer information from the current evaporation estimates to situations with some level of temperature rise. Accordingly, evaporations from reservoirs and lakes as well as evapo-transpiration from crops were derived from the assumed temperature increase and currently available climatic data. Then, the effect of climate change was addressed in the simulations by using generated synthetic time series of flow and evaporation data for different climate change scenarios.

3.6 Water Demand Analysis

Estimation of Potable Water Demand

The estimation of potable water supply is categorized into;

(a) Rural water supply, and
(b) Urban (or municipal) water supply which is divided in to domestic water supply, commercial water supply, and industrial water supply.

The basis of overall potable water supply demand was estimated as a product of per capita consumption rate and population. Population for any year within the planning period (20 years, up to 2030) was estimated on the basis of assumed population growth rates. Similarly, a gradually varying per capita consumption rate ranging from 50 to 120 liters per capita per day was assumed. The lowest figure (i.e. 50 l/c/d) corresponds to rural demand at the beginning of the planning period; whereas the highest (i.e. 120 l/c/d) value correspond to urban areas corresponding to the end of the planning period. Estimated domestic and industrial water demand of major towns are presented by Table 3.9.

Estimation of Irrigation Water Requirement

In determining the potential irrigation development due to the existence of a multipurpose reservoir, the following activities were carried out.

- Identifying locations and sizes potential irrigable lands that can be served by the proposed storage reservoirs.
- Estimating the average irrigation water requirement for: (a) perennial crops, (b) seasonal crops.
- Estimating the quantity (together with the timing) of irrigation water demand that need to be supplied from a reservoir.

In general, the Consultant took into consideration information provided by the reports of previous studies presented by Annex F.1 of this report. Table 1.14 presents estimated average water requirements for rice and other crops.

Table 1.13: Estimated domestic and industrial water demand of major towns

Town	Country	Population		2030 Demand	
		(Year 2009)[7]	(Year 2030)	(m3/day)	(Mm3/year)
Bururi	Burundi	23512	41819	7778	2.84
Gitega	Burundi	29247	52019	9676	3.53
Kayanza	Burundi	11049	19651	3655	1.33
Ngozi	Burundi	24659	43859	8158	2.98
Muyinga	Burundi	9646	17156	3191	1.16
Bugarama	Tanzania	35486	63116	11740	4.29
Ngara	Tanzania	18524	32948	6128	2.24
Kabanga	Tanzania	21314	37910	7051	2.57
Rulenge	Tanzania	24216	43070	8011	2.92
Butare	Rwanda	93556	166400	30950	11.30
Kirundo	Burundi	8557	15220	2831	1.03
Gikongoro	Rwanda	39289	69879	12998	4.74
Gitarama	Rwanda	105488	187622	34898	12.74
Nyanza (Nyabisindu)	Rwanda	72838	129550	24096	8.80
Ruhengeri	Rwanda	86643	154104	28663	10.46
Kigali	Rwanda	672331	1195814	222421	81.18
Ruhango	Rwanda	61707	109753	20414	7.45
Kabuga	Rwanda	62631	111397	20720	7.56
Kibungo	Rwanda	53572	95284	17723	6.47
Rwamagana	Rwanda	55974	99555	18517	6.76
Kabale	Uganda	44709	79520	14791	5.40
Byumba	Rwanda	80290	142806	26562	9.70
Ntungamo	Uganda	15725	27969	5202	1.90
Umutara (Nyagatare)	Rwanda	10222	18181	3382	1.23
Nyakahanga	Tanzania	16069	28581	5316	1.94
Biharamulo	Tanzania	37383	66491	12367	4.51
Kamachumu	Tanzania	17185	30566	5685	2.08
Kyaka	Tanzania	15177	26993	5021	1.83
Isingiro	Uganda	20659	36744	6834	2.49
Katerero	Tanzania	20198	35925	6682	2.44
Kayanga	Tanzania	13614	24214	4504	1.64
Nshamba	Tanzania	21761	38703	7199	2.63
Nsunga	Tanzania	21984	39100	7273	2.65
				Total	**222.81**

[7] The estimated population of Kigali for the Year 2009 is obtained from KWRC (2008). The Year 2009 population estimates for the remaining towns are obtained from National Statistical Agencies of respective countries.

Table 1.14: Average Water Requirements of Irrigation

(Unit: m3/ha)

Name of Irrigation Farm & Location	Upper Ruvubu Irrigation	Kanyaru Irrigation	Nyabarongo (Bugesera) Irrigation	Rusumo Irrigation	Kagitumba Irrigation	Lower Kagera Irrigation
Rice						
Annual WR	7440	7619	8195	12888	13334	13531
January	0	0	0	60	84	95
February	124	130	151	394	429	448
March	1027	1037	1069	1315	1341	1348
April	175	175	179	225	231	231
May	0	0	0	0	0	0
June	2754	2793	2909	3604	3659	3683
July	635	669	772	1574	1636	1665
August	444	468	544	1377	1454	1489
September	313	333	409	1107	1165	1192
October	126	128	132	356	395	411
November	0	0	0	0	0	0
December	1843	1887	2032	2875	2939	2968
Other Crops						
Annual WR	153	162	190	723	816	863
January	0.0	0.0	0.0	0.0	0.0	0.0
February	0.0	0.0	0.0	0.0	0.0	0.0
March	0.0	0.0	0.0	0.0	0.0	0.0
April	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0
June	0.0	0.0	0.0	0.0	0.0	0.0
July	0.0	0.0	0.0	1.3	3.3	4.3
August	36.0	39.0	48.0	274.0	305.0	321.0
September	44.5	48.5	63.0	328.5	375.5	398.0
October	69.0	71.0	75.0	116.0	129.0	136.0
November	3.6	3.6	3.6	3.6	3.6	3.6
December	0.0	0.0	0.0	0.0	0.0	0.0

Estimation of Hydropower Potential

This study included seven dam and reservoir projects for hydroelectric generation or multipurpose purposes. These include the Nyabarongo multipurpose project, Rusumo Falls hydropower and multipurpose project, Upper Ruvubu multipurpose project, Ruvyironza hydropower project, Kanyaru multipurpose project, Kagitumba-Maziba hydropower project, and Lower Kagera multipurpose cascade systems.

In identifying hydropower projects, the basic fact that hydropower potential is directly proportional to the product of head and discharge was considered. For a given plant capacity, powerhouse costs are lower for high head plants and this is because the units run at higher speeds and high-speed machines are smaller than low-speed machines.

In addition, sites with minimum water conduits (tunnels, canals, pipes and penstocks) imply low project costs. This is particularly important at the lower head sites, because of the larger penstock and tunnel diameters involved. In general, in order to be cost-effective, hydropower generating sites were identified on the bases of the following characteristics:

- Potential power head should be as high as possible.
- Suitable sits for forebay (or surgetank), penstock and power house.
- Length of water conveyance structures (pipes, canals, intake tunnels and penstocks) should be as short as possible.
- Excavation requirement for water conveyance structures and power house should be as small as possible.
- Site should be suitable for a large power installations
- Site should be located reasonably close to load centers or transmission corridors

The following optimized values were then derived with regard to hydropower generation:

- Full supply level of the reservoir
- Minimum operating level of the reservoir
- Tail water level of the power plant
- Annual energy
- Firm energy

River maintenance flow

The awareness and concept for stream maintenance flow has been changed with the ages, society, and economical development. In order to manage a river properly, a flow required to maintain normal function running water (normal flow) is defined to be maintained in drought period (maintaining flow rate) and to meet the required rate in consideration of protection river management facilities, smooth functioning of fishing and navigation, preservation of animal and plants, and quality of flowing water.

Stream maintenance flow takes the largest value either in the drought flow of natural factor or environmental protection flow of human factor. It should be satisfactory for both supply

and demand to maintain the normal function and state of stream. It is the amount of flow that is let into the stream for all purposes that has been there historically (in the natural form). Individuals or limited groups cannot exclusively possess it; rather all people within the area and natural ecological system have the right to get access.

For the supply of stream maintenance flow from a dam, a cost like an economical analysis and construction cost in consideration of a benefit and cost to supply the water in the planning stage should be shared, and its capacity among the effective storage should be distributed. It is not too much to say, of course, that it needs method available to scientifically determine the stream maintenance flow for the major sites in downstream of the dam, but it is not a simple thing to decide the method. In order to prevent water pollution as industrialization progresses, it should be determined according to season through modeling of water quality which has river improvement (flow duration, purification of river, prevention from inverse rising of salt, pH control of river water); pollutant load flowed into a river and streamflow.

Moreover, there are not published documents about drought flow and environmental flow along the river in Rwanda. Therefore, for this project study, we suggested just in drought flow without mentioning about environmental flow should be approached in the future after water quality information are available.

Estimation of low-flow magnitudes and frequencies: Low-flow studies were undertaken to determine the low-flow magnitudes at potential development sites in order to allocate and manage low-flows for various needs. Estimating low flow magnitudes and frequencies at dam sites and other selected locations along streams involved the following steps.

a) computing mean annual daily (or other time span) minimum flows of the gauging stations;
b) transferring the mean minimum flows from the gauged stations to the points of interests taking catchment characteristics (area, slope, rainfall, etc.) into consideration; and
c) Driving frequency factors for the region using low-flow data set obtained.

Table 1.15 presents the regional frequency factors as well as magnitudes of low-flows at specified locations corresponding to various return periods. Discharges corresponding to 20-year return period (95 percent exceedance) are known as drought-flows.

Table 1.15: Estimated Low flow Magnitudes Corresponding to Various Return Periods

(With and Without Climate Change Consideration: Unit: m3/s)

Return period (Years)	Growth factor (Qi/Qavg)	Ruvubu (Burasira)	Ruvyironza (Kibaya)	Ruvubu (Gitega)	Ruvubu (Muyinga)	Kanyaru (Butare & Ngozi)	Nyabarongo (Kigali Butare)	Nyabarongo (Kanzenze)	Kagera (Rusumo Falls)	Kagitumba (Kagitumba)	Kagera (Kyaka)
Avg. daily minimum flow (m^3/s)		5.3	8.2	27.9	38.8	8.4	53.5	61.2	132.1	5.0	124.7
Without Climate Change consideration											
5	0.72	3.8	5.9	20.0	27.8	6.0	38.3	43.8	94.6	3.6	89.3
10	0.57	3.0	4.7	16.0	22.3	4.8	30.7	35.1	75.8	2.9	71.6
20	0.47	2.5	3.8	13.0	18.0	3.9	24.9	28.5	61.4	2.3	58.0
50	0.35	1.9	2.9	9.8	13.7	3.0	18.9	21.6	46.6	1.8	44.0
100	0.29	1.5	2.4	8.0	11.2	2.4	15.4	17.6	38.0	1.4	35.9
With Climate Change consideration											
5	0.6	3.2	5.0	16.9	23.4	5.1	32.3	37.0	79.8	3.0	75.3
10	0.44	2.3	3.6	12.3	17.1	3.7	23.6	27.1	58.4	2.2	55.1
20	0.33	1.7	2.7	9.1	12.7	2.7	17.5	20.0	43.2	1.6	40.8
50	0.22	1.2	1.8	6.2	8.6	1.9	11.9	13.6	29.3	1.1	27.7
100	0.17	0.9	1.4	4.6	6.4	1.4	8.9	10.2	21.9	0.8	20.7

3.7 Characteristic of the Infrastructures

Major Components

Table 1.16 presents major characteristics of the large-scale water infrastructures.

Civil works

a) Dam layout: Following issues were considered when proposing the dam layouts

- The capacity of the dam to be adapted to the site conditions. The nature of foundations and abutments are here of importance.
- The availability of the construction materials were also considered, as the economy of the whole project is tightly connected to this aspect of availability.
- As a third consideration, the possibility of passing the flood has been assessed.
- Another major point that was taken into consideration was the feasibility of the dam construction; depending on the site, the river temporary diversion during the construction of the dam governs the dimensioning of the diversion structures and their location

b) Spillway: The major parameters considered for the selection of the spillways were the definition of the floods to be securely passed by the structures designed to evacuate these floods.

c) Water conveyance system, power house and tailrace: Generally, the hydro-electric schemes have as major components the following structures:

- A water intake in the reservoir which is the regulating pond. In some occasions, this intake is a simple run-of the river intake located directly in front of the barrage across the river
- A headrace channel or a headrace tunnel, this latest being either a pressure or a free-flow tunnel
- A pressure chamber (for a headrace channel or a free-flow tunnel), or a surge tank (for a pressure tunnel)
- A penstock which can be underground or open-air, or a steel-lined shaft which is underground
- The power house which can be also underground or an outside structure, depending on the topographical and geological conditions
- Tailrace channel

Table 1.16: Characteristics of the Large-Scale Projects

Description	*Upper Ruvubu Project*	*Ruyironza Project*	*Kanyaru Project*	*Nyabarongo Project*	*Rusumo Falls Project*	*Kagitumba-Maziba Project*	*Lower Kagera Cascade Projects*
River Basin							
Drainage area (km^2)	548	1994	1832	5750	30700	856	47200
Average annual inflow (Mm^3/yr)	239.3	703.7	739.2	2176	7613	162.5	7174
Average annual discharge (m^3/s)	7.59	22.32	23.44	69.0	241.4	5.15	227.5
Unit runoff ($lt/s/km^2$)	13.84	11.19	12.79	12.00	7.86	6.02	4.82
Reservoir							
Reservoir inundation area (ha)	600	1382	1169	2284	20300	723	4010
Maximum water level (m amsl)	1617,0	1528,0	1414,0	1409,1	1325,0	1793,0	1273.0
Flood water level (m amsl)	1616.0	1527.0	1413.0	1408.5	1325.0	1792.0	1272.0
Normal water level (m amsl)	1614.0	1525.0	1411.0	1406.0	1325.0	1790.0	1271.0
Rated water level (m amsl)	1607.5	1518.0	1405.2	1400.2	1324.2	1788.0	1266.5
Low water level (m amsl)	1600.0	1507.0	1394.0	1389.9	1322.0	1780.0	1258.0
Total storage capacity (Mm3)	85.9	210.3	204.5	363.4	495.9	80.0	319.8
Active storage capacity (Mm3)	54.8	153.7	146.7	221.1	472.1	58.5	266.1
Dead storage (Mm3)	31.2	56.6	57.8	88.9	23.8	21.5	53.7
Dam							
Dam crest (m amsl)	1618	1529	1417	1410	1325	1793	1275
Total length, incl. spillway (m)	381	406	353	228	150	172	654
Maximum height (m)	47	57	47	48.5	14.3	38	37
Spillway							
Design flood (m3/s)	168	264	525	803	1345	182	1480
Hydropower							
Ground height (m amsl)	1573	1425	1371	1372.5	1292.9	1540.0	1237.0
Minimum head (m)	27.0	82.0	23.0	18.9	28.0	240.0	64.0
Rated head (m)	35.5	92.0	33.2	28.7	29.6	249.5	72.5
Maximum head (m)	42.0	98.0	40,0	34.2	31.1	253.0	77.0
Installed/Facility capacity (MW)	2.8	19.6	7.4	19.7	61.5	14.1	117.0
Firm Energy (GWh/year)	15.9	113.0	42.1	106.3	420.0	94.5	561.0
Cost							
Total project cost (Million US$)	**69.55**	**109.65**	**95.56**	**153.88**	**336.98**	**117.57**	**652.69**

d) Power house and tail race: The approximate locations of the power houses were mainly determined on the basis of topographical considerations. The downstream conveyance systems were located to best fit with the solution proposed for the power house location.

Power equipment

Basically, the power equipment includes:

- The turbo-generator units;
- The step-up transformers;
- Balance of plant: electrical and auxiliary equipment, lifting equipment;

In selecting the number of units, criteria were taken into account and justified such as:

- The cost of the power equipment increases with the number of units for a given total capacity;
- Minimum number of units;

All power equipment costs of the five projects were estimated on the basis of Nyabarongo and Rusumo projects. The approximate costs estimates were carried out using proportional factor that is related to the energy outputs from each site to that of Nyabarongo and Rusumo.

Construction Plan

Approximately two years for feasibility studies and designs and six years for construction are required for each of the dams. The feasibility studies, detailed designs including the compensation survey, preparing bid documents, and a contract for construction are implemented at least one year before starting the construction. For one year, the preparatory works for main construction and compensation execution for construction lands should be conducted and main construction works are planned to be completed from second year to fifth or sixth year.

The implementation schedule of each of the Large-Scale Projects are given as Annex B and the summary of implementation schedule for all large-scale projects from 2010 – 2030 is given as Figure 1.6.

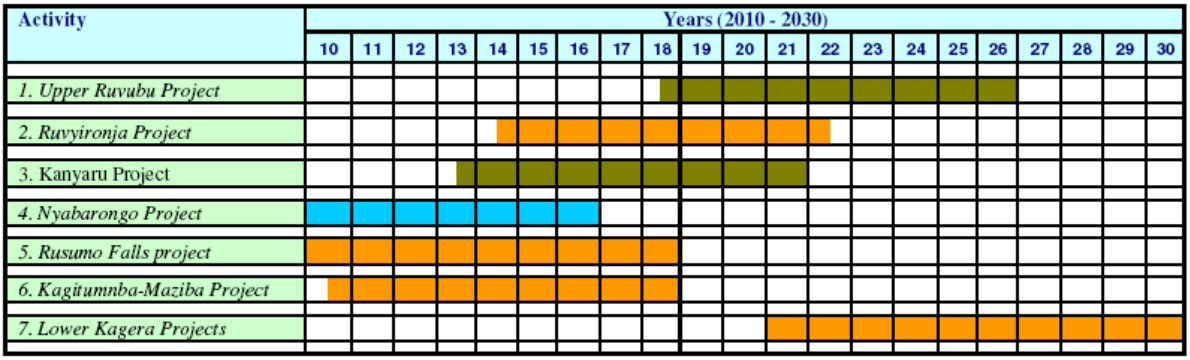


Figure 1.5: Summary of Implementation Schedule for the Large-Scale Projects'

3.8 Rapid Environmental Assessment of Dam and Reservoir Sites

Pre-research activities for the environmental impact review in the seven project areas was carried our through field visit and documents related to general conditions of surrounding areas. This early stage environmental study was carried out in accordance with the ADB (African Development Bank) guidelines.

Environmental impact factors

The selection of environmental impact factors from the checklist for the IEE was conducted according to ADB guidelines. The decision of environmental impact factors according to the project promotion is an important procedure. Therefore, these factors should be diversely selected for the entire impact factors which might occur according to the project procedures. The selection for environmental impact factors are defined as necessary information from the viewpoint of IEE, and the environmental impact factors examined the possibility of the initial environmental impact according to the following procedures.

a) Environmental Impact according to the location selection
b) Matters of water quality management in the designing and planning stage
c) Problems in relation with the construction stage
d) Problems in the operation stage
e) Reviews of the criteria related to the environment.

The checklist (Table 3.13) is marked "no significant impact" if surrounding areas are not influenced, and it is also classified into "small impact", "moderate impact", and "significant impact" if there is an influence on the surrounding environment.

Table 1.17: Rapid Environmental Assessment (REA) Checklist – Seven Large-Scale Projects

Required Items	Upper Ruvubu Reservoir	Ruvyironza Reservoir	Kanyaru Reservoir	Nyabarongo Reservoir	Rusumo Falls Reservoir	Kagitumba-Maziba Reservoir	Lower Kagera 3 Reservoirs	Remarks
	1	2	3	4	5	6	7	
	Yes or No							
A: Selected Location – Are there any environmental problems inside the project area or surrounding area of it?								
❖ Project Area	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Ruvubu, Nyabarongo, Kagitumba and Kagera river basins
❖ Cultural Heritage Sites	No	No	No	No	No	No	No	
❖ Wetland	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Small effect"
❖ Estuarine	No	No	No	No	No	No	No	
❖ Buffer zone to be protected	No	No	No	No	No	No	No	
❖ Special Area for Bio-diversity	No	No	No	No	No	No	No	
B: Latent Environmental Impact								
❖ Is there any conflict related to water right?	No	No	No	No	No	No	No	
❖ Is there any risk of loss related to soil and ecosystem? (marshland, natural ecosystem, estuarine, basin forest)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Small effect"; New ecosystem may be generated
❖ Are there any potential ecological problems according to the decrease of stream capacity, soil erosion, damages from sea wind?	No	No	No	No	No	No	No	

Table.1.17: (…. Continued 2/3)

Required Items	1	2	3	4	5	6	7	Remarks
	Yes or No							
❖ Is there any problem about water resources? (Water supply, qualities of surface water and groundwater, pollution in catchments?	No	No	No	No	No	Yes	No	No upstream contamination for the six projects. There is for Kagitumba-Maziba as it is located immediately downstream of Kabale Town.
❖ Are there any raw water quality problems? (Excessive pathogenic organ, and contaminating organic compounds)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Small effect"
❖ Is it true that the raw water polluted by population, agricultural and industrial waste water from upstream area is supplied	No	No	No	No	No	Yes	No	"No significant impact" for the six projects. But "Small effect" for Kagitumba-Maziba.
❖ Is there any possibility of algae occurrence where raw water is stored?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Small effect"; Management measures are possible
❖ Is there any possibility to pollute surface water and groundwater due to the waste disposal?	No	No	No	No	No	No	No	Few residents
❖ Is there any possibility to pollute surface water and groundwater due to the use of fertilizers and agricultural chemicals?	No	No	No	No	No	No	No	No upstream contamination
❖ Are there any water quality problems in the downstream area (Matters of water use)	No	No	No	No	No	No	No	No upstream contamination
❖ Is there any water quality problem in the downstream area due to decrease of river maintenance flow?	No	No	No	No	No	No	No	
❖ Is there any problem due to the continuous pumping of groundwater?	No	No	No	No	No	No	No	

Table 1.17: (…. Continued 3/3)

Required Items	1	2	3	4	5	6	7	Remarks
	Yes or No							
❖ Is there any cultural property loss in this project area?	No	No	No	No	No	No	No	
❖ Are there any problems from continuous erosions and sediment runoff according to the construction	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Small effect"; Construction management measures are possible
❖ Are there possibilities of temporary floods or road losses by the excavation work in the rainy season?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Small effect"; Construction management measures are possible
❖ Are there noise problems caused by construction equipments?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Moderate effect"; Construction management measures are possible
❖ Are there any obstacles according to the fugitive dust?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Moderate effect"; Construction management measures are possible
❖ Are there any obstacles according to the increase of traffic density in the process of the construction	No	No	No	No	No	No	No	
❖ Are there any troubles related with workers hired from different areas?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Small effect"; Construction management measures are possible
❖ Are there any troubles related with land use and compensation?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Moderate effect"; Suitable compensation is possible
❖ Are there any emigrants?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	"Moderate effect"; Suitable settlement plan is possible

3.9 Partial Preliminary Economic Analysis

Approximate Cost Estimates of Water Resource Projects

The cost required for the proposed multi-purpose projects (both by the previous and current studies) were composed of construction cost for dam and others, the cost of environmental conservation, compensation costs, administrative costs, engineering service cost, and contingency. The quantities for construction were estimated on the basis of the plenary design parameters and the approximate project cost were estimated by applying the unit prices in each work type as obtained from the study Nyabarongo Multipurpose Project[8]. The cost estimations were done on the basis of a rough breakdown of the costs in technical components of the projects:

- Civil works (dam, hydro-technical works, water intake, tunnels, penstocks, powerhouse, etc.).
- Power equipment and transmission grid connection.
- Land cost including cost for expropriation and resettlement of population and activities.
- Access roads to project sites.
- Further structures in relation with the multipurpose use of the projects.

The civil work construction costs were estimated by applying unit rates to the quantities of major civil works, such as mass excavation in alluvium, in rocks, tunnel excavation, concrete, reinforcement, etc. Cost for land acquisition and resettlement were estimated mainly on the basin of reservoir inundation area relative settlement density and other factors that were possible to observe during field visits. The observations made at each reservoir site were compared with the situation at Nyabarongo and Rusumo Falls Reservoirs and other construction sites.

Thus the proposed approach of the cost estimates allowed identifying the cost of the generation only.

- All pricing are in US$ at 2008 and 2009 price level. The cost estimates were based on market international prices assuming international competitive bidding.
- Not-measured items and physical contingencies were estimated to be about 25% of the construction cost.
- The total cost estimates of the projects were compiled from the cost estimates of the various components of the projects.
- The error margin was estimated given the accuracy of the basic data and the level of the studies. It is expected to be in a range of about -30% to +30%, or wider for sites with poor information.
- The cost estimates of the projects together with the benefits allowed assessing the economical attractiveness of these projects.

[8] Source: KWRC (Korea Water Resources Corporation), 2008: Feasibility Study of Water Resources Development in Nyabarongo River in Rwanda, Final report, MINIRENA (Rwanda) and Korea International Cooperation Agency, Final report, September 2008.

Cost estimates of the candidate projects were derived based on the associated relationship with Nyabarongo and Rusumo Falls projects and using the judgment of Consultant (resulting from the long experience with works of similar nature) in filling the gaps.

Construction costs

- Main structures of the proposed project are works for diversion tunnel, main dam, spillway, intake facilities, generation facilities, outlet works, access roads, construction roads, preparatory works for construction, and other subsidiary facilities.
- The unit costs for construction were estimated by foreign currency and local currency.
- The others omitted in terms of the construction costs were estimated by appropriating 25% in case of the public works including the construction cost of irrigation water supply facilities.

Compensation costs

- The indemnity for land and houses, replacement costs for facilities such as relocating roads, administrative approximate cost for compensation were included.
- In case of the administrative cost for compensation, the consignment commission were calculated by appropriating 1% in consideration of land acquisition costs, costs for obstacles, and cost for relocating roads.

Administrative costs and others

- It is composed of administrative costs (project administrative costs, feasibility study, design and construction supervision costs), costs for investigation and design.
- In case of administrative costs, 7% of construction costs are applied according to the generally accepted standards.
- The cost for investigation and engineering service is estimated as 10% of the project cost.

Project Costs and Benefits

Costs: The estimated approximate cost for the dam projects are estimated at US$ 1.54 billion as presented by Table 1.18 and the project expenses for the economic analysis is estimated by the following standards.

- All the money is applied with the same accounting standards, and the amount of money converted into economic cost for the project is applied.
- The annual investment plan of the project is conducted each year based on the disbursement schedule of project costs.
- The O&M cost and repair cost for appurtenant structures and dams are 1% of the construction costs.

Benefits: The multipurpose dams can be classified into direct benefits and indirect benefits. The direct benefits show the project effects which include water supply, flood control, and hydropower. The indirect benefits are secondary benefits caused by the

direct benefit, which leads to the increase of the economic activity by giving an influence to the local or entire economy. The direct and indirect benefits and the costs of the multipurpose dam are well described in Table 1.19.

Basic criteria

Analysis period: According to the dam design criteria, it is common to apply 50 years to the analysis period of the economic analysis. All service lives apply to the analysis of the economic analyses of dams is established by applying 50 years. Therefore, the standard to be applied to the economic analysis of the dam becomes 50 years from the year when the multipurpose dam's operation begins. For the irrigation water supply from the main dam to the downstream area, it is planned to discharge the whole quantity of water. The supply plan including intake weirs, pumping equipments, and farming waterways to be and their service life is assumed as 40 years.

Net present value (NPV): The net present value means the discounted money into the present value by considering the interest rates as inflation rates except the cost caused by the future benefit. The analysis method through the net present value is to measure an added value and measure of value according to the project implementation. If it indicates a good value, the investment can be positively evaluated. The advantage of the present value is as follows. It can be converted into the current value so as to directly compare the future cash flow by applying the time value of the cost. In addition, it can show the inflation and its phased increase, and the overall condition of the project. Moreover, a fixed discount rate is used to analyze, so one needs to be careful in case of the analysis. A method to overcome the disadvantages of this fixed discount rate is the NPV by using discount rate changes. As a rule, the NPV is 0 and less, the project is rejected, and the project which has the highest NPV can be raised to the highest rank if there are no limits to the available capital of the project. The net profit was estimated at 10% of the discount rate in this project.

Benefit/Cost ratio (B/C): This is a method to judge the project feasibility by converting the total benefit and cost into the present value. If this ratio is more than 1, it is acknowledged that this project is feasible. However, the benefit can be estimated at a low value relatively to others as regards difficult conditions, because the calculation of the benefit is more difficult than the calculation of the cost. Therefore, it can be unreasonable to individually consider the benefit and the cost as the basis of the judgment.

Internal rate of return (IRR): This is a value of discount factors when the NPV becomes zero. The internal rate of return (IRR) can be calculated through a diagram of the NPV or the trial and error method. It is favorable to select the project which has the highest IRR because it measures the return of capital. The opportunity to compare with the current discount rate can be also provided. The IRR must be bigger than the discount rate to secure the project feasibility.

Table 1.18: Cost Estimates of Large-Scale Projects

(Unit: Thousand US$)

Description	*Upper Ruvubu Dam site*	*Ruvyironza Dam site*	*Kanyaru Dam site*	*Nyabarongo Dam*	*Rusumo Falls Dam*	*Kagitumba Dam Site*	*Projects (Kikagati, Nsongyezi & Kakono)*	**Total**
1. Preparation and land acquisition	**17184**	**16134**	**18234**	**35934**	**8709**	**20684**	**8709**	**125590**
2. Social & Environm. mitigation costs	**3585**	**5736**	**4660**	**17924**	**2945**	**3406**	**2945**	**41201**
3. Civil Works	**25784**	**33802**	**40193**	**33834**	**101834**	**21011**	**151294**	**407752**
3.1 Care of River	2	7	7	21	1	1	208	247
3.2 Diversion Work	116	337	358	1053	2480	74	10415	14833
3.3 Dam	16742	19596	19522	14790	8393	7350	34519	120912
3.4 Spillway	58	168	178	525	4290	37	5188	10443
3.5 Intake	404	1175	1248	3671	7340	257	36310	50405
3.6 Power Tunnel	0	3667	0	0	11169	2764	0	17600
3.7 Surge Shaft	0	133	0	0	1448	30	0	1612
3.8 Penstocks	63	437	165	394	3625	343	2037	7065
3.9 Power House	697	4835	1829	4356	45974	3790	22520	84001
3.10 Tailrace Outlet	66	191	203	596	4773	42	5895	11765
3.11 Irrigation & Drainage	5141	0	12811	8428	0	4298	20565	51244
3.12 Miscellaneous	2496	3255	3870	3617	12342	2026	13636	41242

Table 1.18: (…. Continued 2/2)

(Unit: Thousand US$)

Description	*Upper Ruvubu Project*	*Ruvyironza Project*	*Kanyaru Project*	*Nyabarongo Project*	*Rusumo Falls Project*	*Kagitumba-Maziba Project*	*Lower Kagera Projects (Kikagati, Nsongyezi & Kakono)*	**Total**
4. Hydraulic Equipment	**696**	**2429**	**2103**	**6113**	**8015**	**3529**	**12170**	**35056**
4.1 Dam and spillway (incl. gates)	335	974	1035	3118	8015	1542	12170	27189
4.2 Intake	260	757	804	2365		1299		5486
4.3 Penstock (steel pipe)	44	306	116	276		394		1135
4.4 Power house	57	393	149	354		295		1247
5. Electro-mechanical Equipment	**1913**	**6266**	**2572**	**6596**	**91045**	**9432**	**273135**	390958
6. Generation, Transmission & Distribution	**7727**	**25312**	**10391**	**26644**	**80000**	**38101**	**160000**	**348174**
Direct Costs	**56888**	**89679**	**78154**	**127045**	**292548**	**96163**	**608253**	**1348731**
7. Administ. & Engineering Service	6977	10999	9585	14782	18736	11794	18736	91609
8. Contingency	5688	8967	7815	12052	25698	9616	25698	95535
Total Costs	**69554**	**109645**	**95555**	**153880**	**336982**	**117573**	**652687**	**1535875**

Table 1.19: Benefits and costs of multipurpose dams

Phase	Benefits	Costs
Direct	• Municipal, industrial, agricultural water supply • Flood control - Preventing submergence of crops and the soil-loss, preventing submergence of farm lands and burying - Damage decreases of channel structures (banks, shore protection, spur dikes, bridges, etc.) • Hydropower generation (facilities and energy benefits) • Improving water quality in the downstream area - Supplying stream maintenance flow, water quality conversion and improvement • Emergency water supply - A measurement for emergency water during the dry season	• Construction cost of dams • Construction costs of power plants • Maintenance costs • Compensation costs • Existing facilities • Construction costs of channels
Indirect	• Increase of land use (low-land area and use of submerged areas) • Deduction of manpower in the flood management • Increase of water management effect (efficient use of water sources) • Decrease of soil inflow (deduction of management cost for water resource facilities) • Alternative effect of oil for generating electric power (foreign currency savings) • Ripple effect of related projects - Effect on production, inducement of a value added, employment creation	• Improvement ratio of environmental ecosystem - Water quality conservation and improvement - Ecosystem conservation
Un-measured	• Environmental amenity and functional improvement: Improving the scenic beauty, cleaning the surrounding environment. • Contribution of national economy: activating economic growth, renewable energy use, resource saving • Development effect of the construction and related facilities: Accumulation of techniques for civil engineering execution, etc. • Improvement of public health and sanitation: Prevention of environmental pollution 8decrease of air pollution), promotion of the welfare.	• The improvement and restoration of environmental ecosystem • Social costs according to the submergence and irrigation

Sensitivity Analysis

The sensitivity of the economic efficiency analysis (mainly for hydropower production) is based on the "with" and "without" *Climate Change* consideration is presented by Table 1.20.

Table 1.20: The sensitivity of economic efficiency

Description	*Climate Change (CC)*	*Upper Ruvubu Project*	*Ruvyironza Project*	*Kanyaru Project*	*Nyabarongo Project*	*Rusumo Falls Project*	*Kagitumba-Mazjba Project*	*Projects (Kikagati, Nsongyezi & Kakono)*	***Total***
Benefit to cost ratio (B/C)									
Discount rate = 10% Inflation rate = 0%	*Without*	0.53	1.82	0.91	1.29	2.54	1.89	1.46	**1.66**
	With	0.44	1.51	0.74	1.04	2.18	1.90	1.10	**1.37**
	Diff (%)	**17.0**	**17.0**	**18.7**	**19.4**	**14.2**	**1.1**	**24.7**	**17.5**
Discount rate = 10% Inflation rate = 3%	*Without*	0.75	2.66	1.30	1.86	3.66	2.73	2.03	**2.36**
	With	0.62	2.21	1.04	1.50	3.15	2.71	1.53	**1.94**
	Diff (%)	**17.3**	**16.9**	**20.0**	**19.4**	**13.9**	**0.7**	**24.6**	**17.8**
Internal rate of return (IRR)									
Discount rate = 10% Inflation rate = 0%	*Without*	4.73	16.80	9.08	12.69	21.87	17.64	14.38	**15.88**
	With	3.54	14.47	7.11	10.41	19.52	17.42	11.08	**13.52**
	Diff (%)	**25.2**	**13.9**	**21.7**	**18.0**	**10.7**	**1.2**	**22.9**	**14.9**
Discount rate = 10% Inflation rate = 3%	*Without*	7.87	20.30	12.35	16.07	25.52	21.16	17.81	**19.36**
	With	6.64	17.91	10.32	13.72	23.10	20.94	14.41	**16.82**
	Diff (%)	**15.6**	**11.8**	**16.4**	**14.6**	**9.5**	**1.0**	**19.1**	**13.1**

As shown in Table 3.13, the decrease in Benefit to Cost (B/C) decreased by about 18 percent while the observed decrease in terms of Internal rate of return is about 14 percent. Definitely consideration of climate change results in significant influence in economic analysis. However, the actual magnitude is very approximate as all impacts of climate change are not included in the analysis. Besides, the accuracy of the estimates of the economic benefits is not to the level that is normally done at feasibility study level. A significant portion of the direct economic benefits are not included since the information readily available do not permit to estimate such costs.

4. Scenario Formulation

4.1 Introduction

While the Kagera Basin is currently relatively underdeveloped, the scope for physical and management-based development is enormous. However, the capacity of the riparian states to finance infrastructural developments is low, and their priorities and opportunities are varied. Thus, while it is certain that development will occur, the nature of the development path is uncertain unless guided by the principles set out in the NBI and LVBC Protocol. The commitment of the countries to those principles is not in doubt, moving from data collection, studies and discussions to actual implementation of projects with cross-boundary implications, governed by defined operational rules, is a major step forward. Similarly, for development partners, the confirmation that there are investment scenarios with clear positive outcomes for all riparian is a prerequisite to support for a development program.

This report explores these concerns, noting at the outset that the potential for riparian states to experience a "future without project" scenario that is environmentally or socio-economically substantially worse than the present situation is a real risk in the absence of a jointly agreed basis for the development and management.

The model referenced (Simple Model for Kagera Basin) has the capacity to test and evaluate development scenarios defined generically in terms of irrigation development and hydropower development. The output of the model is quite narrowly hydrological analyzing water utilized for irrigation and power generation, river flows at key locations. These parameters can in turn provide insights into possible impacts on the environment.

In this report, the results of modeled scenarios are summarized on the basis of selected key indicators, interpreted with the benefit of the insights of the Appendices. The scenarios have been selected to represent feasible development scenarios – some balanced, others unbalanced – thus providing a range of possible outcomes.

The intent of this report is to:

- Report on the application of the Simple Model for Kagera River Basin (SMKRB) to evaluate development scenarios.
- Utilize the model to assess a range of development scenarios.
- Report on key indicators generated by the model.
- Comment on the range of indicators that inform countries as they pursue a shared development pathway.

A development scenario in the context of this report is defined as a hypothetical combination of possible changes of the hydrological conditions and/or multi-sector water demands and/or proposed interventions, describing a plausible future situation.

Previous studies demonstrate that it is important for planning purposes to distinguish between the following future situations:

- ***Baseline situation***, representing development conditions existing in 2008 and the hydro-meteorological conditions up to 2009 particularly of 1971-1990, considered at the basin scale to represent the natural situation (or as close as can be reasonably quantified);

- ***Definite future situation***, which includes water resources developments that will be fixed parts of the Kagera system in a few years from now, such as the proposed water developments (e.g. hydropower and irrigation) in the Kagera Basin.

- ***Foreseeable future*** situation, representing development conditions that could become a reality during the next 20 years, based primarily on country plans and development opportunities;

- ***Long-term future***, representing development conditions in the Kagera Basin that are plausible (or at least not implausible) in 50 years from now.

In addition to man-induced water resources development, the hydrological regime of the Kagera mainstream could also change during the coming decades as a result of climate change.

4.2 Assessment Approach

Assessment framework

The proposed criteria for the scenarios are presented in Table 1.21. This table also highlights which criteria are considered of particular relevance to the various scenarios under consideration and also shows that the assessment criteria covers the triple bottom line of economically beneficial, socially just, and environmentally sound development. They also cover criteria that can measure how well each scenario achieves equitable development.

Generally, assessment criteria have the following characteristics:

- The assessment criteria are policy relevant, which also implies that they are clearly related to a specific development objective, as can be derived from the NBI and LVBC Protocol and national socio-economic and sector plans.

- The assessment criteria are user driven, which implies that they are easy to understand by decision-makers and the public at large. Moreover, the number of criteria is also kept to a minimum to facilitate the presentation and comparison of considered development scenarios.

- The assessment criteria are sensitive to changes caused by water and land resources developments.
- The assessment criteria do not duplicate each other.
- The assessment criteria are likely to be acceptable to each of the four Kagera riparian countries.

Table 1.21: Assessment Criteria for Scenario Analysis

Goal	Primary Objectives		Assessment Criteria			
			Specific Development	Issue	Indicator Description	Unit
Sustainable Development	Optimal Development	1. Economic development	1.1 Increased area covered by WSC	Soil and water conserved	Incremental area	1000 ha
			1.2 Increased irrigated farm	Irrigated agriculture	Incremental area	1000 ha
			1.3 Increased hydropower production	Power generated	Incremental power generated	Gwh/ year
		2. Environmental development	2.1 Maintain water quality and acceptable flow conditions	Flow characteristics	Key low flow characteristics	Lowflow ratio[9]
		3. Social development	3.1 Maintain livelihoods of vulnerable resource users	Health[10], food and income security	Impact on health, food and income security	Trends
			3.2 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in water and related resources	1000 p
	4. Equitable development		4.1 Ensure that all four Kagera Basin riparian countries benefit from the development of water and related resources	Aggregate benefits by country	Summation of incremental net economic and social benefits	Trends

Assessment linkages

The key outputs for indicator assessment which are those identified in the assessment criteria shown in Table 4.2. As can be seen, some of these can calculated directly from the assessment of induced flow regime changes using outputs from the DSF (e.g. irrigated areas), whereas others require understanding of intermediate indicators (e.g. changes in environmental conditions at key locations).

Given below is a summary of the principal linkages factored into the assessment approach.

[9] The values given are Low flow ratios of Kagera River at Kyaka. Kagera at Mouth would have been more appropriate gauging station for this index if it had better quality data than is the case now.
[10] The Domestic Water Supply and Sanitation (DWSS) which is the major contributor to health improvement is not included in the Table. For all Scenarios, DWSS services are assumed to be achieved at the same level.

- ***Hydrological indicators***: Whilst hydrological change is in itself not included in the assessment criteria, it is clearly fundamental to assessing most other indicators.

- ***Irrigated areas***: Irrigated areas are determined in the DSF and are a product of the assumed installed irrigation facilities and the availability of water to meet the unit area water demands.

- ***Energy production***: Energy production is similarly a product of the assumed installed hydropower facilities and the flows available to generate hydropower energy.

- ***Eco-systems and biodiversity***: Changes to the functioning of eco-systems and biodiversity will be brought about by changes in flow conditions in sensitive areas,

- ***Economic impacts***: The economic impact of scenarios is the sum of the incremental aggregate value of the economically productive water-related sectors, viz.: hydropower and agricultural production.

- ***Employment impacts***: The impacts on employment are a product of the changes in labor requirements within the economically productive sectors as above.

- ***Social impacts***: Social impacts are a product of all of the above in terms of the impacts generated on household health, food and income security with particular attention paid to the consequent impacts upon poverty levels and especially to the consequences for vulnerable groups for whom the induced changes in livelihood conditions are beyond their ability to cope with.

4.3 Simulation Study

Determining design capacity of the reservoirs requires reservoir simulation study. The factors that were considered in the analysis include: flow into the reservoir, evaporation from the reservoir, rainfall on the reservoir, water demands (water supply for urban area, hydropower, irrigation, environmental requirement, etc.).

The analysis of multiple-purpose developments are almost wholly dependent upon the demonstrated ability of a proposed project to serve several purposes simultaneously without creating conditions that would be undesirable or intolerable for the other purposes. In order to meet this requirement, the preliminary design capacity of the reservoirs was determined bya simulation study.

A Simple Hydrological Simulation Model for Kagera Basin was developed. Basic output from the Model includes (not limited to):

- Reservoir inflows and outflows
- Municipal and Industrial water supply
- Irrigation water supply
- Reservoir storage and levels (using established water level – volume relationship for the reservoir)
- Reservoir releases, spillage and evaporation losses
- Hydropower generation
- Water use and water deficits

The model is linked with numerical optimisation procedures for optimising reservoir operation considering different management objectives such as optimising hydropower generation, fulfilling domestic water supply and irrigation demands and river maintenance (or environmental demand) flow as well as reservoir evaporation and other losses. The offered optimisation methodology is very flexible and allows definition of any control variable and objective function to be optimised.

5. Scenarios Modeled

A range of development scenarios have been selected to provide a perspective on development opportunities and their impacts. The ***inclusion of a project within the development scenario does not imply any endorsement*** from either the country or the Kagera Basin. The Consultant states, however, that the range of scenarios tested is sufficient to illustrate the range of likely impacts for the next 20 years. The scenarios chosen were principally about developing the irrigation and hydropower sectors. In addition, domestic water supply as well as soil and water conservation are taken into consideration.

5.1 Baseline Condition

The baseline is the reference state to compare other values against. In the context of basin wide water resources management, a baseline development condition is a reference state of physical and management characteristics of the basin at a point in time.

(a) Hydro-climate: A benchmark hydro-climate period of 01/01/1971 to 01/01/1990 has been used for all scenarios. There has been better completeness and coverage during this period compared to other time ranges.

(b) Soil and Water Conservation: It is difficult to estimate the overall coverage of soil and water conservation procedures. From those crude estimates available, it is very difficult to estimate the actual proportion of radical and gradual terraces on the Kagera River Basin. However, some estimates show that there exist 5000 ha of radical terraces and 36000 ha gradual terraces.

(c) Irrigation: Irrigation in Kagera basin is classified into two: as Marshland Irrigation and Plain Irrigation.

Marshland Irrigation: Marshlands in the Kagera basin account for 165,000 ha and 120,000 ha respectively in Rwanda and Burundi, so that it is estimated that they account for around 250,000 ha in the Kagera River basin, of which only 50 % (125,000 ha) are cultivated. The Ugandan and Tanzanian contribution to the marshlands of the Kagera River basin is very low. According to some suggested estimates there is about 1000 ha and 500 ha in Uganda and Rwanda, respectively.

Plains Irrigation: There exist some very small-scale plains irrigation schemes (totaling 288 ha) and Kagera Sugar Company project (about 8,000 irrigated ha) in the Kagera River basin, especially in the lower Kagera basin (Tanzanian part of the basin). The plateau and lowlands areas in Tanzania are indeed more adapted to plains irrigation than the Rwandan, Burundian and Ugandan hills and mountains. The lowlands and plateaus area of Lower Kagera has a large potential for plains irrigation, estimated at around 24,000 ha.

(d) Hydropower: The hydropower potential of Kagera River basin is presented as Table 1.22 (ref: Kagera Monograph). Key conclusions from the studies that are directly relevant to the Kagera basin are as follows:

Table 1.22: Hydropower potential of the Kagera River Basin

Type	Location	Country	Feasible (MW)	Firm Energy (GWh/yr)
Existing	Kagera Basin	All riparians	**43,8**	
Large	Rusumo Falls	Rwanda, Tanzania	61,5	388
	Kikagati	Uganda, Tanzania	48	243
	Nsongyezi	Uganda, Tanzania	24	123
	Kakono	Tanzania	45	228
	Nyabarongo	Rwanda	17	115
	Kanyaru	Burundi, Rwanda	7,4	47,8
	Upper Ruvubu	Burundi	2,8	18,2
	Ruvyironza	Burundi	19,6	127,4
	Maziba	Uganda	14,1	91,8
		Sub Total	**239,4**	**1382,2**
Small/Mini		Burundi	9	
		Rwanda	22,8	
		Tanzania	1,2	
		Uganda	3	
		Sub-Total	**36**	
		Total	**319,2**	

- Only a very small proportion of the population of the region, between 2% and 9% (between 2% and 7% for the Kagera basin countries), has access to electric power supply.
- The current unit consumption in the region is 95 kWh/capita/year including all industrial and commercial consumption. This represents about one tenth of the overall average for Africa of 930 kWh/capita/year!
- Hydropower development alone is not sufficient to meet long-term Kagera basin demands. A regional, transboundary and multi-sectoral (i.e. hydro, thermal, geo-thermal and wind) approach will be required to provide electricity necessary for transformational development in the region in the long-term.

5.2 Scenario 1: Low Development

The Low Development Scenario takes the domestic water supply aspect of Scenario 1 into account. A summary of the key model parameters for the Low Development scenario are discussed in the following paragraphs and shown in Tables 4.4 and 4.5. The combinations *without* and *with* climate change alternatives are shown by 1.(a) and 1.(b) respectively.

Purpose of scenario

The level of development assuming that at the very least, current levels of agricultural production will be maintained is proposed. Some increase in development in the other water usage sectors is also proposed in line with what is likely to happen to meet population growth.

Population is assumed to increase at a rate similar to current population growth rates. Programs are already in place by the four countries to increase access to safe water, so there will also be an increase in per capita demand. Domestic and Industrial uses will then increase. Agricultural production will also need to increase to feed the additional population. Some hydropower dams are also very likely to be built.

The purpose of this scenario is to assess the impacts of the moderate level of development, necessary to maintain current per capita agricultural production and power usage. A moderate increase in water usage, as well as some of the most currently feasible hydropower projects has been included.

Scenario development

(a) Domestic and Industrial demands

Water diverted to meet domestic and industrial demands was estimated as the product of population and per capita water demand. The per capita water demands reflect different levels of access of the population to clean water.

The current and the predicted 2030 total population in the Kagera Basin of the four countries is 15.8 and 25.2 million people, respectively. For the year 2030, the estimated

total rural and urban water usage is about 330 and 360 million cubic meters (Mm^3) corresponding to without and with climate change considerations, respectively. This represents about 4.4 and 7.3 percent diversion from the flow of Kagera River at Kyaka and Mouth, respectively (see Table 1.26).

The rural and urban (domestic and industrial) water supply demands are the same as Scenario 1.(a) and (b) corresponding to without and with climate change considerations, respectively.

(b) Soil and Water Conservation

It is difficult to estimate the overall coverage of soil and water conservation coverage. From those crude estimates available, it is very difficult to estimate the actual proportion of radical and gradual terraces on the Kagera River Basin.

In this Scenario, soil and water conservation covering of a total area of 150,000 ha is included. The breakdown is 50,000 ha of physical (stone bund, soil bund, fanya juu), 100,000 ha of biological (grass strips, agroforestry).

(b) Irrigation demands

This Scenario considers a total of 49,700 ha irrigation consisting of 40000 ha "wide-spread" irrigation and 9,700 ha due to Nyabarongo Multipurpose Reservoir. High-valued crops (mainly rice) and other perennial crops were considered in the process of estimating basin-wide average water demand per unit area. Accordingly, the estimated total water demand for the Year 2030 is 330 to 350 million cubic meters (MCM) depending on without and with climate change consideration, respectively. This represents about 4.5 and 7.3 percent diversion from the flow of Kagera River at Kyaka and Mouth, respectively.

(c) Hydropower

Most of potentially feasible small/mini hydropower developments amounting to a total of 210 GWh/year firm energy. In addition, 110 GWh/year firm energy can be generated from Nyabarongo Multipurpose Project. The overall firm energy of this Scenario becomes 325 GWh/year.

5.3 Scenario 2: Medium (Agricultural) Development

The Medium (Agricultural) Development Scenario takes the domestic water supply aspect of Scenarios 1 and 2 into account. Besides it increases the soil and water conservation, irrigation and hydropower aspects as discussed in the following paragraphs. A summary of the key model parameters for the Agriculture Development Scenario are shown in Table 1.24 and 1.25. The combinations *without* and *with* climate change alternatives are shown by 2.(a) and 2.(b), respectively.

Purpose of scenario

This scenario is designed to assess the impact of large scale water diversion for irrigation without compensating releases from major hydropower dams. This will test limits to water availability at different control stations, as well as impacts on dry season flows.

Scenario definition

A scenario is defined by a combination of physical and management characteristics. Physical characteristics include:

- Climate
- Domestic and industrial demand
- Irrigated crop type, area, and delivery infrastructure
- Storage characteristics (location, size, shape and other structure)

Management characteristics can include water allocation rules and operating conditions for reservoir storages.

(a) Hydro-climate: The same as Scenario 1.

(b) Domestic and Industrial demands: The same as Scenario 1.

(c) Soil and water conservation: On the top of soil and water conservation development considered in Scenario 1, this Scenario adds another 150,000 ha. This makes a total area of 300,000 ha with a breakdown of 100,000 ha of physical (stone bund, soil bund, fanya juu), 200,000 ha of biological (grass strips, agroforestry).

(d) Irrigation

The irrigation aspect of the Medium Development Scenario (Scenario 2) has two components:

(a) All irrigation aspects included in Low Development Scenario (i.e. 49,700 ha);
(b) Additional 20000 ha of "wide-spread" irrigation as that of Scenario 2; and
(c) Additional 37,300 ha associated with three large storage reservoir systems.

The three reservoir systems are:

- Nyabarongo multipurpose reservoir
- Kanyaru multipurpose reservoir, and
- Upper Ruvubu multipurpose reservoir.

For the additional Irrigation demands were estimated on the basis of information on:

- Crop types (rice and other crops)
- Crop areas (coverage of rice is assumed to be at least 50%)
- Irrigation efficiency and return flows

Crop areas, types and distribution were estimated using information obtained from different relevant reports. Irrigation efficiency of 50% has been assumed. An efficiency of 0.50 (or 50%) means that only half the water taken from a river is applied to the crop. Most of this water may find its way back to the river system. This volume returning is estimated as a ratio of the volume of return flow.

The total water demand for the 107000 ha irrigation located at different parts of Kagera Basin is estimated to be 760 to 790 million cubic meters (Mm3) depending on without and with climate change consideration, respectively. This represents about 10.5 and 16.5 percent diversion from the flow of Kagera River at Kyaka and Mouth, respectively. The simulation results are shown by Table 1.24 and 1.25.

(e) Hydropower

The hydropower aspect of this Scenario consists of:

(a) The 210 GWh/year firm energy from small/mini hydropower developments considered by Scenario 1; and
(b) A total of about 160 GWh/year firm energy generated by Nyabarongo, Kanyaru and Upper Ruvubu multipurpose projects.

The overall firm energy of this Scenario becomes 370 GWh/year.

5.4 Scenario 3: High Development

A summary of the key model parameters for the High Level Development Scenario are shown in Table 1.24 and Table 1.25. The combinations *without* and *with* climate change alternatives are shown by 3. (a) and 3. (b), respectively.

Purpose of scenario

This scenario represents the highest likely level of development by 2030. It includes the maximum likely hydropower and water use development. This is used to look at high level of impact of development on the basin.

Scenario definition

(a) Hydro-climate: The same as Scenarios 1 and 2.

(b) Domestic and Industrial demands: The same as Scenarios 1 and 2.

(c) Soil and water conservation: The same as Scenario 2 (Medium Development Scenario).

(d) Irrigation: The same as Scenarios 2 (Medium Development Scenario).

(e) Hydropower

The hydropower aspect of this Scenario consists of:

(a) The 210 GWH/year firm energy from small/mini hydropower developments considered by Scenario 1; and
(b) Additional 1350 GWh/year generated by Nyabarongo, Kanyaru, Upper Ruvubu, Ruvyironza, Rusumo Fall, Kagitumba-Maziba and three cascade projects (Kakigati, Nsongyezi and Kakono) large scale projects.

5.5 Climate change

The historic basis for designing and operating infrastructure will no longer hold with climate change because it cannot be assumed that the future hydrological regime will be the same as that of the past. The key challenge, therefore, is incorporating uncertainty into water resources planning and management. For this study, three simplified assumed situations were examined in order to assess the impacts of climate change. There are: (a) increase in evaporation and evapotranspiration, (b) increase in flood frequencies, and (c) increase in drought frequencies. Finally, the sensitivity of the basic three scenarios to various levels of climate change impacts were examined.

Evapotranspiration and evaporation: The impacts of temperature increase on evapotranspiration (ET) and evaporation (Eo) and the corresponding changes in irrigation water demand, evapotranspiration from major wetlands and evaporation from relatively large lakes were assessed. The sensitivity of ET and Eo to air temperature changes were evaluated using the modified Penman-Monteith equation.

Extreme hydrological events: Flood magnitude and frequency are likely to increase and low flows are likely to decrease in the region. The general direction of change in extreme flows and flow variability is broadly consistent among climate change scenarios. The general increase in flood magnitude and frequency is a consequence of a projected general increase in the frequency of heavy rainfall events. Changes in low flows are mainly a function of changes in evaporation. Evaporation generally is projected to increase as temperature is increased, which may lead to lower low flows even where precipitation increases or shows little change.

The hydro-meteorological baseline used covers 20 years (1971-1990). This period was selected as being that period for which there was the most contiguous set of hydro-meteorological data across the Kagera Basin with a spatial resolution consistent with basin-scale modeling. Besides the normal situation, some aspects of possible climate change situations were induced. Average temperature rise of up to 1.0 degree centigrade (ref: Table 1.23) and drought frequency up to 1.3 times the current situation have been included in the scenario analysis. Then, the impacts of these assumptions as a result of increase in evaporation as well as frequency droughts on the Kagera river flow were estimated.

Table 1.23: Regional[11] averages of temperature and precipitation projections

	Temperature Response (°C)						Precipitation Response (%)						Extreme Seasons (%)		
Season	Min	25	50	75	Max	T yrs	Min	25	50	75	Max	T yrs	Warm	Wet	Dry
DJF	2.0	2.6	3.1	3.4	4.2	10	-3	6	13	16	33	55	100	25	1
MAM	1.7	2.7	3.2	3.5	4.5	10	-9	2	6	9	20	>100	100	15	4
JJA	1.6	2.7	3.4	3.6	4.7	10	-18	-2	4	7	16		100		
SON	1.9	2.6	3.1	3.6	4.3	10	-10	3	7	13	38	95	100	21	3
Annual	1.8	2.5	3.2	3.4	4.3	10	-3	2	7	11	25	60	100	30	1

Source: Chistensen, et al. (2007)[12]:

5.6 Summary of Scenarios

A summary of the combination of trial parameters and the resulting outputs corresponding Scenarios are shown in Table 1.24 and Table 1.25.

Table 1.24: Irrigation requiring additional water supply corresponding to each Scenario

Scenario: (a) without, (b) with CCF	Population growth rate (%)	Distributed Irrigation (1000 ha)	Temperature increase due to CC	Frequency factor of extremes due to CC	Upper Ruvubu Reservoir	Ruvyironza Reservoirs	Kanyaru Reservoir	Nyabarongo Reservoir	Rusumo Falls Reservoir	Kagitumba Reservoir	Lower Kagera Reservoirs	Total
	PGR	IRR	ToC	Freq	R1	R2	R3	R4	R5	R6	R7	
					(1000 ha)							
1.(a)	2.5	0.,0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.(b)	2.5	0.0	1.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
2.(a)	2.5	40.0	0.0	1.0	0.0	0.0	12.7	0.0	0.0	0.0	0.0	**49.7**
2.(b)	2.5	40.0	1.0	1.3	0.0	0.0	12.7	0.0	0.0	0.0	0.0	**49.7**
3.(a)	2.5	60.0	0.0	1.0	5.0	0.0	12.7	9.7	2.5	2.1	15.0	**107.0**
3.(b)	2.5	60.0	1.0	1.3	5.0	0.0	12.7	9.7	2.5	2.1	15.0	**107.0**
4.(a)	2.5	60.0	0.0	1.0	5.0	0.0	12.7	9.7	2.5	2.1	15.0	**107.0**
4.(b)	2.5	60.0	1.0	1.3	5.0	0.0	12.7	9.7	2.5	2.1	15.0	**107.0**

[11] The region is defined by the latitude/longitude box and the coordinates of the bottom left -hand (12S, 22E) and top right hand (18N, 52E) corners.

[12] Christensen, et al. (2007): Regional Climate Projections. In: *Climate Change 2007: The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*

Table 1.25: Generated firm energy corresponding to each Scenario

~ without, (b) with CCF	Population growth rate (%)	Distributed Irrigation (1000 ha)	Temperature increase due to CC	Frequency factor of extremes due to CC	Upper Ruvubu Reservoir	Ruvyironza Reservoirs	Kanyaru Reservoir	Nyabarongo Reservoir	Rusumo Falls Reservoir	Kagitumba Reservoir	Lower Kagera Reservoirs	Total
	PGR	IRR	ToC	Freq	R1	R2	R3	R4	R5	R6	R7	
					(GWh/year)							
1.(a)	2.5	0.,0	0.0	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
1.(b)	2.5	0.0	1.0	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.0**
2.(a)	2.5	40.0	0.0	1.0	0.00	0.00	0.00	107.1	0.00	0.00	0.00	**107.1**
2.(b)	2.5	40.0	1.0	1.3	0.00	0.00	0.00	86.1	0.00	0.00	0.00	**86.1**
3.(a)	2.5	60.0	0.0	1.0	15.81	0.00	41.89	105.41	0.00	0.00	0.00	**163.2**
3.(b)	2.5	60.0	1.0	1.3	12.86	0.00	32.50	84.47	0.00	0.00	0.00	**129.8**
4.(a)	2.5	60.0	0.0	1.0	15.91	114.38	41.89	105.41	468.25	94.53	510.02	**1350.4**
4.(b)	2.5	60.0	1.0	1.3	12.86	93.02	32.50	84.47	400.33	94.53	386.99	**1104.7**

Table 1.26: Summary of water demand corresponding to different Scenarios

Scenario	Water Demand (Mm3)	Change in flow (%) (at Kyaka)	Change in flow (%) (at Mouth)
Domestic water supply (without CC)	297,9	4,15	6,33
Domestic water supply (with CC)	327,3	4,56	6,95
1.(a): Low Development (without CC)	612,3	8,53	13,00
1.(b): Low Development (with CC)	655,4	9,13	13,92
2.(a): Medium Development (without CC)	1033,7	14,4	21,95
2.(b): Medium Development (with CC)	1092,6	15,22	23,20
3.(a): High Development (without CC)	1180,9	16,45	25,08
3.(b): High Development (with CC)	1246,2	17,36	26,46

6. Indicators

Each scenario is intended to provide a different balance (or trade-off) between economic, environmental and social objectives of the Kagera Basin riparian countries. The assessment appraised (quantified and qualified) how well each scenario would achieve these objectives. After consultations (with the stakeholders) on the assessment results, which scenario would provide the most acceptable balance between economic, environmental, and social outcomes in the Kagera Basin, and would bring mutual benefits to the riparian countries was determined. The selected scenario will support the definition of the Kagera Basin development space as an IWRM-based Basin Strategy.

The scope of the development scenarios assessed is limited to those with transboundary impacts where trade-offs between sectors will have to be considered. The scope of the assessments of the development scenarios is to be triple bottom line, i.e. to embrace economic, social and environmental cumulative impacts, at a level of detail that enables decisions to be reached on the key issues within the defined time-frame. The scope of assessments is expressly not to endorse specific project-level interventions, which will require detailed studies of their own to confirm their individual viability and acceptability.

A range of indicators have been selected to show the impacts of flow change at key locations throughout the Kagera basin. The indicators can be grouped into three broad categories:

- Mainstream flow indicators
- Irrigation production
- Hydropower generated

The mainstream flow indicators have been selected to look in flow and how this relates to conditions with and without factors indicating climate change and basic IWRM principles. These indicators are also used to investigate change in low flows.

The irrigation production provides results on irrigated areas. The irrigated areas take into consideration water access constraints and the areas represent the amount of area that could be grown with the water that is available.

Mean Monthly Dry Season Flow

The mean monthly flow indicator is used to assess the impacts in changes in development as they might relate to the principles set out by NBI and LVBC Protocol.

Accordingly, the maintenance of the flows on the mainstream were considered by securing acceptable minimum monthly natural flow during each month of the dry season from all reservoirs include in the simulation.

Table 1.27: Ratios of Low flows at Downstream of Reservoirs and Selected Control Stations

Site	Current Flow	WSS		Scenario 1		Scenario 2		Scenario 3	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
1	1,00	0,97	0,97	0,93	0,93	0,74	0,88	0,74	0,88
2	1,00	0,96	0,96	0,92	0,92	0,90	0,90	1,24	1,31
3	1,00	0,96	0,96	0,94	0,93	0,76	0,83	0,76	0,83
4	1,00	0,96	0,95	1,03	1,03	1,01	1,01	1,01	1,01
5	1,00	0,96	0,96	0,94	0,94	0,93	0,91	0,99	0,99
6	1,00	0,91	0,91	0,85	0,84	0,82	0,81	0,86	0,91
7	1,00	0,95	0,95	0,92	0,91	0,91	0,89	0,86	0,86
8	1,00	0,92	0,92	0,81	0,81	0,78	0,78	0,84	0,85
9	1,00	0,92	0,92	0,90	0,90	0,86	0,86	0,86	0,86
10	1,00	0,95	0,94	0,91	0,90	0,86	0,84	0,84	0,82
11	1,00	0,92	0,91	0,88	0,87	0,71	0,68	0,70	0,66
Average	**1,00**	**0,94**	**0,94**	**0,91**	**0,91**	**0,84**	**0,85**	**0,88**	**0,91**

Irrigation Reliability

The irrigation reliability is estimated from water availability for the irrigated area. With all reservoir systems, irrigation reliability is 95%. Table 1.24: Irrigation development dependent on reservoir systems.

Hydropower Generated

The average annual hydropower generated for each of the modeled dams for all scenarios is reported in Table 1.25. The hydropower generated show that, if these major projects were to proceed, five to six times more hydropower would be generated in the Kagera Basin.

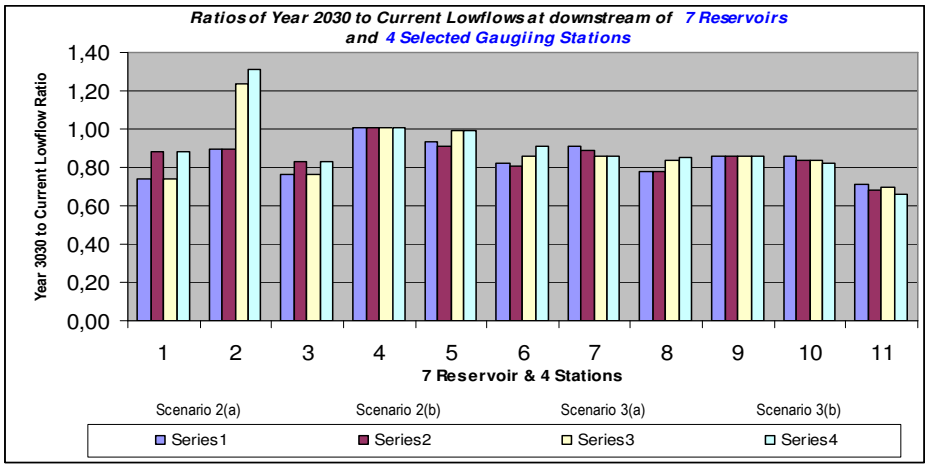


Figure 1.6: Ratios of Low flows

7. Assessment of Outputs from Scenario Analysis

7.1 Overview

The aims of the hydrological assessments are three-fold:

(i) To make an assessment of the nature and magnitude of the hydrological changes in the Kagera River Basin mainstream relative to baseline conditions brought about by the assumed set-up conditions in each scenario;

(ii) To create an information platform upon which other assessments (irrigated agriculture, environmental, social and economic) can be undertaken in a manner that relates these assessments to changing hydrological conditions; and

(iii) To prepare a report on each scenario run together with an overall assessment drawing together the findings from each scenario test conducted.

The DSF was designed with these functions in mind and equipped with the necessary tools to accomplish this.

Key nodes: Twelve reporting nodes in the DSF have been selected for all assessments of temporal hydrological changes. These are seven dam sites and five gauging stations along the mainstream and major tributaries.

Time-series reporting: For each scenario the time-series reports given in Table 4.8 are were produced.

Table 1.28: Time-series reporting at key nodes for each scenario

	Title	*Specific Requirement*	*Key Relevance(s)*
1	Average seasonal flow in wet and dry seasons	Seasonal volume (Mm^3) Average discharge (m^3/s)	Overview of hydrological changes
2	Average seasonal flow in dry seasons	Seasonal volume (Mm^3) Average discharge (m^3/s)	Environmental assessment
3	Average monthly flow	Seasonal volume (Mm^3) Average discharge (m^3/s)	Overview of hydrological changes
4	Average monthly flow for a dry year	Seasonal volume (Mm^3) Average discharge (m^3/s)	Environmental assessments
5	Average monthly flow for a wet year	Seasonal volume (Mm^3) Average discharge (m^3/s)	Environmental assessments
6	Average daily flows	Average discharge (m^3/s)	Maintenance of flows in the mainstream
7	Annual average minimum and maximum daily flows	Average discharge (m^3/s)	Overview of hydrological changes

7.2 Creating an assessment platform

Approach to assessing basin-level indicators: The nature of the assessment and of the general approach to the assessment is to relate changes in each of the indicators to changes in hydrological conditions prompted by the interventions and external conditions assumed for each scenario.

Increase in irrigated agricultural production: The key indicator for the hydrological assessment is incremental area of irrigated area production measured in '000ha. The assessment of incremental irrigated areas is undertaken using the decision support framework (DSF) model. The DSF computes for each scenario the area that can be irrigated at each model node with irrigation attached up to the maximum irrigable area present at that node. The area irrigated is thus constrained by the irrigation demands (which are dependent upon climate assumptions) and the water resources available (which are dependent upon both climate assumptions and water management infrastructure in place, principally dams and storage reservoirs). The data generated from the DSF is reported at each irrigation node as the maximum feasible area irrigated in each year during the run (baseline 1971-1900).

Increase in hydropower production: The key indicators for the hydrological assessment are the incremental power generated measured in GWh/year. The assessment of hydropower generated is undertaken by the DSF models based on the available water flows throughout the year, the installed capacity and the assumed operating rules at each site. In the case of mainstream dams, more detailed modeling has been undertaken of each of the nine dams under consideration in the Kagera Basin and this information, where relevant, is used in preference in the economic assessments. The data generated from the DSF is reported at each hydropower node as the energy generated in each year during the run (baseline 1971-1990). These are abstracted and an average energy generated computed at each

Maintain water quality and acceptable flow conditions: The key indicators for maintaining water quality and acceptable flow conditions in the mainstream are the key flow characteristics.

7.3 Observation

Hydrological Impacts: All development will have impact and the model reflected change in the hydrology of the river that would result from the development. Decisions on what is the reasonable balance of development is a matter that can be informed by the model outputs but requires the economic, environmental and socio-political inputs by the country concerned to determine the appropriateness and priority of each investment. Current development of the Kagera River Basin is very limited. The natural flow pattern is essentially intact.

Tables 1.30, 1.31, 1.32 and 1.33 as well as Figures 1.8, 1.9, 1.10 and 1.11 show the hydrological simulation results at four control gauging stations. More simulation results are presented as Annex A.

Summary observations are:

- The overall character of the hydrograph is maintained
- Wherever hydropower projects are introduced, low flows are significantly increased and are higher than historically observed range
- High flows are marginally reduced, but within historically observed range

Future development must be properly coordinated, and managed, to preserve the environmental flows that support the ecosystem in order to be consistent with objectives set out in the NBI and LVBC Protocol. The results confirm the importance of balanced and coordinated approach to water management. The results set out here confirm that agreement on access to the waters of the Kagera River is a precondition to provide development security at a country level, ensuring that the benefits of development in one country are not eroded by development in another. Only a coordinated approach provides assurance of sustainable development opportunities.

Irrigation: To support national objectives of basic food security and crop diversification an increase in irrigated area is inevitable. There is currently 28300 ha irrigated land facilitated with minimum infrastructure. The high development scenario considers 10700 ha of irrigation resulting and increases the total area to 135300 ha. This increases the amount of overall diverted water for irrigation by 525 Mm3 to 547 Mm3 per year. This will in total result in 11.1 to 11.6 percent of the annual flow of Kagera at mouth.

Hydropower: The projected hydropower in the Kagera River Basin in the various ranges is summarized by Table 1.25. The hydropower corresponding to the high development scenario with and without climate change consideration amounts to 1100 and 1350 GWh/year.

Overall Observation

Summary of the overall results corresponding to the selected assessment criteria are presented by Tables 1.26 and 1.29. Table 1.26 shows that the High Development Scenario consumes about 17 and 26 percent of the flows of Kagera at Kyaka and Mouth, respectively. However, the actual consumption could be much less than this figure. Because of the difficulty of estimating the proportion of irrigable land and the possible moisture deficiency level, the estimated total amount of water budgeted irrigation has been estimated in a conservative manner. In the modeling process, while correction for effective rainfall has been considered, no correction has been made to balance the evaporation and evepotranspiration losses due to utilization of wetlands that are already consuming the same amount or more water prior to being irrigated. ***Future studies should include issues of this nature in order to accurately estimate irrigation water requirements as well as drainage infrastructure requirements***.

Table 1.29: Results corresponding to the Assessment Criteria for Scenario Analysis

Goal	Primary Objectives		Assessment Criteria: Specific Development	Issue	Indicator Description	Unit	Scenarios (Without Climate Change) S1(a)	S2(a)	S3(a)	Scenarios (With Climate Change) S1(b)	S2(b)	S3(b)
Sustainable Development	Optimal Development	1. Economic development	1.1 Increased area covered by WSC	Soil and water conserved	Incremental area	1000 ha	49.7	107	107	49.7	107	107
			1.2 Increased irrigated farm	Irrigated agriculture	Incremental area	1000 ha	150	300	300	150	300	300
			1.3 Increased hydropower production	Power generated	Incremental power generated	Gwh/ year	150	309	1458	150	269	1208
		2. Environmental development	2.1 Maintain water quality and acceptable flow conditions	Flow characteristics	Key lowflow characteristics	Low flow ratio[13]	0.88	0.86	0.84	0.87	0.84	0.82
		3. Social development	3.1 Maintain livelihoods of vulnerable resource users	Health[14], food and income security	Impact on health, food and income security	Trends	1300	2390	2400	1300	2390	2400
			3.2 Increased employment generation in water related sectors	Incremental sustainable employment from water resource interventions	Incremental number of people engaged in water and related resources	1000 p	2600	4800	4850	2600	4800	4850
	4. Equitable development		4.1 Ensure that all four Kagera Basin riparian countries benefit from the development of water and related resources	Aggregate benefits by country	Summation of incremental net economic and social benefits	Trends	Low	High	Very High	Low	High	Very High

[13] The values given are Low flow ratios of Kagera River at Kyaka. Kagera at Mouth would have been more appropriate gauging station for this index if it had better quality data than is the case now.

[14] The Domestic Water Supply and Sanitation (DWSS) which is the major contributor to health improvement are not included in the Table. For all Scenarios, DWSS services are assumed to be achieved at the same level.

Table 1.30: Patterns of flow of Ruvubu River near Gitega

Month	Current Flow	WSS		Scenario 1		Scenario 2		Scenario 3	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Jan	225	217	217	212	212	209	208	204	201
Feb	231	223	223	218	218	214	213	209	208
March	291	283	283	273	272	262	261	257	257
April	285	276	276	272	271	265	266	260	261
May	227	218	218	215	214	211	211	207	207
June	150	142	142	121	120	106	106	105	106
July	111	102	102	91	91	86	85	87	87
Aug	98	90	90	80	79	77	77	83	84
Sept	105	97	97	88	88	85	85	95	97
Oct	148	140	140	134	134	130	128	139	139
Nov	190	181	181	178	178	172	170	175	173
Dec	204	196	196	179	178	163	161	154	148
Annual	**2264,1**	**2165,4**	**2165,4**	**2060**	**2055,1**	**1978,4**	**1971**	**1975,2**	**1967,8**

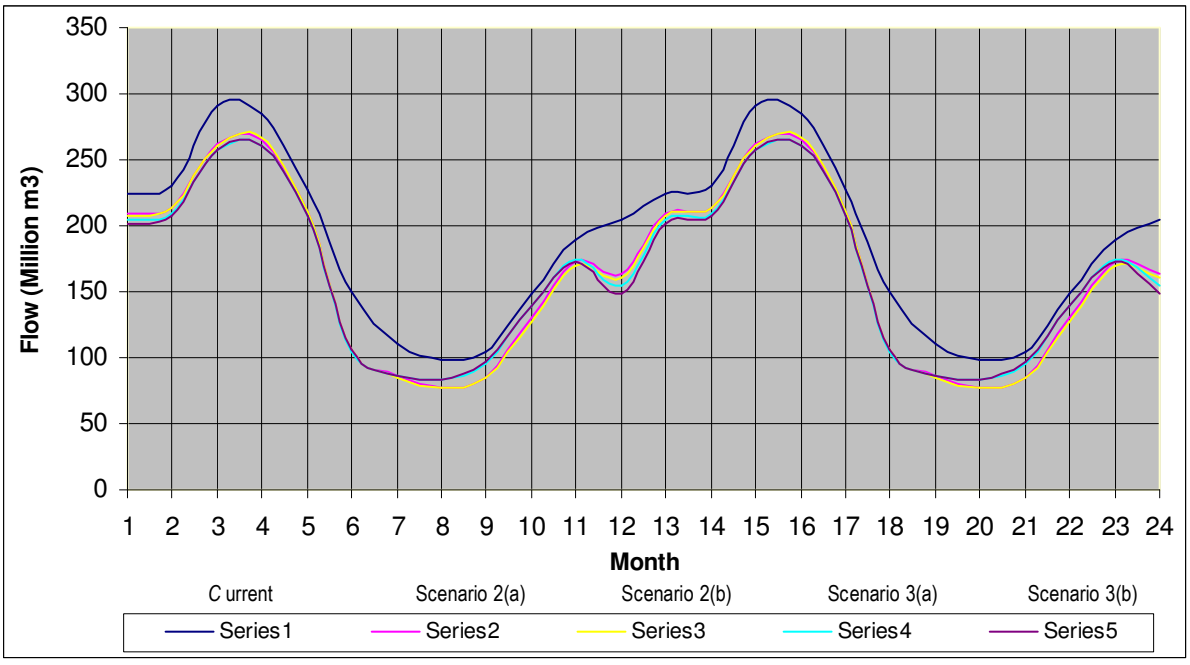


Figure 1.7: Patterns of flow of Scenario 2 & 3 at Ruvubu River near Gitega

Table.1.31: Patterns of flow of Nyabarongo at Kanzenze

Month	Current Flow	WSS		Scenario 1		Scenario 2		Scenario 3	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Jan	326	309	309	306	303	303	299	303	299
Feb	345	327	327	315	312	308	304	308	305
March	438	420	420	387	386	364	362	364	363
April	494	477	476	462	458	446	443	446	444
May	493	476	475	463	463	459	460	459	458
June	333	315	315	255	254	220	221	220	221
July	236	219	218	200	199	187	188	187	188
Aug	219	201	201	196	196	187	188	187	188
Sept	242	225	224	213	213	205	203	205	203
Oct	288	271	271	261	261	257	253	257	253
Nov	333	315	315	309	310	304	301	304	301
Dec	340	323	323	278	274	246	242	246	242
Annual	**4085**	**3878,8**	**3875,1**	**3644**	**3630,4**	**3485,8**	**3465,8**	**3485,8**	**3465,8**

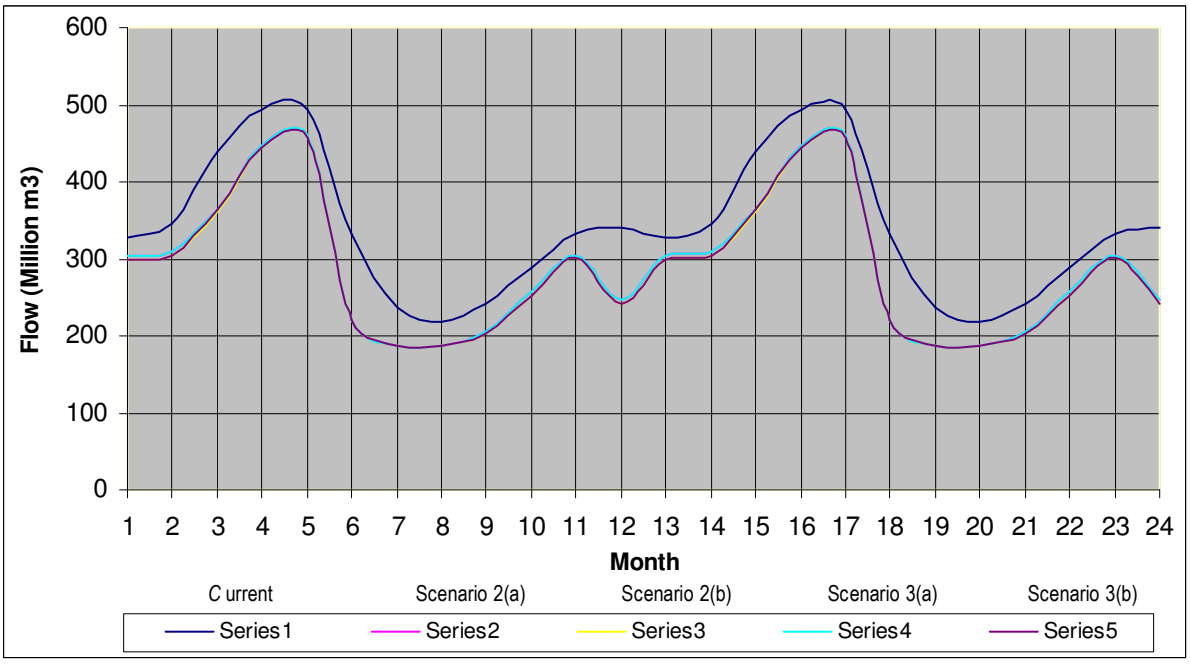


Figure 1.8: Patterns of flow of Scenario 2 & 3 at Nyabarongo River at Kanzenze

Table 1.32: Patterns of flow of Kagera River at Kyaka

Month	Current Flow	WSS		Scenario 1		Scenario 2		Scenario 3	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Jan	489	464	462	462	457	457	450	419	408
Feb	455	430	428	415	411	400	394	382	381
March	536	511	508	469	466	411	406	382	373
April	588	564	562	548	543	503	499	454	449
May	709	684	681	672	670	644	643	612	608
June	732	708	705	622	618	554	553	536	529
July	761	736	733	708	704	670	667	659	655
Aug	700	675	672	661	658	631	628	634	632
Sept	598	573	570	554	552	526	521	543	543
Oct	553	528	525	517	514	491	483	519	518
Nov	516	491	489	486	485	464	458	463	461
Dec	542	517	514	453	446	392	384	397	376
Annual	**7178,6**	**6880,4**	**6851**	**6566,3**	**6523,3**	**6144,8**	**6086,2**	**5997,6**	**5932,3**

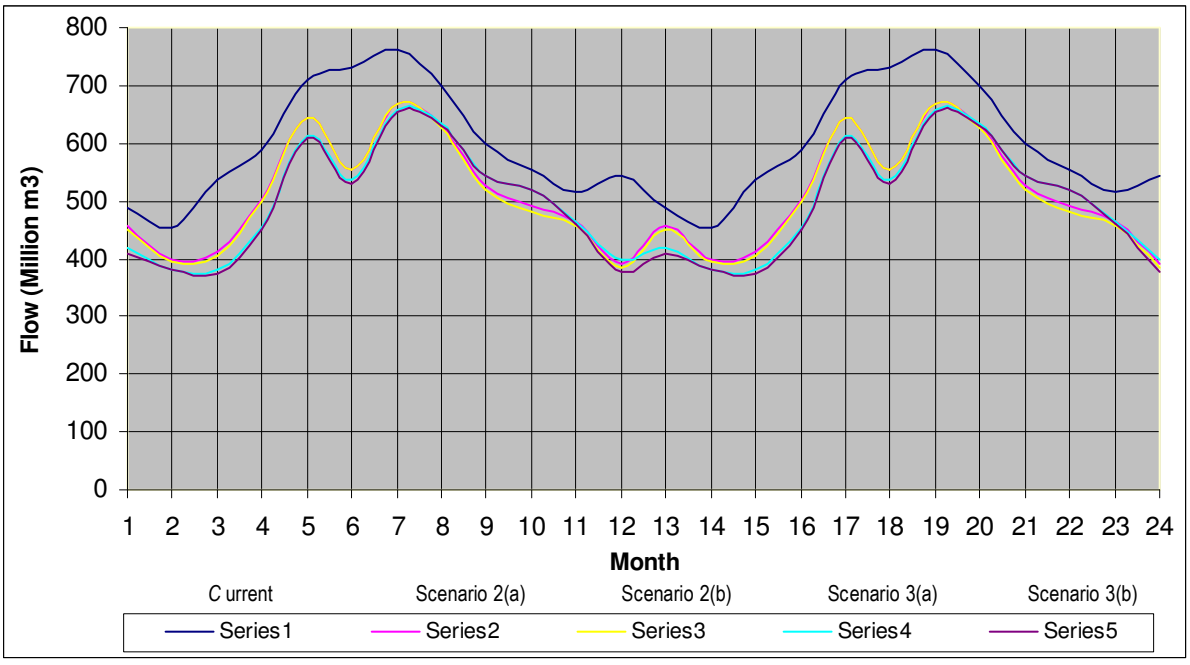


Figure 1.9: Patterns of flow of Scenario 2 & 3 at Kagera River at Kyaka

Table 1.33: Patterns of flow of Kagera River at Mouth

Month	Current Flow	WSS		Scenario 1		Scenario 2		Scenario 3	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Jan	387	359	357	355	351	350	344	313	301
Feb	348	321	319	305	301	290	283	272	270
March	387	360	357	316	313	258	252	228	219
April	416	389	387	372	367	327	322	277	273
May	490	463	460	450	448	422	421	390	385
June	467	440	438	351	347	281	280	263	256
July	435	407	404	377	373	338	335	327	324
Aug	393	365	362	349	346	318	315	321	319
Sept	341	313	311	293	291	264	259	281	281
Oct	327	300	297	288	285	261	253	289	289
Nov	330	303	300	297	295	275	269	273	271
Dec	388	361	358	293	286	232	223	236	216
Annual	**4709,3**	**4380,1**	**4350,7**	**4047,5**	**4003,7**	**3616,7**	**3556,9**	**3469,6**	**3402,9**

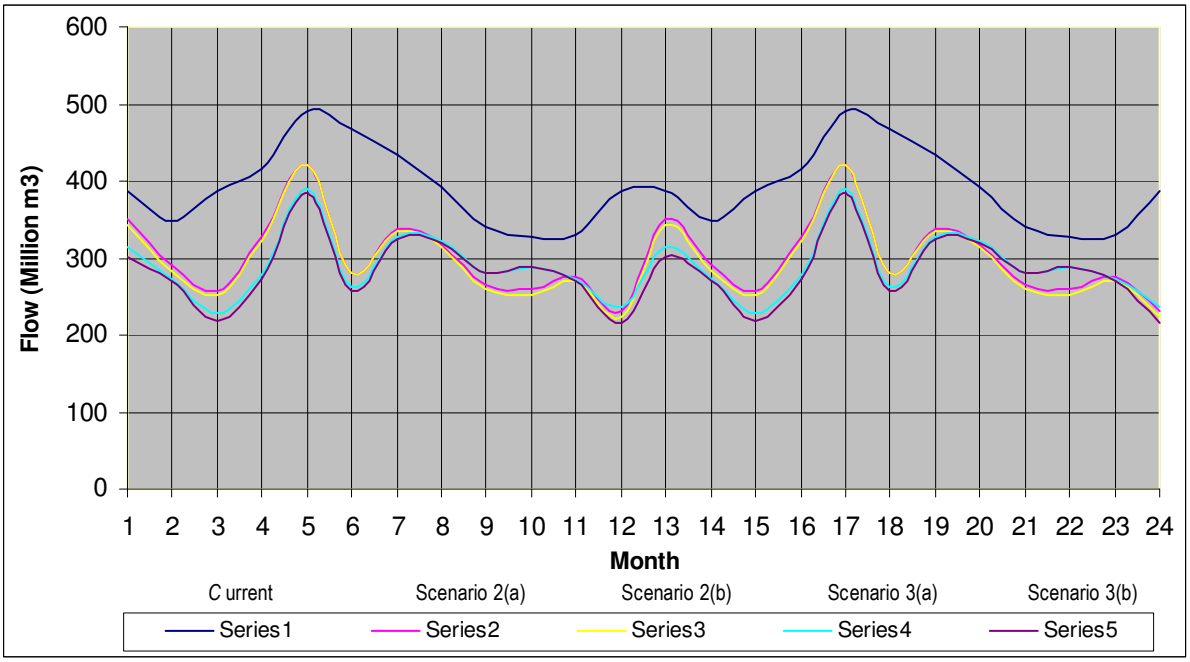


Figure 1.10: Patterns of flow of Scenario 2 & 3 at Kagera River at Mouth

8. Summary and Recommendations

8.1 Summary

Three Scenarios were used to compare various "what if" cases. They provided a structured method of thinking about possible future water resource development and management options, opportunities and risks, and how these interact.

The three basic Scenarios were built from a combination of facts and possible changes, situations or future series of events. Development scenarios for the IWRMD Strategy purposes are defined by assumptions of:

- future hydrological conditions;
- future water demands; and
- interventions assumed to be in place.

Analyses of these assumptions have shown how water resource regimes will alter, along with the resulting positive and negative economic, environmental and social implications.

Each development scenario was formulated for the entire basin to represent various levels of resource development in the various locations along the main Kagera River and its major tributaries during the next 20 years. The basin-wide development scenarios are based on many factors, including water and related resource development, population and investments, poverty reduction, and other issues. Each development scenario was examined the long term consequences of climate change. The following observations with regard to sectors are made.

Water supply and sanitation

In the Kagera basin, currently 8 million (52%) people lack access to safe drinking water, 10 million (67%) people lack adequate sanitation, 1.5 million (10%) people die every year from diarrhoeal diseases and the rate is nearly double (18%) for children under 5. This situation is no longer bearable. The demand will be much higher as the population increases from the current 15 million to 25 million people in the year 2030. The future demand rate per capita is likely to increase not only in quantity but also in quality. Therefore, there is a need to carry out infrastructural and institutional development to meet such future demands.

Soil and water conservation

In the Kagera basin, most of the people live in hilly and mountainous areas. For instance, in Rwanda and Burundi over 90% of the populations are engaged in subsistence farming, with extremely small farms and fragmented and fragile plots (the mean area is 0.6 ha; only 2% of holdings exceed 3 ha.).

Soil and water conservation measures in these hilly and mountainous areas will certainly reduce the loss or top fertile soil and also let rain water seep into subsoil resulting in better food production. In addition, the water seeping into the ground also recharges the groundwater which is the main source of domestic water supply. Therefore, it is recommended that soil and water conservation measures be implemented.

Irrigation and drainage

No matter what actions are taken, the carrying capacity of the hilly and mountainous areas have reached to their limit. It is not advisable to continue aggressively moving in the direction of subsistence cropping into more fragile and drier hilly and mountainous areas. As the population continue to grow faster than increases in food production, the options for meeting the consequent incremental demand for food need to be considered. The excessive pressure felt in the hilly and mountainous areas need to be relieved, to a certain extent, by implementing irrigation and drainage schemes.

In areas such as Bugesera that are drought prone areas rainfed agriculture will not be reliable and therefore irrigation can provide full insurance against drought as far as the sites are along the banks of the river channels. However, it should be realized that irrigation development costs will often only be justified by high value crops others will have limited markets and will bring primary benefits to only a few of the people normally at risk.

A large proportion of potentially irrigable lands are under the threat of submersion under water due to poor natural-drainage. Efforts have to be made on regulation of several low-lying areas going under inundation.

In conclusion, however, since suitable irrigable areas are limited compared to water availability, irrigation development cannot, and perhaps should not, be relied upon to meet the *entire future increase* in demand for food supply. Future irrigation investment in the Kagera Basin must focus on low cost development solutions by making better use of infrastructures on increasing output value per unit of land and per unit of water used. Planners should seek to establish the conditions that will promote this focus.

Hydropower

It is important to note some facts about the electricity demands and supplies:

- Currently, the majority of the basin's population depends on locally gathered fuel-wood for their energy. Wood is also used for cooking in schools and other public institutions and for brick making and agro-processing. Erosion and deforestation has been extremely severe over the last few decades, especially in Rwanda and Burundi and it will be worse unless the problem is averted.
- Only a very small proportion of the population of the region, between 2% and 9% (between 2% and 7% for the Kagera basin countries), has access to electric power supply (BRLi, 2008).
- The current unit consumption in the region is 95 kWh/capita/year (i.e., a total of 1425 GWh/year) including all industrial and commercial consumption. This

represents about one tenth of the overall average for Africa of 930 kWh/capita/year.

- High forecast scenario of 181 kWh/capita/year (4525 GWh/year) for the year 2030, an increase to almost double the current level in the region but still well under the current average for all of Africa (even excluding the wealthier countries).

Knowing that hydroelectric is the most desirable source of energy and knowing that ***hydropower development alone is not sufficient to meet long-term Kagera basin demands***, it can be concluded that focusing on the High Development Scenario is very much desirable.

Investment Costs

Implementation schedules and associated costs are shown in Chapter 2. Similarly, the Kagera River Basin Organization (KRBO) activities and associated budget requirements are presented are discussed in Part II. Summary of overall investments and disbursement schedules in the Kagera River basin over the coming 20-year (2010-2030) is presented as Annex B. In addition the corresponding responsible organizations for implementing the investments are also presented in Annex B. The investments have been estimated at about US$ 3.0, US$ 4.4 and US$ 5.6 billion for Scenario 1 (Low Development), Scenario 2 (Medium or Agricultural Development) and Scenario 3 (High Development), respectively. The investments proposed by this report do not cover all investments in the Kagera Basin, but still it covers those which are considered to be essential for the sustainable integrated water resource development and management.

Remarks

The positive and negative impacts each scenario were assessed by applying sound professional analysis and judgment. These assessments were used to prepare a few strategic options for meeting the water needs of all users. The strategic options formed the subjects of basin-wide discussions with national and regional stakeholders. Ultimately, the achieved consensus among the stakeholders on how the basin will be developed was Scenario III (High development Scenario). Accordingly, Scenario III will inform the IWRM-based Kagera Basin Strategy which is discussed in Part II of this Report.

8.2 Recommendations

It recommended that Feasibility Study of Kanyaru Multipurpose Project and Nsongyezi Hydropower Project (within Lower Kagera System) be carried out. These two projects were selected based on the criteria of trans-boundary dimension, tangible poverty reduction benefits and sustainable use of water resources.

The studies will have two phases: Phase I (Prefeasibility Study) and Phase II (Feasibility Study). Phase I will be carried out in order to be able to make a decision on whether or not to continue with the feasibility study (Phase II). The results and recommendations of Phase I will be communicated and discussed with line agencies of

riparian countries and stakeholders as to whether to proceed or not with the full feasibility studies of the project. This approach will avoid unnecessary spending of efforts and funds.

Kanyaru Multipurpose Project

The region where Kanyaru Multipurpose is located has suffered serious food insecurity for some years now. The region has witnessed chronic famine and the population's standard of living has deteriorated sharply. Due to rapid population growth there is an increasing need for more arable land. To alleviate these problems, to some extent, the Governments of Rwanda and Burundi decided to implement Kanyaru Multipurpose Project.

The Kanyaru Dam Site is located on the Kanyaru River, upstream of Burambi swamp at the border between Rwanda on the left bank (Gisara District) and Burundi on the right bank (Ngozi District). The site of the proposed dam is located crosses the Kanyaru River at Latitude 2°46' South and Longitude 29°49' East. This Project is intended:

- To supply power to Burundi and Rwanda, via interconnections with the national grids, as well as to provide rural electrification to the communities located within the vicinity of the Project;
- To supply dependable irrigation water for the downstream irrigable lands; and
- To control floods or high flows that usually inundate farm lands thereby provide a mechanism to control water quantity and timing required for maximum productivity.

The irrigation and drainage component of the project comprises areas within Rwanda and Burundi, and especially the Kanyaru marshland shared between the two countries. The area covers lands adjacent to the banks of Kanyaru River within the Western Ngozi (Burundi), Western Kirundo (Burundi), Eastern Gisagara (Rwanda), Eastern Nyanza (Rwanda) and Western Bugesera (Rwanda) administrative boundaries.

The feasibility study will be based on the following activities which will be established at the beginning of the study:

- Preparing additional topographic maps of suitable scales, and geological, seismological and geotechnical surveys for the purpose of design and costing;
- Establishing a gauging station at or nearby the dam site for measuring water flow quantity and quality as well as sediment concentrations ;
- Conducting a basic hydrology study which shall aim at providing the best possible design data for the hydropower plant and irrigation farms;
- Carrying out simulation runs for irrigation water demand, flood control and generation capability using selected plant generation units combinations;
- Carrying out preliminary design and cost estimation of optimum alternatives of irrigation & drainage, hydropower and flood control;
- Conducting environment and social impact assessments and prepare the ESIA Report;
- Making a final recommendation on the way forward;
- Preparation of Feasibility Report.

Nsongyezi Hydropower Project

The Nsongyezi Dam Site is located on the Kagera River, near *Kibwera* (Uganda) and *Kijumbura* (Tanzania), at the border between Uganda on the left bank (Isingiro District) and Tanzania on the right bank (Karagwe District).

The site of the proposed dam crosses the Kagera River at Latitude 1°00' South and Longitude 30°45' East. The dam site is located downstream of a fall but at relatively narrow section that corresponds to less quantity of building materials requirement for a large range of dam height. This Project, with an installed capacity of 65 to 85 MW, is intended to supply power to Uganda, Tanzania, Rwanda and Burundi, via interconnections with the national grids, as well as to provide rural electrification to the communities located within the vicinity of the Project.

The Project includes the following main elements:

- A hydroelectric power station over the Kagera River at Nsongyezi having a capacity of 65 to 85 MW, to be shared between Uganda and Tanzania;
- Transmission facilities connecting the hydroelectric power plant to that of Rusumo Falls hydropower project and the regional (Burundi, Rwanda, Tanzania and Uganda);
- At the Project level a joint utility/institutional mechanism for the co-management of power generation and distribution to national utilities.

Nsongyezi Hydropower Project is interconnected with Rusumo Falls Hydropower and Multipurpose Project. The major planning constraints derive from the interdependence of the two projects, which are main river schemes and together account for most of the hydropower potential of the Kagera basin. The upstream scheme at Rusumo Falls has the only potential for significant holdover storage to regulate the flows and optimize power production at downstream sites. The downstream scheme Nsongezi focuses on creating infrastructure that will create desirable energy head while making use of the water released of Rusumo Falls reservoir.

The Feasibility Study will be based on the following activities which will be established at the beginning of the Study:

- Preparing additional topographic maps of suitable scales, and geological, seismological and geotechnical surveys for the purpose of design and costing;
- Establishing a gauging station at or nearby the dam site for measuring water flow quantity and quality as well as sediment concentrations ;
- Conducting a basic hydrology study which shall aim at providing the best possible design data for the plant;
- Carrying out simulation runs for generation capability using selected plant generation units combinations;
- Carrying out preliminary design and cost estimation of optimum alternative corresponding to maximum reservoir water level of between 1250 masl and 1260 masl;

- Conducting environment and social impact assessments and prepare the ESIA Report;
- Making a final recommendation on the way forward;
- Preparation of the Feasibility Report.

Part II: INTEGRATED WATER RESOURCE MANAGEMENT AND DEVELOPMENT STRATEGY

1. Introduction

1.1 Elements of Good IWRM

Good river basin management is analogous to good integrated good IWRM, so it is useful to explore contemporary trends in IWRM in assessing what impacts the basin manager can have on influencing the scope, nature and quality of major infrastructure projects.

In recent years the key principles of good IWRM have become a matter of international consensus. The principles are based on the often poorly appreciated fact that water is a finite resource, vulnerable to degradation, and essential for life. From the 1992 Rio Summit on Sustainable Development one of the clearest sets of management principles was developed and agreed. Agenda 21 describes them as follows:

Integrated water resources management (IWRM) is based on the perception of water as an integrated part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilization (UN 1992, ICOLD 1977, World Bank 2006, NBI 2006(b), WSP 2007). To this end, water resources have to be protected, taking into account the functioning of aquatic ecosystems and the perennial nature of the resource, in order to satisfy and reconcile needs for water in human activities. In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems. Beyond these requirements, however, water users should be charged appropriately.

IWRM will be carried out at the level of the Kagera River Basin will be pursued the following four principal objectives:

(a) To promote a dynamic, interactive, iterative, and multi-sectoral approach to water resources management, including the identification and protection of potential sources of freshwater supply, that integrates technological, socioeconomic, environmental and human health considerations;

(b) To plan for the sustainable and rational utilization, protection, conservation and management of water resources based on community needs and priorities within the framework of national economic development policy;

(c) To design, implement and evaluate projects and programs that are both economically efficient and socially appropriate within clearly defined strategies, based on an approach of full public participation, including that of women, youth, indigenous people and local communities in water management policy-making and decision making;

(d) To identify and strengthen or develop, as required, in particular in developing countries, the appropriate institutional, legal and financial mechanisms to ensure that water policy and its implementation are a catalyst for sustainable social progress and economic growth."

Stated simplistically, this is all about:

- Water sharing among competing uses and users;
- Water protection to ensure access for present and future generations to acceptable quality water;
- Water supply to all citizens in a fair and equitable manner.

In basins/countries where good IWRM is practiced, there are four common features which can be considered to represent best practice. They can be simply stated as follows:

(a) An institutional framework is developed which is both robust and flexible, and includes modern legislation and an integrated policy framework.

(b) Planning and management is knowledge driven. Strategic assessment of water and related resources receives high priority, and does not stop at mere data management, but actively pursues the generation of strategically focused information and knowledge.

(c) Integration is built into institutions, resource management, and policy. There is recognition of the holistic nature of ecosystem, and all policies, decisions and projects are evaluated against this background.

(d) Community participation is built into all processes. It is now the accepted way of doing business in the public sector, although understandably it is in its infancy in many developing countries. It recognizes also that the natural resources of a country belong to its people, and they have a right to participate in its management. Not only that, but community participation leads to government efficiency, ownership of policies and actions by the community, and to readily accepted principles of cost sharing.

2.2 Basin-wide Cooperation

As the principles of good basin management apply equally to international and national basins, no differentiation is made here between the two variations. It is all about the extent and power/authority of member organizations and how cooperation is organized.

Although no one should play down the difficulties in resolving water sharing arrangements that have both equity and historical rights as emotionally-charged issues, taking a river basin perspective can generate real gains from cooperation and perhaps create a "win-win" for all players.

The *Mekong River Commission* illustrates the advantage in this context. The international cooperation is underpinned by a modern legal agreement that contains provisions to share water – particularly dry season flows -, to allow consultation prior to one country developing projects and to require basin wide long term planning to be undertaken. It has a strong administrative framework, a requirement to maintain an adequate data base and to involve the basin community at an appropriate level.

Whilst it is not perfect, it is a good example of what good basin management can do in the context of international cooperation even in an initial environment of conflict and distrust. Some would argue that the new Mekong agreement was not driven by principles of equitable utilization of resources, but more on achieving progress in areas that were politically feasible. No doubt there is an element of the later but a fair assessment will quite clearly see equity in low flow sharing, environment protection, a mechanism to consult and debate prior to a one-country development proposal and commitment to long term sustainable planning.

- To be successful, basin cooperation must be underpinned by a strong and fair legal agreement that clarify defines how shares of the natural resources base are utilized and managed and how basin wide planning is to occur. It must be capable of generating trust and confidence amongst the members and stakeholders.

Basin-wide water management

Best practice requires a suite of natural resource basin wide policies and strategies to be developed to guide the formulation of a variety of action plans covering both economic development and resource protection. That is, a joint river basin organization (JRBO) should create this natural resource planning framework and then undertake broad water planning or so-called master water planning that enables the 'partners' in the JRBO to then undertake detailed project development within this umbrella planning framework.

It can be assumed that country boundaries are non-extent (i.e. it can be considered solely the river basin) and then identify the most suitable and radical solutions for utilization of the river basin. Obviously, implementation of such idea requires high level of political will by all parties.

A solid master water planning framework across a whole river basin can promote good water management even in the absence of a formal basin institutional arrangement.

Good technical data, system and models covering all aspects of the natural resource base across a whole basin are essential for achieving sound water management. Such technical information is needed even if the politics don't allow an integrating institutional framework to be developed. It can create the necessary pre-conditions for better coordination to emerge. Hence, it is vital that the technical experts across all

countries in a river basin continue to work to create an accepted technical answer to basin management and allow the politics to follow.

A second critical feature must be that the JRBO can create, or influence the creation of, a wide ranging package of natural resource related policies and strategies upon which new development proposals can be judged. Nobody doubts the role that JRBO's can and do play on the "supply" side but to be totally effective, and to be able to properly promote the concept of sustainability, a role on the "demand" side must also apply, through policy and strategy formulation. If JRBO's have real control over the bulk sharing or allocation of water, then optimal allocation of a scarce resource amongst competing users becomes possible.

- Successful JRBO's have a capability to develop and test policies and strategies on both the "supply" and "demand" sides and must be able to use this role to access new development proposal for basin sustainability.

Skill and knowledge within a JRBO is vital if trust and confidence is to develop. It is often noted that planning models are more likely to be effective where the institutional framework allows sharing and implementation of the model results and policy conclusions. This says that wide ranging skills are necessary within a modern basin agency. It is not anymore just a collection of engineers and scientists but now must include, or have close access to environmental, social, legal and process-management skills to allow a balanced view to be developed.

- Capacity building program within water institutions should be on-going and implemented in parallel with other water resources development program.

How a JRBO responds to changing circumstances and how it implements the change process is a real measure of its effectiveness.

- A modern JRBO has extensive data and monitoring system that provide information and create knowledge about the basin's behavior, and provide the factual basis upon which a change in role can be predicated. It must be able to respond to changing trends identified through the monitoring systems and adjust its legal framework and strategic responses accordingly.

Data generation and modeling

It is obvious that reliable data are a necessity for good basin planning and management. Hydrological data, combined with data on the use of water allows present and future demand and supply of water to be projected. This, combined with socio-economic, cultural, environmental and other related data, drives the processes that constitute good basin management. It does not mean that the JRBO must operate all data networks within the basin. In fact, this would create duplication and it is likely that the various state organizations within the basin – whether it be international or national – would be better at data collection in any case.

The critical issue is that the JRBO can influence the standards, range and quality of data collected and can readily access all the necessary data from the member countries, can

augment thus if found necessary and has a full suite of models to manipulate the data to test the impact of new policies and strategies, and new development or environment protection proposals.

- An underpinning strength of a well functioning JRBO in access to quality data across all aspects of the natural resource base. It does not have to be the 'collector' of data but must be able to ensure that standards of collection and processing are developed and adhered to, and that it has unfettered access it. Yet a basic problem with data collection undertaken individually by all riparian countries is that a countries' strategic behavior leads it to not reveal the 'true' data. Cooperation in data sharing is the first step in achieving sustainable decisions in major water infrastructure proposals and non-structural alternatives.

Conflict resolution

Many potential conflicts over water use arise between the various stakeholders in a river basin, for example:

- Conflict claims for the same water;
- Upstream-downstream claims over water quantity, quality and timeliness;
- Balancing consumptive use with in-stream needs;
- Use of land for major water development projects;
- Location of resettled persons;
- Financing aspects;
- Interests of upper and lower irrigators.

Successful conflict resolution in major water issues ideally requires several conditions to be present.

- There should be institutional framework within which conflicting parties can meet to discuss and debate grievances. A JRBO?
- There should be a framework of laws, regulations or conventional rules applying to the settlement of conflicts, e.g. the enabling agreement of a JRBO with a specific section on dispute resolution.
- There must be good data and models to evaluate the merits of the coefficient and economic instruments and a compensation mechanism available to assist or mitigate the 'losers'. Again, basic elements of a JRBO.

Participation and representation

One point should be made in connection with the participatory approach, namely that for effective participation to evolve for the basin community, in water resources planning and management (including perhaps representation in the internal structure of JRBO's) there must be considerable efforts made to lift the level of maturity and knowledge of the users themselves. This knowledge must extend into key environmental issues affecting the basin. It is a basic obligation of water managers to bring the basin community with them as new policies and strategies are developed and to not only take account of community desires and objections, but involve the community in how these concerns are addressed. This is the only way that the highly desirable approach of 'bottom-up planning' can truly evolve.

2.3 Lessons from Best Practices

To understand better how experiences are occurring in practice around the world a study on selected JRBOs was conducted (Millington 2000)[15]. The study has analyzed trends that are valuable in determining where present day practice lies in relation to what is seen as 'best practice'.

- To be successful at the basin-wide level, cooperation must be underpinned by a strong and fair legal agreement that clearly defines how shares of the natural resource base are utilized and managed and how basin wide planning is to occur. It must be capable of generating trust and confidence amongst the members and stakeholders. If implementation and operation of major infrastructure is a role, the accountability links to the 'resource manager' must be clearly identified.

- There should desirably be a clear separation of roles of regulator/standard setter, natural resource manager and operator. If this cannot be achieved by mandating separate organizations for each function, then there must be clear separate lines of accountability for ach function within an organization.

- JRBO's must remain dynamic and responsive and be able to evolve to meet changing societal needs and the emerging natural resource problems. It is unrealistic to expect a new JRBO to be capable of playing a key or dominant technical and political role from inception. They need to build gradually, evolving and growing stronger and more integrated in approach, as links with other national and international administrations develop.

- An underpinning strength of good basin management, through a well functioning JRBO, is access to quality data across all aspects of the natural resource base, covering economic, social and environmental attributes. It does not have to be the 'collector' of data but must be able to ensure standards are adhered to, and have access to it. Yet, a basic problem with data collection undertaken individually by all riparian countries in that a counties' strategic behavior leads it to not reveal the 'true' data. Cooperation in data sharing is the first step in achieving sustainable decisions in major infrastructure proposal.

- Good technical data, systems and models covering all aspects of the natural resource base across a whole basin are essential for achieving sound water management. Such stretched information is needed even if the politics don't allow an integrating institutional framework to be developed. It can create the necessary pre-conditions for better coordination to emerge. Hence, it is vital that the technical experts across all countries in a river basin continue to work to create an accepted technical framework to basin management and allow the politics to follow.

[15] WCD Thematic Reviews – Institutional Processes: V.3. "River Basin Management: Its role in Major Water Infrastructure Projects". Draft, 8 January 2000: Prepared for the WCD by P. Millington.

- Successful JRBO's have a role and capability to develop and test policies and strategies on both the 'supply' and 'demand' sides and must be able to use this role to assess all aspects of new development proposals and their alternative for basin sustainability.

- It is a basic role of water and natural resource institutions to promote public awareness of natural resource issues in a river basin and to develop and openly implement appropriate community participation processes. Only when the community can participate through a defined process suitable for the social and cultural values of a country can truly sustainable decisions in major water matters be achieved.

- A sound funding base and charging policy to support efficient operation and maintenance, good basin management and sustainable development (both major infrastructure and non-structural options) must start with proper strategic planning that defines objectives, goals, priorities, etc. and an investment program and a 'basin natural resource business plan' that gives governments and donors a clear indication of what can be achieved and at what cost.

- Clear guidelines need to be developed that will allow all these elements of 'best practice' to be followed in investigating, assessing, constructing, operating and evaluating the performance of dams, including an approach to modify those found to be deficient in terms of long term sustainability. Irrespective of whether this is focused on a basin agency or on national water institutions, it should start with a separation of roles of:
  - ✓ Standard setter/regulator
  - ✓ Resource manager
  - ✓ Developer/Operator/service provider

  and with an expansive set of functions and responsibilities for the resource manager that ensures that a basin-wide approach is adopted, that a full suite of natural resource policies and strategies can be developed, that such policies and strategies cover economic, environmental and social impacts and that non-structural options are taken into account.

Any JRBO that has these functions and has the capability to evolve over time to respond to changing circumstances will be capable of quality IWRM.

2. Specific Strategies for IWRM Components

It can be concluded that principles of IWRM are very well accepted by the four Kagera River Basin riparian countries. Basically relevant policies, strategies and programs that are in line with the priciples of IWRM are in place in all the four riparian countries. However, none of the riparian has strategies that can directly be applicable to the entire Kagera River Basin. Accordingly the following specific strategies will focus on the strategies and their implementation mechanism that need to be in place jointly by all riparian countries.

2.1 Strategies for Protection of Water Resources

Protection of water source

The fundamental objectives for managing Kagera Basin's water resources are to achieve equitable access to water resources and their sustainable and efficient use. Although they are limited and highly variable, the basin's water resources will be sufficient to support social and economic development for the foreseeable future provided they are judiciously managed, and wisely allocated and utilized.

Equitable access has both a short-term and long-term dimension. It is important that the needs of present and future generations are considered in the management of water resources.

To give effect to the interrelated objectives of sustainability and equity an approach to managing water resources has been adopted that introduces measures to protect water resources by setting objectives for the desired condition of resources, and putting measures in place to control water use to limit impacts to acceptable levels.

The approach comprises two complementary strategies as follows:

***Resource-directed measures*:** These measures focus on the quality of the water resource itself. Resource quality reflects the overall health or condition of the water resource, and is a measure of its ecological status. Resource quality includes water quantity and water quality, the character and condition of in-stream and riparian habitats, and the characteristics, condition and distribution of the aquatic biota. Resource quality objectives will be defined for each significant resource to describe its quality at the desired level of protection.

***Source-directed controls*:** These measures contribute to defining the limits and constraints that must be imposed on the use of water resources to achieve the desired level of protection. They are primarily designed to control water use activities at the source of impact, through tools such as standards and the situation-specific conditions that are included in water use authorizations. Source-directed controls are the essential link between the protection of water resources and the regulation of their use.

Coherent and integrated approaches to balancing the protection and use of water resources will therefore require the collective application of resource-directed measures and source-directed controls in respect of water quantity and quality, as well as the biological and physical dimensions of the resource.

Resource protection to support long-term sustainable use and development, water resources are sometimes polluted or damaged through accident, negligence or deliberate actions. In such cases the parties responsible for the pollution or damage should be hold liable for any clean-up or rehabilitation that may be necessary.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with protection of water sources are responsible within their own countries.

Principal No.2: JKRBO will be responsible for the protection of water source that have significant or cumulative basin-wide implications.

Protection of groundwater resources

Groundwater resources differ from surface water resources in that they are not confined to distinct, visible channels, move very slowly and are less prone to rapid temporal variations than surface water. Without proper monitoring and management human impacts are usually difficult to detect. As the rehabilitation of polluted or impacted aquifers is technically very difficult, lengthy and costly, a careful approach to groundwater protection is required. Because of the technical differences between surface and groundwater, groundwater management has to be considered in its own right, although an integrated approach is required if effective water resource management is to be achieved.

Resource-directed measures will continue to play an important role in the management of groundwater resources, specifically to ensure that groundwater use is sustainable. The protection of groundwater quality will, however, mainly is achieved by source-directed controls focusing on land-based activities that impact underlying groundwater bodies.

The groundwater reserve: Because of the contribution of groundwater to surface water flow in certain circumstances, the volume of groundwater that can be abstracted without impacting the ability of groundwater to sustain or contribute to the surface water has to be determined. This is done by determining recharge to a particular groundwater resource, assessing the groundwater contribution to (base) flow of a surface water resource and calculating the basic human needs to be met from groundwater supplies. It is also necessary to control the amount of water abstracted to protect the structural integrity of the aquifer and to protect terrestrial ecosystems dependant on groundwater supplies.

Resource quality objectives for groundwater resources: Resource quality objectives for groundwater resources are considered crucial for the effective protection of

groundwater. Numeric or descriptive statements for a groundwater resource will be set in order to guide the use and management thereof. Typically these will relate to – groundwater levels or gradients (time and locality specific):

- groundwater abstraction rates;
- groundwater quality;
- spring flow; and
- targets for the health of terrestrial ecosystems that is dependent on groundwater.

Responsible Organizations

Principal: As the principal groundwater user is the water supply and sanitation (WSS) sector, it is logical to assume the major responsibility in groundwater resource protection goes to the line agencies of the Kagera riparian States responsible for WSS.

Supporting: It is expected that knowledge-based technical support will be provided by JKRBO.

Wetlands

Wetlands are important features of water resource systems. If they are sufficiently protected they offer multiple benefits including a range of services such as flood attenuation, groundwater recharge and sediment control, and act as natural filters by trapping pollutants. However, they also "use" significant quantities of water through evaporation. They are biologically productive, and can be also important centres of biodiversity. Wetlands offer a range of resources for human use, such as reeds and grasses. Many wetlands have however been completely destroyed or severely damaged, most often by draining to provide additional croplands. However, there are still very vital wetlands within the Ruvubu and Kagera National Parks the need serious protection. The protection of wetlands will be effected by the strategies and procedures prescribed for resource directed measures, and in conjunction with the riparian countries national line agencies of environmental affairs which have a key role in the protection of biodiversity.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with environmental protection are responsible for wetland protection.

Principal No.2: JKRBO will be responsible for the protection of wetlands that have significant or cumulative basin-wide implications.

2.2. Strategies for Water Use

The definition of water use relates to the consumption of water as well as to activities that may affect water quality and the condition of the resource itself. Water use includes:

- Taking (abstracting) water from a water resource;

- Storing water;
- All aspects of the disposal of waste in ways that could impact on water resources.
- Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.
- Making changes to the physical structure of watercourses;
- Impeding or diverting the flow of water in a watercourse;
- Altering the bed, banks, course or characteristics of a watercourse.
- Certain activities that may affect the quantity or quality of water in the resource
- Using water for recreational purposes.

This broad definition of water use applies throughout the Kagera River Basin Integrated Management and Development Strategy (KIRBMDS).

A licence to use water:

- May only be issued by a responsible authority, to which a prospective user must apply;
- Is specific to the user to whom it is issued and to a particular property or area;
- Is specific to the use or uses for which it is issued;
- Is valid for a specified time period, which may not exceed 40 years;
- May have a range of conditions attached to it; and
- Must be reviewed by the responsible authority at least every five years.

Compliance with conditions of water use: All water users are required to adhere to the conditions of use attached to general authorizations and licences, and the responsible authorities are required to ensure that they do so. It will, however, be preferable for water users to comply voluntarily with reasonable conditions of use, which have been co-operatively determined and mutually agreed to by users and responsible authorities. Under these circumstances it will be necessary for responsible authorities to resort to enforcement by legal command-and-control measures only in exceptional cases. A comprehensive compliance management strategy will be developed during the course of the first compulsory licensing exercise and implemented.

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with water use issues are responsible for water quality issues within the respective countries.

Principal No.2: JKRBO will be responsible for large-scale water use issues that have significant or cumulative basin-wide implications.

2.3 Strategies for Maintaining Water Quality

Sources of pollution are broadly categorised as point sources, such as discharges from sewage treatment works or industrial sites, and diffuse sources, for example settlements without a sewerage system, and surface runoff from agricultural land to which fertilisers are applied.

Specific actions in terms of resource directed measures that require attention at basin level in respect of water quality management include:

- Formulation of objectives for managing sources of pollution and associated single source interventions.
- Benchmarking water resource quality.
- Identification of emerging threats to the water resource and prioritization for action.
- Establishing priorities in relation to, for instance, remediation of water resources and degraded land as a focus for regulation using source-directed controls.

Implementing source-directed controls: Decisions about the nature and extent of permissible water uses and developments that may pollute water resources are guided by a structured decision-making framework that balances the need to protect water resources and the need for social and economic development.

The preferred approach is to prevent the pollution of water resources. In those cases where the discharge of pollutants into water resources is unavoidable the emphasis is on minimising the pollution and its effects. Decisions to authorize such discharges are based on consideration of their social, economic and ecological impacts. Where pollution has already caused degradation of water resources, or where contaminated land areas pose a threat to water quality, improvements (remediation) will be effected as appropriate.

Each application for authorization to discharge wastes into water resources will therefore be preceded by an assessment of the probable impacts of the discharge on the water resource and other water users. In the case of hazardous wastes the aim is to prevent discharge altogether or, if this is not possible, to minimize the extent of the discharge and its impacts. For non-hazardous wastes the risk-based resource water quality objectives approach will continue to be used. This approach assumes that the water environment has a finite and quantifiable capacity to assimilate non-hazardous wastes discharged into it without violating predetermined water quality objectives in accordance with its class. The assimilative capacity will be different for each water resource and for each management class. Where, after all relevant factors have been considered, assimilative capacity is sustainably available it must be equitably shared among all water users**.**

Source-directed controls that may be applied to prevent or minimize pollution include recycling or re-use of waste, water recovery, detoxification, neutralization and treatment, and the introduction of cleaner technology and best management practices.

Preventing pollution: Wherever possible, source-directed controls will be promoted to prevent water resources being polluted or degraded, particularly for hazardous wastes.

Minimising pollution: The discharge of waste or water containing waste to water resources, or the disposal of waste, will be permitted only under the following conditions:

- Pollution costs are, as far as possible, to be borne by the discharger (internalized), and not passed on (externalized) to the water resource or to other water users.

- For other water uses that may impact on water quality, such as impeding or diverting the flow of water in a water course, measures to meet resource quality objectives will be stipulated in guidelines and directives.
- If, in specific situations, the applicable minimum requirements or standards are not sufficient to ensure suitable water quality, standards stricter than the minimum requirements or standards will be prescribed.

Standards for discharges will be prescribed by regulation. Relaxation of standards will be contemplated only where there are pressing social or economic reasons to do so, and will be considered in situations where it is evident that:

- The enforcement of the measures could result in notable impairment of social or economic development or related environmental values; and
- The relaxation of requirements or standards could facilitate or contribute to enhanced participation and benefit-sharing arising from water use by those who were historically disadvantaged by racial and gender discrimination; but where resource quality will not be unacceptably degraded.

Whilst the overall intention is to prevent further degradation of the quality of the basin's water resources and to effect improvements where possible, limited and short-term degradation of the water quality of specific water resources could be allowed if it can be demonstrated with confidence that the degradation will not cause irreversible damage, and that pollution costs will not be externalized to other users of the resource.

Decision-making in this regard will also be guided by the following principles:

- Strict controls to protect human health will be applied.
- Concessions will apply for a defined period of time.
- Relevant stakeholders must be involved in the decision-making process.

Remediation: Remediation strategies will be developed to effect improvement in the condition of degraded and impaired water resources, or contaminated land areas such as abandoned mines, as required by the resource quality objectives adopted for the water resource. Clean-up levels and targets, remediation approaches and measures, and the prioritization of remediation focus and effort will be dictated primarily by appropriate risk-based approaches. However, rule-based best management practice measures could be appropriate and a requirement in some cases. Implementation of the relevant financial provisions to cover remedial actions will form part of the remediation strategy.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with water quality issues are responsible for water quality issues within the respective countries.

Principal No.2: JKRBO will be responsible for large-scale water quality issues that have significant or cumulative basin-wide implications.

2.4 Strategies for Water Conservation and Water Demand Management

The principles of water conservation and water demand management

The WC&WDM Strategy is based on three fundamental principles, namely -

- *Water institutions should strive to supply water efficiently and effectively, minimize water losses and promote WC&WDM among their consumers*. Water institutions responsible for supplying water to users should take steps to reduce leakage in their systems, and develop and implement measures to promote WC&/WDM.

- *Users should not waste water and should strive to use it efficiently*. Wasted water is water used without any direct benefit being derived. Inefficient use of water is water use that exceeds the accepted benchmark for the particular purpose, or water used where the derived benefit is sub-optimal.

- *WC&WDM should be an integral part of the planning processes for water resources management, water supply and the provision of water services.* In situations of water shortage demand-side solutions will be considered alongside supply-side augmentation options. The participatory and consultative approaches to implementing WC&WDM will extend the planning process down the supply chain to the end user by requiring water institutions and water users to share the responsibility for ensuring the efficient use of water.

Basin level water conservation and water demand management strategy

Water conservation and water demand management relate to the efficient and effective use of water and to the minimization of loss and wastage of water, and are important elements of the approach to the care and protection of water resources. Many of the provisions and requirements are thus either directly related to or refer to water conservation, for instance:

- Resource protection measures.
- Conditions for water use in general authorizations and licences.
- Water pricing as an incentive for efficient use.
- Management of land-based activities via stream-flow reduction and controlled activities.
- Control of invasive alien vegetation.

Water Conservation and Water Demand Management (WC&WDM) Strategy, and subsidiary strategies for water supply and sanitation, irrigation and hydropower production. The strategies will outline measures and interventions aimed at encouraging and supporting water institutions and water users to increase the efficiency of their water use and reduce their demand for water. They are based on the premises that, first, many water users can maintain their quality of life, and achieve the desired outcomes or products from their water use, whilst using less water and, second, that significant

reductions in water use can be achieved by minimizing wastage and increasing the efficiency of water use by changes in behavior and adopting water-saving technologies.

The strategies will not present rigid prescriptions to water institutions and users. The core objective of the strategies is to create a culture within all the water management and water services institutions and among water users. JKRBO will provide support to water institutions and help them to develop and implement strategies that suit their own circumstances and which are economically coherent and financially sound with regard to the costs and benefits of the proposed measures. Accordingly, an essential component of the Basin WC&WDM Strategy is a program of communication, education, awareness creation and promotion, and the development of supportive networks.

Water demand management is not, however, concerned merely with reducing water use as an end in itself, as there are social, economic and environmental advantages to be gained from programs designed to achieve sustained reductions in water use, such as:

- Water users are empowered to understand the value of water as a scarce resource, and to adopt a responsible attitude to its use.
- Water is made available for allocation to other uses, either within the particular sector or for competing uses, and for the reserve.
- The financial security of water institutions can be improved by reducing non-revenue demand - that is, unaccounted-for water caused by leakage from supply and distribution systems, and water wasted by non-paying consumers.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with water quality issues are responsible for water quality issues within the respective countries.

Principal No.2: JKRBO will be responsible for large-scale water quality issues that have significant or cumulative basin-wide implications.

2.5 Strategies for Sectoral Water Demand and Uses

IWRM constitutes s***ectoral integration*** approach which refers to the planning and management of water resources taking into account the competition and conflicts for water among irrigated agriculture, hydropower, domestic water supply and sanitation, the environment, and so on.

When implementing IWRM in the Kagera River Basin, it is important for a particular sector to know the perspectives of other water related sectors besides its own. The same amount of water is valued differently depending on the sector because each sector treats and uses water in different own ways. Water is also valued differently depending on when and where it can be obtained, and at what quality. Implementation of IWRM means proposing a plan to individual sectors (which tend to think of their own benefits as their first priority) that is close to their ideal plans, and obtains compromises by making proposals that present advantages to them. It is also important that as many sectors as possible are satisfied with the plan before a consensus is reached. For this,

managers in charge of coordination should take a horizontal approach to obtain the perspectives of the coordinated sectors, so as to deepen their level of understanding. The coordinators must understand the goals of the activities undertaken by the sectors or stakeholders, and how they relate to water resources of the basin in order to appropriately implement IWRM. Furthermore, good understanding by the coordinators on the benefits of IWRM to the individual sectors will facilitate efficient, appropriate and socially justifiable consensus-building. Thus, it is important to establish a good understanding of 'sectoral perspectives' in implementing IWRM.

The main sector objectives can be briefly and approximates summarized follows:

Sector	*Main objective*
• *Domestic water supply and sanitation*	Water available to people in sufficient quality and quantity
• *Irrigation and drainage*	Safe food production, high value and high employment generated by irrigation water use
• *Hydropower*	Meeting the increasing energy demand with affordable electric energy
• *Soil and water conservation*	Increasing groundwater recharge and reducing reservoir siltation problems
• *Environment*	Ensuring ecological diversity and social consensus

***Water supply and sanitation*:** An effective WC&WDM program for the water supply and sanitation services sector is essential. Allocation of water for basic human needs in adequate quantity and acceptable quality will receive high priority, while other uses will be subject to social and economic criteria.

Irrigation and drainage: There are significant losses in many distribution and irrigation systems. Efficiency gains in the irrigation and drainage sector will make water available for other uses. Accordingly the following actions will be taken:

- Implementing appropriate measures that will bring about a reduction in water wastage;
- Assuring that water user associations and end users understand and appreciate the need to progressively modernize their water conveyance systems and irrigation equipment;
- Assuring that water allocation processes to promote the equitable and optimal utilization of water;
- Assuring that sufficient irrigation information is generated and is accessible to all stakeholders; and
- Assuring that water management institutions and service providers implement audits from the water source to end users and beyond.

To facilitate achievement of the objectives consideration will be given to requiring water users in the irrigation sector who apply for water use licences to develop and submit to the responsible authority a water management plan.

Hydropower generation: The wellbeing of this sector is crucial to Kagera Basin's economic development and it requires a high assurance of supply. Hydropower will contribute towards meeting the increasing demand for affordable electric energy in the Kagera riparian countries. Its implementation will be met with minimal negative impacts on the environment and local people, thereby promoting economic growth for the countries' mutual benefit

Soil and water conservation measures: Increase in groundwater recharge in results in increase in water available for potable water supply as well as increase in dry season flows; as a result soil and water conservation measures that will play a significant role in modifying the hydrological process by increasing the groundwater recharge will e given priority. Similarly, soil and water conservation measures that have impact on maintaining and protecting water generation sources of rivers and reservoirs will be given first priority.

Environment: IWRM cannot exist without the introduction of environmental perspectives, thus, the implementation of IWRM is a definite advantage for the environmental sector. However, the economic perspective is also important in gaining the consensus of relevant sectors, thus the importance of the environment has to be prioritized in social demands.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with water sectoral management and development are responsible for application of sectoral water demand and uses.

Principal No.2: JKRBO will be responsible for large-scale water demand and use issues that have significant or cumulative basin-wide implications. In addition, it will provide knowledge-based technical support for line agencies responsible for sectors through training and guide manuals.

2.6 Strategies for Sustainable Water Resources Development

The objective of sustainable water resource development includes:

- Ensuring integration occurs between planning for sustainable water resources development and with plans for protection, exploitation and use of water resources and with prevention and control of adverse impacts caused by water, and with the plans for socio-economic development.
- Ensuring the construction of multi-purpose water projects with priority given to those areas suffering water scarcity.

(a) Development of physical infrastructure

Where ever feasible and appropriate, development of water infrastructure such as dams and reservoirs will be considered as possible options for increasing the availability of water resources.

The strategy for water resources development will be to: (a) identify the potential for adopting particular resource development options for different locations; (b) investigate and develop economically viable resources for different situations and locations; (c) development of water resources including construction of dams; and (d) determine the possible application of options based on economic, social and environmental considerations, particularly in water scarce and dry areas.

National line agencies of the riparian countries will continue to investigate the necessity for the construction of a number of major government waterworks comprising dams and, where necessary, associated infrastructure such as pumping stations, pipelines and canals, to meet projected future water needs. The mandated government agencies will continue to be responsible that all development projects will be screened through social and environmental impact assessments as well as economic feasibility studies.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with development of physical infrastructures are responsible for implementation of the strategies the respective countries.

Supporting: JKRBO will provide major knowledge-based technical and management support for development of jointly owned physical infrastructures (by two or more riparian countries) that have significant or cumulative basin-wide implications. In addition, JKRBO will provide knowledge based technical support to development of physical infrastructures of various natures.

(b) Operational activities

Operational activities relate to all ongoing activities required for the protection, use, development, conservation, management and control of Kagera Basin's water resources. There are two broad groups of activities: routine operational activities; and commissioning or establishment activities.

Routine operational activities: This group comprises activities that will be routinely undertaken include:

- The reconciliation of water requirements and water availability
- The planning and design of capital works
- The operation and maintenance of bulk water supply systems and schemes
- Control of water use
- Water conservation and demand management
- The setting of tariffs and the collection of revenue
- The collection, storing, analysis and dissemination of water-related information
- Dam safety control.
- The control of invasive alien vegetation

Commissioning/establishment activities: This group comprises activities which will be undertaken only once and will have a finite (although in some cases rather long) duration. These are referred to as commissioning or establishment activities and they are

intended to create an environment in which the efficiency and effectiveness of water resources management can be progressively improved. They are of considerable magnitude and neither financial nor human resources are available to undertake them simultaneously in all water management areas. Accordingly, they have to bee prioritized to reflect the needs and circumstances in each area. The activities included in this category are the following:

- Compulsory licensing
- The establishment of catchment management agencies.
- The delegation of operational responsibility for physical infrastructure and transfer of the ownership of infrastructure to water management institutions
- The establishment of new water user associations
- The establishment of new monitoring networks and information systems, and the expansion of existing ones

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with operational activities are responsible for implementation of the strategies the respective countries.

Supporting: JKRBO will provide major knowledge-based technical and management support for operational activities that have significant or cumulative basin-wide implications.

2.7 Strategies for Water Related Disaster Management

Water-related disasters

One of the objectives of Integrated Water Resource Management and Development (IWRMD) is to contribute to public safety and security in water matters. This section gives a brief description of some of the water resources management activities that contribute to preventing the occurrence of water-related disasters and emergencies, and mitigating their effects when they do occur.

Water-related disasters take many forms and range in the extent of their influence. They threaten life, health and livelihoods, especially among the poor, and damage valuable infrastructure.

Floods occur naturally as a result of highly variable climate. They often cause loss of life and destruction of dwellings in communities living in the flood prone areas. Floods damage roads and bridges, inundate valuable agricultural land and destroy crops. Extreme rainfall events, often accompanied by high winds, not only cause floods, but also damage property, especially the less substantial dwellings in poorer communities.

Droughts can occur at any time, anywhere in the basin, and often last for a number of years. They reduce the availability of water to all sectors of society, but their effects are particularly severe where people do not have access to piped potable water, or where they rely on run-of-river flows for their water supplies. Droughts prejudice food security

by affecting production from rain-fed and irrigated agriculture, and disruptions in electricity generation and industrial output can have negative economic consequences.

Another threat is the pollution of water resources from spills of hazardous or toxic materials. These can render water unfit for use and damage the ecological functioning of water resources. Bacteriological pollution can cause outbreaks of diseases such as cholera. Communities that are not serviced by water supply schemes, and draw water direct from streams and rivers, are particularly vulnerable to the effects of pollution.

Disaster management

Dealing with disasters diverts resources from and retards the pace of social and economic development. There are clear advantages in preventing disasters or mitigating their effects.

- Increasing preparedness for disasters and improving response capacity among all sectors of society by, among other things, disseminating relevant information and undertaking programs of awareness creation, education and training;
- Reducing the probability of disasters occurring and reducing the severity of the consequences when they do occur; and
- Reducing the vulnerability of communities, especially the poor and disadvantaged, to the hazards and threats posed by disasters.

To achieve these objectives it is proposed that risk reduction strategies should be incorporated in all development planning and actions undertaken. Development plans will be prepared within the framework of coherent and integrated disaster management frameworks. Responsibility for development of the frameworks will lie with disaster management centres established to co-ordinate all disaster management activities.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with disaster management are responsible for monitoring within the respective countries.

Principal No.2: JKRBO will be responsible for large-scale disaster management that has significant or cumulative basin-wide implications.

2.8 Strategies for Mitigation of Climate Change Impacts

Climate change affects all water uses and users including domestic water supply, irrigation and drainage, hydropower, fishery and the environment in general.

Impacts of climate change that are likely to affect planning and design of water systems include changes in rainfall and runoff patterns, land use and changes in water demand and allocation. Despite recent advances in climate change science, great uncertainty remains as to how and when climate will change and how these changes will affect planning design and management of irrigation and drainage systems at both the watershed and field levels.

So, water authorities should begin to re-examine design criteria for the present and future planned water systems under a wide range of climatic conditions and explore the vulnerability of both structural and non-structural components of the systems to possible future climate change. Water authorities have relied in the past on the assumption that the future climatic conditions will not be different from the past ones. Water development systems have been designed using historical information on temperature, rainfall and crop water requirements and expected to last 50 years or even longer. Past records of hydrological conditions may no longer be a reliable guide for the future. New planning principle, design criteria, operating rules, contingency plans and evaluation procedures are needed able to respond to new information with midcourse corrections and to include hedging strategies along with the option value of alternative courses of action. The challenge today is to identify short-term strategies to face long-term uncertainties (IPCC, 1996).

Possible impacts that may especially affect planning principles and design criteria include changes in rainfall and runoff patterns, flooding of irrigated lands and land use. Warmer temperatures will accelerate the hydrologic cycle, altering rainfall, the magnitude and timing of runoff, and the intensity and frequency of floods and droughts. Higher temperatures will also increase evapo-transpiration rates and alter soil moisture and infiltration rates.

The planning and design process needs to be sufficiently flexible to incorporate consideration of and responses to many possible climate impacts. Introducing the potential impacts of and appropriate responses to climate change in planning and design of water systems can be both expensive and time consuming. The main factors that might influence the worth of incorporating climate change into the analysis are the level of planning, the hydrologic conditions, and the time horizon of the plan or life of the project.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with climate change issues are responsible for monitoring within the respective countries.

Principal No.2: JKRBO will be responsible for climate change issues that have significant or cumulative basin-wide implications.

2.9 Strategies for Water Monitoring and Information

The need for monitoring and information systems

The availability of reliable data and information on all aspects of water resources management is fundamental to the successful implementation of the Kagera River Basin Strategies. No proper decision on any matter can be made unless it is informed by reliable, relevant, up-to-date information.

Information for decision-making should reflect the integrated nature of water resources, in which the quantity and quality of surface and ground water are all inextricably interrelated. For instance, decisions about the licensing of proposed water uses require data and information on, among others: the management class of the resource and the associated reserve and resource quality objectives; international obligations that have to be satisfied; the quantity of water available in the resource and its quality; the extent and nature of other lawful and authorized uses from the resource; the potential for efficiency gains through managing demand; and the potential for augmenting supply by dam construction. If there are information deficiencies in any of these aspects, the decisions reached will not necessarily be optimal.

The Kagera River Basin information system for water services will be linked to information systems for water resources in all of the riparian countries. Kagera RBO must be empowered to require any person to provide data and information on either an *ad hoc* or a regular basis for tits monitoring and information systems, to facilitate the management and protection of the basin's water resources. Regulations may be written in this respect. Water management institutions are also obliged to make information on any water-related matter held in the national systems about which the public needs to know available to the public, particularly if it concerns an actual or potential disaster, or an emergency situation.

Monitoring systems

Line agencies of riparian countries and JKRBO should be mandated to establish monitoring systems for water and related resources to collect appropriate data and information that is necessary to assess:

- the quantity, quality and use of water in water resources;
- the rehabilitation of water resources;
- compliance with resource quality objectives;
- the health of aquatic ecosystems;
- atmospheric conditions that may influence water resources; and
- other data and information that may be necessary.

The national line agencies already operate a number of climitological and streamflow gauging stations that collect some of the required data and information. However, the systems were developed and are being operated largely in isolation from one another. Spatial coverage is incomplete and as a result little or no information is collected in some areas. Problems are also being experienced with the quality and reliability of information. The dissemination of and access to information is not as effective or as comprehensive as it should be.

Line agencies and JKRBO will be addressing these shortcomings by amalgamating all existing and planned monitoring and assessment systems into a coherent and structured monitoring, assessment and information system. Monitoring systems may be grouped into logical subsystems, each comprising three functional components: data acquisition; data storage, maintenance and dissemination; and data analysis, information generation and reporting.

Improvements in efficiency and effectiveness are expected through sharing logistics and infrastructure in data collection and storage, by adhering to common standards and guidelines, and by refining analytical techniques to maximize the information derived from available data.

An important component of the monitoring and assessment strategy will be to develop co-operative and collaborative relationships between the national line agencies of the riparian countries, JKRBO and other organizations that also operate water-related monitoring, assessment and information systems.

Brief details of monitoring systems and plans to meet the requirements are provided below:

Surface water - flow monitoring: Flow in rivers is monitored at monitoring stations, each of which can be a combination of all or some of the following:

- Gauging stations at which river flow are measured directly
- One or more flood monitoring points
- Meters measuring flow in reservoir off-takes or outlets
- Gauging stations at which reservoir water levels are measured
- Meteorological station at which rainfall, evaporation and other climatological data are measured

Data collected at monitoring stations is assessed and interpreted to derive catchment hydrological characteristics, and to obtain customized information for water resource managers and other users.

The present spatial density of monitoring stations is considered to be inadequate for a basin that by international standards. Based on the best practice standards described in the World Meteorological Organization's *Guide to Hydrological Practices*, and considering the characteristics and probable requirements in each water management area, the station density should, assuming the continued use of existing monitoring methods and technology, be increased to an average of one monitoring point in less than 1000 square kilometres.

The monitoring network will be continuously reviewed to ensure optimal coverage for existing and new data needs. The expansion of the monitoring network is a long-term project, which could take between 20 and 25 years to accomplish. In view of the high cost of the expansion and the requirement for ongoing operation, a review will be undertaken of technological trends in this area to determine if more cost-effective options are available and appropriate.

Surface water - water quality monitoring: Various water quality parameters are monitored. These include:

- Physico-chemical monitoring
- Microbial monitoring
- Eutrophication monitoring
- Biological monitoring
- Toxicity monitoring

- Radioactivity

The structure and co-ordination of these programs will be reviewed as part of the implementation of the overall monitoring, assessment and information system, the various substructures will be prioritized and their implementation and expansion will be programmed in accordance with available resources.

Groundwater monitoring: Groundwater has the potential to contribute significantly to meeting the needs for water in rural areas, particularly for domestic supply. Monitoring networks will need to be established and surveys undertaken to improve understanding of the quantities and quality of water available if this potential is to be mobilized, and the use of groundwater integrated with surface water use. Groundwater levels and water quality need to be recorded on a continuous basis at selected points and at regular intervals.

Resource requirements for monitoring: The establishment of the proposed monitoring systems will require resources - staff, funding, physical infrastructure, instrumentation and information technology equipment - in order to produce desirable performance. The training of water resources management practitioners will also need a significant investment, especially where new technologies are introduced.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with water resource monitoring are responsible for monitoring within the respective countries.

Principal No.2: JKRBO will be responsible for large-scale water resource monitoring that has significant or cumulative basin-wide implications.

Information systems

It is required to establish Basin's information system, including:

- A hydrological information system
- A water resource quality information system
- A groundwater information system
- A register of water use authorizations

A mainframe-based Hydrological Information System which is a server-based commercial system - that is already in use in several other basins - will be established. Such a system is basically user-friendly, has extensive graphics capabilities, supports data analysis, can provide a range of information and makes use of GIS mapping to display systems and networks. It can be used as an independent system by, for instance, hydrological practitioners providing services to water management institutions. It can also be used as an integrated, web-enabled system with inter-connections between JKRBO and catchment management agencies.

JKRBO can be involved by establishing water quantity and quality monitoring systems and thereby storing, processing and disseminating the results. Such a system facilitates

the consolidation of monitoring activities to reduce or eliminate duplication through the auditing of monitoring schedules and quality assurance of the monitoring process.

Responsible Organizations

Principal: JKRBO will be responsible for establishing the required basin-wide information system.

Supporting: It is expected that line agencies will provide the necessary support to the JKRBO.

2.10 Strategies for Water Management Institutions

The institutional framework is one of the most important aspects of IWRMD since it determines the effectiveness of policy implementation. Institutions are also important because they are the focus for requirements to consult widely with water users and other interested persons before policies relating to the management and use of natural resources are implemented.

One of the main objectives is to progressively decentralize the responsibility and authority for IWRMD to appropriate regional and local institutions in order, among other things, to enable water users and other stakeholders to participate more effectively in IWRMD. Some of these institutions will have to be created, whilst some of the existing institutions will have to be modified/changed to reflect new or changed responsibilities in terms of the new approach embodied in the Strategy.

Responsible Organizations

Principal: Line agencies of the Kagera riparian States will be responsible for creating the necessary institutional arrangements.

Supporting: Knowledge-based technical advice on institutional frameworks for IWRM.

2.11 Strategies for Capacity Building

This section provides brief descriptions of strategies for ***Building capacity and expertise among practitioners in the water sector*:** A program for Integrated Water Resources Management and Development (IWRMD) in which the JKRBO will play a leading role in partnership with line agencies of riparian countries and other role players in the sector.

The approaches to capacity building in the water sector, and educating and creating awareness among will need to be implemented at catchment and local levels in partnership with riparian countries line agencies and other role players.

Capacity building in IWRMD

Strategies will not be effective if there are too few competent people available to implement them. One reason that the implementation of the Strategy will take place progressively over time is that Kagera Basin's financial and human resources are, at present inadequate to implement all of its provisions at once across the basin. It is imperative to ensure that sufficient capacity is created in the water sector to implement and sustain the implementation of Kagera IWRMD Strategy.

IWRMD is a relatively specialized activity that now requires competencies in a wider range of disciplines than was previously the case. The training, re-training and development of the potential of people who currently work or will in future work at all levels of all organizations and agencies involved in the water sector is recognized as being a critical determinant for the achievement of wise and efficient water resources development and management in the Kagera River Basin.

JKRBO and line agencies will be playing a prominent role in this initiative. The focus will be on people: the creation and development of the skills, knowledge and attitudes required to support the development of the infrastructure, institutions, knowledge and information management, and financial management necessary to undertake IWRMD. There are already some encouraging developments in this regard, with new, specialized courses being offered at post-graduate level at a number of tertiary institutions in the riparian countries

Furthermore, in line with the general requirement for social and economic transformation, all capacity building initiatives must address representivity in terms of ethnic, gender and other social aspects.

An important component of the capacity building strategy will be the promotion of networking among education and training service providers and users. In this regard, JKRBO will provide institutional support and seed funding to encourage the creation of networks to promote effective co-operation between universities, research institutions, and the public and private sectors.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States associated with capacity building are responsible for capacity building in IWRMD within the respective countries.

Principal No.2: JKRBO will be responsible for capacity building in IWRMD that have significant or cumulative basin-wide implications. In addition, it will be responsible for capacity building within JKRBO and provide support for line agencies in the form of training in IWRMD.

2.12 Strategies for Survey, Research and Technology

The importance of survey, research and application technology to IWRMD cannot be over-emphasized. Survey and research is fundamental to understanding Kagera Basin's water resources and will contribute to the development of many of the techniques and tools used for IWRMD. New challenges in the basin's water resource arise continually and require new understanding and new tools and techniques. To meet these challenges, JKRBO will support surveys, researches and technology choice and development that will deal with issues affecting water resources of Kagera basin. In this regard, the major missions will be

- Enhancing basic surveys and assessments of water quantity and quality and the current status of water resources exploitation, use, pollution and other factors causing impacts on water resources.
- Promoting water management related research and developing technologies and applications of scientific and technical advances in management, protection, exploitation and use of water resources; prevention, control and mitigation of adverse impacts caused by water.
- Progressive application of automation and digital technologies in the monitoring and supervision of water resources exploitation, their use and the discharge of wastewater into water sources.
- Carrying out periodical inventories of water resources, an inventory of current water resources exploitation and use, and discharge of wastewater into water sources. Enhancing the development and efficient use of the basin's water resources information and database systems.

The JKRBO's approach is to support research and development through IWRMD-centred key strategic areas as follows:

- *Water resource management*, an integrating key strategic area that considers issues of equity and sustainability in the management of water resources
- *Water-linked ecosystems*, which addresses the protection of water resources.
- *Water use (industrial and domestic) and waste management*.
- *Sustainable water use for agriculture*, which address the sustainable use of water in their respective user sectors with more emphasis on irrigation water requirement and efficiency.
- *Soil and water conservation* in the context of integrated rainfed agriculture
- *Water infrastructure and water use for hydropower production*.

JKRBO will also support the transfer, dissemination and application of knowledge through a fifth key strategic area, *IWRMD-Centred Knowledge*, an integrating key strategic area that addresses the mechanisms needed to ensure the effective dissemination of research results and products to water resources managers and other prospective users in an effective format.

To ensure that research results are also relevant to the broader objectives of IWRMD: the relevance and applicability of research in each key strategic area are maximized by

addressing the relationships between: water and society; water and the economy; water and health; and water and the environment.

A key crosscutting objective of the JKRBO is to support the development of human resources in IWRMD. Accordingly, involvement in research is recognized as an important vehicle for building and developing expertise among water resource practitioners. Every research project is therefore required to incorporate a strong element of capacity building.

Responsible Organizations

Principal No. 1: It is assumed that line agencies, higher learning and research institutes of the Kagera riparian States dealing water and related resources are responsible within the respective countries.

Principal No.2: JKRBO will be responsible for coordinating and supporting surveys, researches and technology development and choice that have significant or cumulative basin-wide implications.

2.13 Strategies for Public Consultation

This section provides brief descriptions of strategies for ***Educating and creating awareness among stakeholders*****: JKRBO** programs of public consultation, communications and education.

Public consultation

There are a number of sections in the Strategy that require future formal public consultation on proposed initiatives to implement the Strategy's provisions. All comments received in response must be taken into consideration.

For water users and other stakeholders to effectively contribute to water resources management they need to be aware of the issues and difficulties, and have an understanding of what is required. However, while some water users and other stakeholders are often very well informed, others, particularly in poorer, historically disadvantaged communities, may not be able to participate effectively in consultation procedures without additional support. A comprehensive stakeholder analysis, aimed at determining the capacity of users and stakeholders to participate, is therefore a key part of any consultation program.

JKRBO and national line agencies will undertake public consultation exercises in a way that enables all stakeholders to participate effectively. Where ever it is needed, special help will be offered to ensure that they understand the issues under discussion, and can participate in an informed and meaningful way.

JKRBO will develop guidelines for public participation in IWRMD issues to ensure a consistent approach throughout the basin. It is anticipated that all water management institutions will adopt these guidelines for their consultative processes.

Responsible Organizations

Principal No. 1: It is assumed that line agencies of the Kagera riparian States are responsible for public consultation within their respective countries.

Principal No.2: JKRBO will be responsible for public consultations that have significant or cumulative basin-wide implications. It will also provide knowledge based guidelines on public participation related to IWRMD.

2.14 Strategies for Water Pricing and Financial Issues

(a) Water pricing

The following three types of water use charges are identified:

- ***Funding water resource management.*** Activities such as information gathering, monitoring water resources and controlling their use, water resource protection and water conservation.

- ***Funding water resource development and use of waterworks.*** The costs of the investigation, planning, design, construction, operation and maintenance of waterworks, pre-financing of development, a return on assets and the costs of water distribution. Resource management and resource development charges are financial charges, which are directly related to the costs of managing water resources and supplying water from schemes and systems.

- ***Achieving the equitable and efficient allocation of water.*** Economic incentives to encourage more efficient use of water, water conservation and a shift from lower to higher value uses. This is an economic charge and relates to the value of water to particular users.

The objective of the pricing strategy is to contribute to achieving equity and sustainability in water matters by promoting financial sustainability and economic efficiency in water use. One objective is to ensure that the real financial costs of managing water resources and supplying water, including the cost of capital, are recovered from users. Provisions are, however, made for a range of subsidies for water users from historically disadvantaged groups to promote equitable access to the use of water resources.

Pricing strategy for abstracting and storing water, and stream flow reduction activities: In this component of the water pricing strategy charges apply to two consumptive uses of water that can be expressed in terms of annual volumes of water used. These are:

- *Abstracting* (taking) raw water directly from surface and groundwater resources.
- *Storing water* - this refers to the abstraction of water from storage or, in the case of dams constructed to enhance property values or for recreational use, the initial filling and annual refilling.

Charges for waste discharge: This component of the pricing strategy will deal with charges for all aspects of waste discharge, as follows:-

- Engaging in a controlled activity
- Discharging waste or water containing waste into a water resource
- Disposing of waste in a manner which may detrimentally impact on a water resource
- Disposing of water which contains waste from any industry
- Aspects of removing, discharging or disposing of water found underground where this has an impact on water quality.

The charging system will be based on the polluter pays principle and will address point and diffuse sources of pollution. The system will be designed to ensure that there is no duplication of charges between charges for waste discharge and water use charges for funding water resource management.

Responsible Organizations

Principal: It is assumed that line agencies of the Kagera riparian States associated with pricing are responsible for dealing the issues.

Supporting: Knowledge-based technical advice on pricing can be provided by JKRBO through its various programs.

(b) Water use charges

All charges will be specific to each of four end-user sectors, namely:

- Municipal (water services authorities), industry, mining and energy
- Agriculture
- Stream flow reduction activities

Charges may be different for each user sector, depending on the costs of and benefits from water resource management services, or from the use of a particular supply scheme.

Setting charges, collecting and disbursing revenue*:* Depending on the socio-economic circumstances and physical and demographic characteristics and attributes of each area, charges may differ between water management areas. After budgets have been prepared and proposed charges determined, consultations will be held with key stakeholders and the charges announced and made known to users prior to the start of the financial year in which the charges are to be imposed.

Charges for funding water resource management: The charges will be based on the budgeted annual costs that include the following activities, which will eventually become the responsibility of catchment management agencies:

- The planning and implementation of catchment management strategies
- The monitoring and assessment of water resource availability and use, and resource quality

- The management of water allocation and utilization
- Water quality management, including waste control and pollution control in respect of mines, industries, agriculture and dense settlements. Charges will not include costs related to waste discharge, or the capital costs of abandoned mine rehabilitation, until a waste discharge charge system is implemented
- Dam safety control
- Water conservation and demand management, including the control of invasive alien vegetation, education and awareness creation, and control of aquatic weeds. Costs related to poverty relief activities, which do not directly contribute to improving water availability, are excluded from the charge.

Responsible Organizations

Principal: It is assumed that line agencies of the Kagera riparian States associated with water use charges are responsible for dealing with the issues

Supporting: Knowledge-based technical advice on water use charges can be provided by JKRBO through its various programs.

(c) Charges for funding water resource development and the use of waterworks

Specific charges will be imposed on users of water schemes and systems which will be based on volumes of water used, and fixed and/or variable charges may be implemented.

In accordance with generally accepted accounting procedures, charges for water resource development on water schemes will be based on the rate-of-return-on-assets approach, with allowance being made for the depreciation of asset value. A return on assets will ensure efficient use of capital and generate funding for new developments, whilst asset depreciation will fund the refurbishment of infrastructure at the end of its useful life.

On multipurpose water schemes, capital costs will be divided between sectors on the basis of water allocations. Charges may be different for different sectors depending on the assurance of supply required (in respect of the use of water from storage), or on peak demand rates (in respect of water received from conveyance structures such as canals and pipelines).

Application of water resource development and use of waterworks charges: Charges will be phased in progressively over time, and the target of achieving full cost recovery will therefore be achieved at different times for different sectors, as follows:

- *Municipal sector and Industrial, mining and energy sector:* On water schemes charges will include depreciation, return on assets, and operations and maintenance. All costs must be recovered in respect of waterworks owned by other water management institutions.
- *Irrigation based emerging farmers***:** The operating and maintenance charges for water supplied to emerging farmers from water schemes will be subsidized on a

reducing scale over initial periods. Depreciation charges will be phased in over a further period appropriate to each case until all costs are fully recovered.

Responsible Organizations

Principal: It is assumed that line agencies of the Kagera riparian States associated with funding of waterworks are responsible for dealing the issues

Supporting: Knowledge-based technical advice on funding of waterworks can be provided by JKRBO through its various programs.

(d) Actions required from main parties

The measures proposed in this report call for actions by seven main categories of actors: central governments from Kagera riparian countries and developing countries, sub-sovereign bodies, community organizations and NGOs, banks and private investors, aid donors, multilateral financial institutions, and members of the UN system and other international organizations.

Governments of Kagera riparian countries need to prepare water strategies and action programs. They need to start reforms for public water institutions, drawing on various models for cooperation. They need to work out the financial relationship between central governments and sub-sovereign entities and to propose measures to expand and deepen local capital markets.

Governments of developed countries have responsibilities to ensure that the international institutions and agreements that have governed the world economy over the last few generations are well adapted for the challenges of the new Millennium - and if not, how they should be reformed. This applies particularly to aid, the governance of MFIs, and the consensus over international finance and export credit.

Sub-sovereign national bodies, such as local governments and water authorities, are the fulcrums of reform and action in the water sector. They have the responsibilities, but not all of them have the necessary skills, efficiency and financial powers. Theirs is a huge and challenging agenda of actions.

Community organizations, supported by service-oriented NGOs, are the first line of attack on the water sector at the grass-roots. They should aim for a more ambitious role in influencing and monitoring the performance of the institutions that supply water services. They should explore ways of raising more external funds through their NGO partners and become involved in local finance through micro-credit and other multi-partner schemes.

Banks and private investors should be looking for ways to increase their involvement in the water sector, following several years of decline. Exploring innovative financing techniques adapted to the specific needs of the sector is part of the answer. But there is much scope for the greater uptake of what is available, such as guarantees and insurance. Contracts and documentation could be streamlined. The proposed facility to inject liquidity after devaluations should be of interest.

Aid donors need to stand by their commitments to increase aid for water, which should immediately be doubled as a first step. Donors should focus unremittingly on helping achieve the wider goals of global water security. ODA will need refocusing among countries and within the sector itself, and should support the strengthening of core public capabilities. It should favor countries with sound water programs and reward early progress. Aid should increasingly be seen and used to catalyze other kinds of finance. Donors should take the lead in developing the new instruments proposed here, such as the Decentralized Fund, the Devaluation Facility and the Revolving Fund.

Multilateral financial institutions (MFIs) need to be the pillars of the new water financial architecture. They should do everything to reverse the recent decline in their water lending and make every effort to expand their use of guarantees and insurance. They should overcome their reluctance to lend for water storage schemes.

UN agencies and other international organizations need to develop new forms of relevant cooperation to support the reform effort in the water institutions of developing countries. The OECD and its DAC have a clear role in mobilizing, coordinating and monitoring the water aid effort. The OECD should look hard at the impact of its export credit consensus and whether it can be changed to favor the water sector.

3. The Role of Joint Kagera River Basin Organization

3.1 Introduction

The most pressing priority for all the Kagera riparian countries is to achieve higher levels of economic and social development. The proper use and development of water and related resources will be a key driver in this regard. This will require a strong partnership of the basin's stakeholders which can effectively link development and natural resource conservation. The riparian States' goals for sustainable economic growth and development are inextricably linked with poverty alleviation and environmental protection.

Due to potential basin-wide and transboundary impacts, as well as potential impacts on the lives of the basin's people, the JKRBO has roles to play in irrigation water management, hydropower, flood management and mitigation, drought management, and environmental management. However, the scope and depth of actual involvement by the JKRBO in these areas varies greatly due to the scale of typical projects and ongoing activities of other organizations.

Some specific questions that may help to the clarification of the role of JKRBO include: *What functions, responsibilities and influence does Joint Kagera River Basin Organization (JKRBO) need to effectively and efficiently participate in the implementation of Kagera River Basin Integrated Water Resource Management and Development Strategy?*

The role of the JKRBO in serving the joint interests of the riparian States is to promote sustainable development in the Kagera River Basin. The primary value-added of JKRBO as an International River Basin Organization is to focus on the joint and basin-wide issues, including development scenarios, identification of important joint and basin-wide projects and programs, and the analysis of implications (economic, social and environmental) of ongoing and proposed developments in the basin including the cumulative impacts of national developments. In this role, the JKRBO will work to find long-term solutions to common problems in the region.

The mission of the JKRBO will be achieved through an Integrated Water Resources Management (IWRM) approach within the framework of the Nile Initiative and the LVBC Protocol which combines the value-added capabilities of the JKRBO, namely, knowledge management and capacity development, a framework for regional cooperation, and environmental monitoring and protection. These capabilities support the promotion of sustainable development in the Kagera River Basin.

With its unique mandate, knowledge base and expertise in the areas of water and related resources management together with its effective regional cooperation framework in these areas, JKRBO is particularly well-placed to provide guidance and support to sustainable development. In particular, the JKRBO will focus its efforts on:

- Basin-wide projects and programs, initially including the four riparian states of the Kagera Rive Basin.

- Transboundary projects or suites of complementary projects, between two or three or all the four riparian states.

- National water and related resource projects, or land and water policies, with significant or cumulative basin-wide implications.

Given this emphasis, JKRBO will avoid dispersing its efforts over a large number of small projects that have no significant impacts. Through the BDPP, JKRBO has an important role in registering all developments in the basin. This will enable:

i) Comprehensive development and analysis of scenarios; and
ii) Analysis of implications of projects, including the cumulative effects of national developments.

JKRBO will also play a role in the screening of suites of smaller projects in a broader basin context, hence assisting in identifying and prioritizing projects to be further developed by national agencies and their donors.

The role of JKRBO in promoting sustainable development will remain limited to the functions for which it has value-added and capacity as compared with other key development partners in the region. However, there are clear roles for JKRBO which can enhance project quality with an emphasis on joint and basin-wide projects.

Three broad issues were identified as central to the development of the Short & Medium Strategic direction:

(a) Tangible results focused on poverty reduction through sustainable development
(b) Creating ownership and value-added with a broadened interpretation to include better integration of JKRBO and national development plans
(c) Adopting an integrated water resource management approach which is necessary for the JKRBO to jointly promote development and conservation to ensure sustainable cooperation for the utilization of the Kagera's common resources.

The most pressing priority for all the riparian States is to achieve higher levels of economic and social development. The proper use and development of water and related resources will be a key driver in this regard. This will require a strong partnership of the basin's stakeholders which can effectively link development and natural resource conservation. The riparian States' goals for sustainable economic growth and development are inextricably linked with poverty alleviation and environmental protection.

Due to potential basin-wide and transboundary impacts, as well as potential impacts on the lives of the basin's people, the JKRBO has roles to play in domestic water supply, irrigation water management, hydropower, flood management and mitigation, drought management, fisheries, tourism and environmental management. However, the scope and depth of actual involvement by the JKRBO in these areas varies greatly due to the scale of typical projects and ongoing activities of other organizations.

It should be recognized that the work of the JKRBO has to complementary and has to avoid duplication with other development partners.

3.2 Towards Integrated Water Resources Management (IWRM)

Moving toward an integrated approach for developing and managing water and related resources will require changes impacting institutions, policies, technology, infrastructure, and financial mechanisms. Moreover, the very nature of an integrated approach will call upon the active and coordinated participation of almost all of the countries' resource management agencies. Table 2.1 presents recommended strategic directions for IWRM at the basin scale

Implementing an IWRM approach at the JKRBO will require full recognition of the need to pursue management of water that balances "use of water as a basis for livelihoods for the Basin's increasing population with the protection and conservation of the water resource." This in turn results from planning with full consideration of IWRM's social equity, economic efficiency, and ecological sustainability approach. It is recognized that there is no blueprint for achieving IWRM and that various management instruments, enabling environments and institutional entities are involved.

The JKRBO will further develop close partnerships with its members and become more responsive to the needs within the basin. Personal interaction with the focal points in National Kagera Committees and line agencies will be strengthened and their close involvement in the work encouraged. The JKRBO Program's strong technically- and environmentally-oriented knowledge generation function will be strengthened and

complemented by increased economically- and socially-oriented planning functions. Finally, it is recognized that full implementation of an IWRM approach will involve a significant period of time.

Three broad issues were noted as important for the development of Short and Medium Term Strategic Direction:

Table 2.1: Strategic directions for IWRM at the Basin Scale

Issues	Strategic direction
Economic development and poverty alleviation	To promote economic growth through use and development of joint water resources in a manner that significantly alleviates poverty.
Integration through basin planning	To implement a participatory, multi-sectoral basin planning process which integrates economic, social and environmental concerns across the Kagera River Basin.
Social development and equity	To ensure equity in the allocation of water resources and services across different economic and social groups; to reduce conflict and promote socially sustainable development.
Regional cooperation	To integrate and coordinate water resource development and management between countries to optimize benefits from the joint resource and to minimize the risk of water-related conflicts.
Governance	To further and implement open, transparent and accountable institutions and regulatory frameworks that will promote IWRM at all levels.
Environmental protection	To protect the environment, natural resources, aquatic life and conditions and the ecological balance of the MRB from harmful effects of development.
Dealing with climate variability	To prevent, mitigate or minimize people's suffering and economic loss due to climate variability.
Information based management	To ensure that water resource management decisions are based on best available information.

(a) Tangible results by focusing on poverty reduction through sustainable development

This translates into sustainable soil and water conservation, efficient and productive water use in irrigated agriculture, appropriate exploitation of the hydropower potential and healthy river systems in terms of vital functions and water quality. The JKRBO will take the lead in developing water and related resources within the overall basin development process and make links with on-going regional initiatives and thereby exploit its comparative advantage as an inter-governmental River Basin Organization owned by the Kagera riparian countries themselves.

(b) Establishing ownership and value-added

The concepts of ownership and value-added are interdependent and will require a more coordinated approach than has been used in the past. Ownership has typically referred

to the financial contributions by the four riparian States to the JKRBO, while value-added refers to what the JKRBO can add to the existing national planning processes. The perception of ownership and value-added must be broadened to include national cooperation with the JKRBO and national utilization of the tools of the JKRBO for enhancing national planning processes. Three important areas the JKRBO will need to address are integration, benefits (real value-added) and accountability mechanisms, and communication. Ownership can be enhanced by providing more roles for riparian staff to manage the JKRBO Secretariat and by using the local expertise and local knowledge in the planning process. Enhanced country ownership can also be reflected in having the JKRBO Strategic Plan and Basin Development Plan linked to national development plans.

(c) Adopting an integrated water resource management approach:

Integrated water resource management (IWRM) is a concept which is getting acceptance by water professionals in the Kagera Basin. A meaningful integration within the context of the Kagera Basin requires a good understanding of the diversity of functions of the natural resource systems and the effects that planned interventions in one part of the basin might have in another part. These functions of the natural resource are inseparably connected to the economic, social and environmental values that the societies in different parts of the basin normally enjoy. Such values, when taken into consideration, permit a first assessment of tradeoffs between benefits and costs associated with a particular development intervention. It will be necessary for the JKRBO to jointly promote development and conservation to ensure sustainable cooperation for the utilization of these common resources. As IWRM is a complex planning and management concept which will require the strengthening of various management and institutional capacities, it is expected that it will take many years to fully achieve IWRM within the Kagera River Basin's context. Moreover, it should clearly be understood that a large share of institutional roles related to implementation of IWRM will remain at the national level.

3.3 Goals, objectives and outputs of JKRBO

The overall goal of the JKRBO is to support the riparian States for: ***Effective use of the Kagera's water and related resources to alleviate poverty while protecting the environment.***

JKRBO will support the riparian States to contribute to the alleviation of poverty in the Basin through more effective use of the Kagera River's water and related resources with an aim to protect the environment and prevent conflict. The potential areas for cooperative development include soil and water conservation, irrigation, hydropower, flood management and mitigation and drought mitigation and preparedness, fisheries, domestic water supply, and tourism. However, this range of areas for cooperation neither specifies a limit nor a target for JKRBO activity. All efforts to increase development will be undertaken in balance with an aim to protect the environment. Development planning will be conducted in a manner to optimize the multiple-use by and the mutual benefit for all riparian countries, while keeping potential harmful effects to a minimum.

The Short and Medium Term Strategic Plans will focus on the following five goals based on strong commitment on the part of riparian States, donors and stakeholders. The goals correspond to the five roles of the JKRBO with regard to water and related resources:

Goal 1: To establish an effective organization, capable to promote, in partnership with other institutions, basin-wide development and coordination.
Goal 2: To enhance effective regional cooperation.
Goal 3: To promote coordinated, sustainable, and pro-poor development.
Goal 4: To support sustainable pro-poor development efforts of other agencies
Goal 5: To establish and promote basin-wide environmental and socio-economic monitoring and impact assessment systems, recommendations, and policy guidelines;

These goals are considered realistic and achievable, given sufficient resources are available and JKRBO's organizational structure, staffing levels, motivation, and skills, and management and financial systems are appropriate and constantly improved. In the following, each specific goal is supported by a set of objectives, which form the basis for JKRBO Programs.

Goal 1: ***To establish an effective organization, capable to promote, in partnership with other institutions, basin-wide development and coordination***

The knowledge base under this goal encompasses the JKRBO Decision Support Framework as a central basin planning tool. Capacities will be strengthened through a program approach under the JKRBO Integrated Training Program. There are considerable resource development and capacity building needs for this goal to be realized and scheduling and costing will need to be well-integrated into Program approaches.

The outcome of this goal will be that: (a) a Joint Kagera River Basin Organization (JKRBO) is established and strengthened; (b) JKRBO bodies, NKCs and Line Agencies are able to manage water resources applying the IWRM principles using JKRBO's basin-wide GIS and knowledge management system.

Objectives

- To establish a Joint Kagera River Basin Organization (JKRBO) that can operate as a highly effective, transparent and innovative International River Basin Organization.

- To establish a technical coordination capacity for preparing and coordinating the implementation of JKRBO's Work Program applying IWRM principles.

- To establish key water quantity and quality monitoring stations and assist the basin-wide process of meteorological and hydrological data collection, analysis and reporting systems.

- To enhance and maintain a common GIS-based information and knowledge management and dissemination system to support all JKRBO activities.

- To maintain partnerships with leading organizations, universities and civil society stakeholders for program-focused collaboration of common interest.

- To strengthen the human resources capacities of the JKRBO, NKCs and the Line Agencies.

- To develop and update as new knowledge becomes available regional assessment tools for all development projects to be implemented in the Kagera River Basin.

Goal 2: ***To enhance effective regional cooperation***

This goal will entail the development of dispute resolution and compromise mechanisms such as co-management, public participation, stakeholder involvement and institution building. In an organizational perspective the JKRBO will establish links with existing and emerging sub-basin organizations.

The outcome of this goal will be increased use of the JKRBO by the riparian States as the key mechanism for joint planning, cooperation, and resolution of transboundary water-related issues.

Objectives

- To initiate and strengthen JKRBO's function as a transparent and effective cooperation mechanism among riparian countries and develop and demonstrate enhanced linkages, compatibility and complementarities of partnerships with other regional organizations and initiatives.

- To initiate, adopt and make applicable mechanisms, procedures and guidelines required to facilitate cooperation of riparian countries.

- To identify potential transboundary issues for negotiation, mediation and conflict prevention; and develop mediation and conflict management capacity.

Goal 3: ***To promote coordinated, sustainable, and pro-poor development***

This goal will be implemented using the JKRBO Strategic Directions on Integrated Water Resources Management as a guideline for sustainable development of the Kagera Basin's water and related resources. IWRM concepts and principles will therefore be fully applied in a planning process which is participatory and pro-poor for providing the development opportunities. The planning process will be information system (IS) based and use the JKRBO Decision Support Framework which will include a water balance assessment for the basin.

The outcome of this goal will be a significant increase of sustainable development based on basin-wide planning guided by the IWRM Strategic Directions, for poverty alleviation and more effective water use.

Objectives

- To establish a system for analyzing water demand, water supply and water use in the basin to support the basin development planning process.
- To establish processes and mechanisms enabling the balancing of trade-offs between economic and political net benefits of different sectors, areas, and regions; and benefits from environmental and social protection.
- To produce a regularly updated rolling plans applying the planning process for identification, categorization and prioritization of projects and programs.

Goal 4: ***To support sustainable pro-poor development efforts of other agencies***

This goal will be supporting identified sustainable development options, which the riparian countries can pursue, will benefit the people of the basin by contributing to alleviating poverty and increasing livelihood security through enhanced and sustainable income generation.

The outcome of this goal will be increase in quantity and quality of basin-wide sustainable developments that have significant contribution for poverty alleviation.

Objectives

- To screen, formulate and promote wise development options at the transboundary and basin levels for preparation and implementation by other appropriate development agencies.
- To support sustainable use of land and water through development of effective and integrated utilization of irrigation and drainage systems.
- To support sustainable land and water management through more effective and integrated implementation of soil and water conservation systems.
- To assist in the development of the basin's hydropower potential to ensure safeguarding of the environment and social interests while meeting the Basin's increasing need for energy.
- To assist domestic water supply and sanitation efforts to ensure adequate protection and improvement of peoples' lives and the environment.
  - To assist in the efforts of maintaining sustainable economic productivity (fishery, aquaculture, tourism, navigation,) of the Kagera River Basin.

- To build regional water disaster management capacity for prevention, minimization or mitigation of people's suffering and economic losses due disasters.

Goal 5: ***To establish and promote basin-wide environmental and socio-economic monitoring and impact assessment systems, recommendations, and policy guidelines***

The environment includes physical, biological and social features of the Kagera River Basin, considering the economic and social condition of the people of the Kagera River Basin and the effects of their dependence and impacts on the biological resources such as fish and forests and physical resources such as soil and water. Within its work towards this goal the JKRBO will also develop, maintain and make accessible a basin-wide environmental and socio-economic knowledge base as part of IS-based knowledge system of JKRBO.

The outcome of this goal will be operational basin-wide environmental monitoring and impact assessment systems.

Objectives

- To improve monitoring of the environmental condition of the Kagera River Basin, focusing on water quantity and quality, ecological health and social impact.

- To regularly report on the environmental condition of the Kagera River Basin and disseminate this information widely.

- To raise awareness of the JKRBO, NKCs, and line agencies on transboundary and basin-wide environmental issues and to increase the capacity to address them.

- To ensure that development initiatives are planned and implemented with a view to minimize negative environmental impacts.

- To ensure that social, economic and environmental concerns are incorporated into basin-wide water resources development strategies.

Strategic outputs
Key Actions/Activities and Outputs and other important issues are presented in the Logframe Matrix (Section 3.7.6).

It is important to note that with each output a range of associated processes and mechanisms is implied, which must be well established and understood by the main partners involved in the work. It is equally important to note that the list of deliverables makes provision for all JKRBO programs to support the Basin Development Planning process and the subsequent implementation of priority projects and programs. Such services are regarded as crucial to achieve rapid progress in the sustainable development process in the Kagera River Basin.

The listed strategic outputs and activities have been assigned an indicative priority classification. These priority classifications are indicative only and will require regular updating. The main purpose of the classifications is to assist the riparian States and donors in identifying important areas for funding. A low priority does not mean that the output is unimportant but rather that it is less urgent in terms of funding. The prioritization process and updates would also be dependent on funds made available by donors.

4. Implementation Approach

This section describes the operational approach within the framework of the JKRBO and its programs which will enable JKRBO activities to support the Kagera Program and achieve sound River Basin Management (RBM).

4.1 Activities of JKRBO

The guiding principle of the JKRBO Short & Medium Term Strategic Plans is that the JKRBO's role is within the JKRBO's mandate, complement the comparative advantages of others, avoid duplication of efforts and reflect the expressed interest of the riparian States.

To effectively carry out its roles, it will be crucial that the JKRBO forges effective links with other regional economic cooperation initiatives. Efforts will be made to minimize overlap based on a mutual assessment of each partners' comparative advantages. Links will be built on the principles of cooperation and coordination and be guided by the need for the JKRBO to maintain its independent status as an impartial International River Basin Organization.

The integrated program structure of the JKRBO will comprise the following:

- Water supply and sanitation
- Irrigation and Drainage;
- Dams and Hydropower;
- Soil and Water Conservation

This cohesive set of programs will be cross-cut by four programs in Environment Management, Information and Knowledge Management, Integrated Capacity Building and Water Utilization.

Within this structure, the basin planning function through the Basin Development Plan (BDP) will take on a pivotal role in a highly integrated and coordinated manner. This planning function will use acquired knowledge from the JKRBO Programs to build an overall perspective of what the development needs and knowledge gaps are, and that will eventually set the agenda of the JKRBO Programs. The BDPP will further ensure that project programming is done in harmony with the IWRM Strategic Directions.

The Integrated Basin Flow Management (IBFM) process is another important and effective vehicle for implementing IWRM in JKRBO. IBFM is a set of multidisciplinary activities providing information and knowledge to decision makers on economic benefits and environmental and social impacts of development as related to changes in the flow regime.

Programs implemented by the JKRBO will provide support to a regional cooperation program for sustainable development of water and related resources in the Kagera River Basin jointly implemented by the Kagera Countries in cooperation with donors and development banks, referred to as the Kagera Program.

The goals of the Short and Medium Term JKRBO Strategy specify the important role of JKRBO in all areas of river basin management. The approach of the Short & Medium Term Strategy orients JKRBO funding towards two main purposes:

a) Support for sustainable development of water and related resources in the Kagera River Basin.
b) Support to strengthening the JKRBO as an International River Basin Organization.

The JKRBO will work with donors to develop new and appropriate budget aid mechanisms in order to move further from project aid to program aid. Donors will thus be encouraged to provide budget aid to the overall JKRBO program.

Country ownership and commitment is evident in the Member States' annually increasing contribution to the JKRBO.

The present general organizational structure of the Secretariat will be continued. There will be three Divisions reporting to the CEO, each headed and managed by a senior riparian officer. These three Directors together with the CEO, one from each country, form the “Executive” or senior management team of the JKRBOS.

The JKRBO will be guided by several management principles and approaches during the Short & Medium Term strategic period. These are:

- Program coordination, through a stronger integration of the various JKRBO programs following an IWRM approach;
- Sustainability, ownership and riparianization, through a regular-increase in member riparian country contributions and a strengthened profile in the management and guidance of the JKRBO;
- Building capacity of JKRBO staff, through the development of a Human Resources Strategy and policies;
- Stakeholder participation, through close communication and collaboration with civil society and NGOs;
- Transparency and openness, through pro-active efforts in communication with the JKRBO’s stakeholders;
- Integrating gender perspectives in JKRBO’s actions, through the development and dissemination of comprehensive gender guidelines and policies.

JKRBO should aim to have made major progress towards:

- Being acknowledged as a leading International River Basin Organization operating by the best practice principles of sustainable development and management of the basin's resources and in organizational processes and practices.
- Being accepted as a 'centre of excellence' for information and knowledge backed by excellent analytical and management systems pertaining to the water-related and environmental resources of the basin.
- Compiling a list of feasible and justifiable development projects that reflect the social and environmental aspirations of the riparian countries, and grouping priority projects into a basin-wide Kagera Program.

Building awareness and understanding throughout the basin of the JKRBO as a world-class International River Basin Organization that contributes to poverty alleviation and sustainable development.

The Short and Medium Tem Strategy of JKRBO will provide the basis for enhancing the JKRBO's support to the sustainable development of water related resources in the Kagera Basin and thus be a major step forward in contributing to poverty reduction in its riparian countries.

4.2 Organizational and managerial strategy

Besides the Line Agencies of the riparian countries, the implementation of Kagera Integrated River Basin Management and Development (KIRBMD) Strategy needs jointly established Joint Kagera River Basin Organization (JKRBO).

In general, the need for Kagera Basin Organization (KBO) was recognized as early as more than 30 years ago. KBO fully established itself with its headquarters in Kigali, Rwanda in 1981 (KBO 1982). At that time, Uganda formally joined the KBO as a full member. The KBO prepared a Plan of Action covering such areas as agriculture, energy, transport and communication, small scale industries and environmental protection and conservation. Due to funding constraints, the most viable projects from the general scope of the KBO priority sectors were selected and the KBO finally undertook studies for the implementation of fourteen projects in four key sectors: (a) transport and communications, (b) energy, (c) agriculture, and (d) information and training. By 1992, project documents and feasibility study reports had been prepared for most of the projects. The presentation of funding proposals to the donors for four priority projects, including the Rusumo Falls Hydroelectric Project, was scheduled for June 1995 but it had to be called off (ECA, 2000). In early to mid 1990s, the activities of KBO and its headquarters faced unexpected disruption because of the political and civil strife in both Rwanda and Burundi which damaged most of RBO's projects. Disruptions of the KBO's functions put a hold on the preparation of the projects. After several years of inactivity, the KBO was officially dissolved in July 2004.

Very recently, Kagera River Basin Management Unit (KBMU)[16] is recommended as institutional option for the Kagera Basin Cooperative Framework (COWI Uganda, 2009) This option is to institutionalize cooperation under the auspices of the LVBC and the EAC with ties to the NBI (ref: Annex D). This will have the advantages of:

- being part of an existing organization with a strong legal basis and political support;
- operating on the lowest appropriate level in accordance the subsidiarity principle; and
- maintaining linkages with the larger Nile Basin organizations.

However, the proposed KBMU (at its capacity as recommended) can not be sufficient to handle the expected role in implementing basin-level management and development strategy from 2010-2030. Accordingly, the following sections discuss the establishment of JKRBO and its role in implementation of KIRBMD Strategy.

Joint Kagera River Basin Organization (JKRBO)

Organizing and managing the JKRBO successfully will largely depend on the effectiveness of the Advisory Council which links between Standing Joint Executive Committee (SJEC), NELSAP, LVBC, the National Kagera Committees (NKCs) and Donor Consultative Group and the JKRBO Secretariat. The proposed Advisory Council composition is given by Figure 3.1.

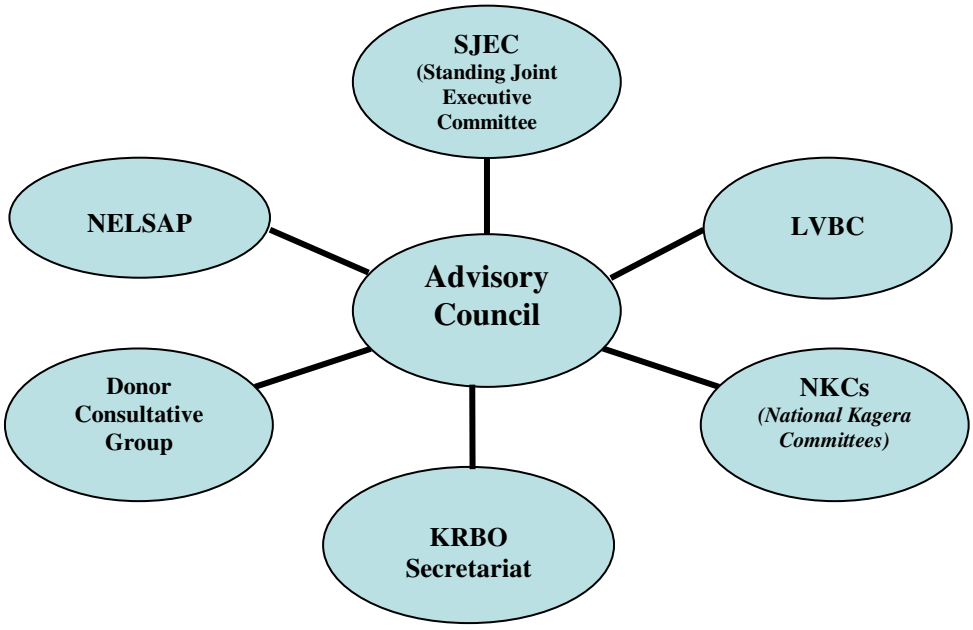


Figure 3.1: Composition of the Advisory Council

The proposed JKRBO organizational structure is presented as Figure 3.2. More detailed information about JKRBO organizational and managerial arrangement is given in

[16] Reference: Draft Cooperative Framework Agreement and Set Up of KBMU: Development of a Kagera River Basin Transboundary Cooperative Framework and Management Strategy in the Four Riparian Countries of Burundi, Rwanda, Tanzania and Uganda, Volume 2: COWI Uganda, February 2009

Annex D "*Draft Charter for Kagera River Basin Institutional Framework*". Issues and performances with regard to high level objectives, goals and targets are to be reported by the various institutional levels of the JKRBO.

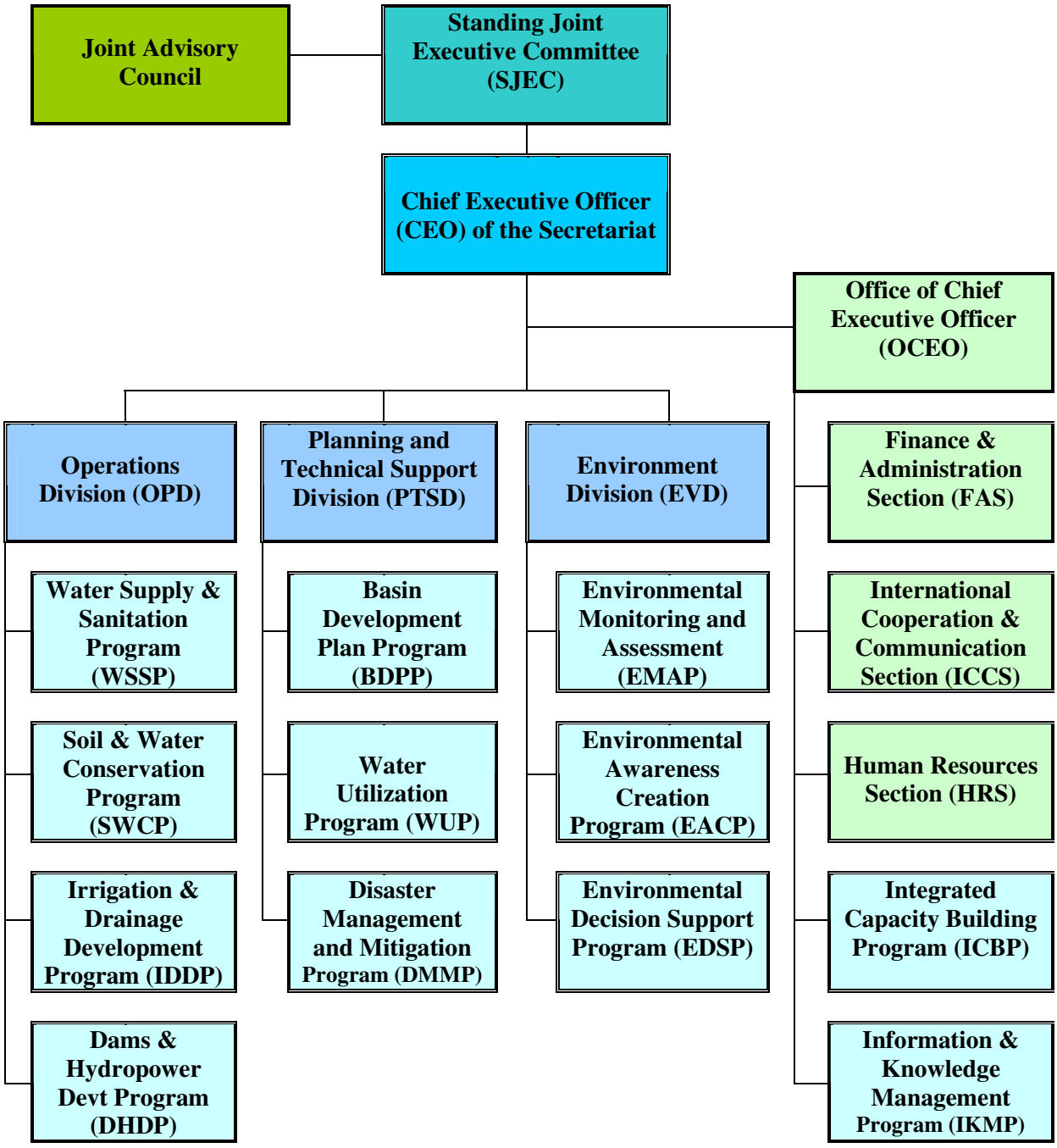


Figure 3.2: Organizational Structure JKRBO

Highest organ of JKRBO is the Standing Joint Executive Committee (SJEC). The Standing Joint Executive Committee shall be composed of one member from each participating riparian State at no less than Head of Department level. The members of the Standing Joint Executive Committee shall also be the members of the Joint Adisory Council. It is responsible to oversee the basin planning studies and the range of policies and strategies that need to be developed to underpin the JKRBO activities and to supervise the activities of the Secretariat.

The day-to-day activities of the SJEC will be run by the Senior Management Team (SMT) of the Secretariat. The SMT of the Secretariat reports to the SJEC. SMT is responsible for implementing The SJEC's decisions such as to have various studies and investigations undertaken; to carry out the basin planning studies and the implementation of policies and strategies will be carries out by the SMT. The JKRBO Secretariat and its SMT and the CEO report to the SJEC based on performance criteria that specify the key issues that have to be addressed. Reporting relations within the JKRBO Secretariat include the following levels (from bottom to top): From Program to Division to the CEO.

A key feature of the JKRBO is the role of National Kagera Committees in linking the JKRBO Secretariat with the national line agencies (ref: Table 2.2), including their strategies, plans and actions. The four committees play a key role in obtaining country input for all activities relating to the JKRBO. However, JKRBO policies do not apply in guiding the sovereign country actions and programs unless a broad consensus is reached. The JKRBO will therefore pay more attention to strengthening the technical and administrative capacity of the National Kagera Committees (NKCs), and thus their credibility, in order to enhance their ability to influence, coordinate and participate in national policy formulation and project development planning processes.

The JKRBO will need to lead an evaluation of the roles, functions and responsibilities of the NKCs. Key to this evaluation will be an analysis of the coordination procedures between the JKRBO and NKCs and the development of recommendations for institutional reform. It is envisaged that the JKRBO will play a leadership role in building capacities within the JKRBO, which will be closely aligned with the need to implement IWRM approaches. This evaluation and capacity strengthening within the NKCs will require support from the riparian States and donors.

JKRBO Secretariat organizational structure

The general organizational structure of the Secretariat will have three Divisions and Administrative Support. Individually, the three Division Directors will be reporting to the Chief Executive Officer (CEO) and each will be headed and managed by a senior riparian officer. The three Division Directors, together with the CEO, will form the "Executive" or senior management team (one from each country) of the JKRBO Secretariat. The JKRBO will remain open to and regularly consider future revisions to the JKRBOS organizational structure.

Management principles

The management of the JKRBO will be based on several fundamental principles and approaches. These include program coordination, ownership, riparianization, JKRBO Secretariat staff capacity building, stakeholder participation, transparency and openness, and gender equity. The following sections describe the basic management principles and approaches to guide the JKRBO in the Short and Medium strategic period. The specific modalities will be detailed in separate documents and manuals.

Table 2.2: Key National Line Agencies in the Kagera River Basin

Country	Key National Stakeholder
Burundi	Ministry of Land Management, Environment and Tourism Ministry of Energy and Mining Ministry of Agriculture, Fisheries and Livestock Ministry of Health Ministry of Home Affairs and Public Security Geographical Institute of Burundi National Institute for Nature Conservation
Rwanda	Ministry of Lands, Environment, Forests, Water and Mines (MINERENA) Ministry of Agriculture (MINAGRI). Ministry of Infrastructure (MININFRA) Ministry of Health (MINISANTE) Rwanda Environment Management Authority (REMA)
Tanzania	Ministry of Water and Irrigation (MoWI) Ministry of Health Ministry of Agriculture Ministry of Energy The Energy and Water Utilities Regulatory Authority (EWURA) Urban Water Supply and Sewerage Authorities Water Supply and Sanitation Authorities
Uganda	Ministry of Water and Environment (MoWE). Ministry of Lands and Mineral development Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) Ministry of Health (MoH) Ministry of Energy National Environmental Management Authority (NEMA)

Program coordination

This Strategy calls for a stronger integration of the various programs within the JKRBO. This is a key requirement for the Basin Development Plan (BDP) to be developed with an IWRM approach. The various Programs must be aware of activities in other programs and provide input to the planning process in such a way that tradeoffs of various development options can be analyzed and screened. Such integration requires increased communication and collaboration among the programs, especially at the level of BDPP. This is also the case for activities requiring inputs from various JKRBO programs such as the IBFM process. To achieve this, a Technical Coordination Advisor will be recruited to ensure that all mechanisms required for program integration are put in place and operate effectively.

Sustainability, ownership and riparianization

Country ownership of the JKRBO is to be strengthened at all levels during the next Strategic Period. In addition to the riparian country financial contributions, the States will assume a higher profile in the management and guidance of the JKRBO. In particular, the establishment of Program Steering Committees with membership from the four countries will greatly enhance ownership in the activities that the JKRBO pursues. Other principles to increase ownership are riparianization and staff capacity building.

"Riparianization" is a key objective of the organization. This riparianization will not only secure sustainability of the JKRBO capacity, it will also contribute to financial sustainability in the medium term through reducing staff costs. It must occur in tandem with capacity building and targeted training, and also in a phased way that allows Riparians to become managers with the appropriate management skills plus with the right degree and nature of technical support. As well, JKRBO staff and management policies must be appropriate for riparian managers and key staff to be able to develop career paths at JKRBO Secretariat and also to contribute to corporate experience and memory through suitable periods of service at JKRBO Secretariat. All aspects of a "riparianization" policy and strategy need careful review and appropriate amendments should be made to the applied procedures to facilitate a more effective "riparianization" of the JKRBO Secretariat. An "organizational management working group" which reports to the senior management team could be created to oversee this work.

Building capacity of the JKRBO staff

An Integrated Human Resource Strategy will be developed. It will improve on the current staff appraisal scheme, particularly in how good and poor performances are managed and will complement the integrated training strategy/program by identifying management development approaches to prepare staff for higher roles, staff management policies, recruitment and so on. JKRBO wants to be an expert organization managed by competent riparian managers and supported by local and international experts as necessary and it can only do this with clear and strong human resource policies and strategies.

International staff should only be senior level with recognized international technical experience and solid project and program management skills, including finance management. International Chief Technical Advisors (CTAs) are senior technical specialists who assist the Program Coordinators on the basis of a co-management approach.

Stakeholder participation

Within the framework of IWRM, stakeholder participation is one of the key objectives of the JKRBO. Given the significant potential of water resource developments to affect the lives of the people of the Kagera River Basin, it is essential to build in processes for public involvement and input into JKRBO activities. Consideration of public opinion and preference is essential for ensuring that identified development options are both

appropriate and socially acceptable. Stakeholders represent both people who have direct interest in the Kagera's water resources as well as people who posses a rich supply of knowledge and opinions to guide planning processes. The overall objective for fostering stakeholder participation is to allow those who will be affected by a project to have an influence in decision-making over the planning, implementation, and monitoring of a given project.

Effective stakeholder participation in the JKRBO's work to realize sustainable management and development requires that stakeholders possess adequate awareness and education on the emerging water-related issues at basin-wide and local levels.

Improved stakeholder participation can be accomplished by working through the NKCs who are best able to implement improved participation, including civil society and NGOs. NGOs can be particularly helpful in lending independent assessments of planning tools and processes developed by JKRBO. Internally, the JKRBO Secretariat will ensure that public participation policies are incorporated into and acted upon by each program as appropriate. Procedures and processes for increased stakeholder participation need to be developed, including forums for participation, methods for cataloguing information, and how gathered information will be used as input into planning and monitoring activities. Improved stakeholder participation will, of course, require resources which the donors should be prepared to support. Improved stakeholder participation will also require the strong commitment of the Member States.

Transparency and openness

Transparency and openness are key characteristics for the way the JKRBO will operate. Transparency and openness will be improved through pro-active efforts in communication with the JKRBO's stakeholders. Communications issues are both internal and external in the JKRBO and are a key part of the strategy for promoting regional cooperation and conflict prevention. JKRBO already has a strong communications approach and is highly regarded for the quality of its publications, brochures and general information. A strong emphasis will continue to be given to these aspects and it will be tailored to respond to the particular goals of the Strategy. However, an updated communications strategy should be developed to increase understanding and recognition of the JKRBO in the basin and internationally.

4.3 Integrating gender perspectives in JKRBO's actions

The JKRBO's Gender Strategy is based on the acknowledgement that gender is a critical element for integrated water resources management. This is to ensure that development options respond equitably to the needs of men and women. Incorporating women into decision-making processes also increases the degree of social acceptance development decisions receive. Moreover, a gender perspective in development ensures that the needs, capacities and vulnerabilities of men and women are fully recognized and addressed.

The JKRBO will focus on mainstream gender perspectives internally and externally. Such effort should be reflected in more comprehensive gender guidelines and policies

being developed and disseminated. Moreover, annual reviews of progress on gender mainstreaming should be undertaken and reported in appropriate meetings and publications. The JKRBO should identify opportunities and report on progress for enhancing gender equity and awareness within its organizational structure at all levels. Additionally, the JKRBO Secretariat should encourage the NKCs to give attention to gender issues including equity in staffing. All Programs should include a gender element within their strategies which aims to increase gender mainstreaming both within projects and among staff. It is important that research and project designs include gender need and impact assessments, where appropriate, for various development options. To be effective, the Gender Strategy must have the commitment and support from top-level officials and managers at the JKRBO.

4.4 Monitoring and Evaluation

Overall performance

The Strategic Direction aims JKRBO to have made major progress towards:

- *Being acknowledged as a leading International River Basin Organization operating by the best practice principles of sustainable development and management of the basin's resources and in organizational processes and practices;*

- *Being accepted as a "centre of excellence" for information and knowledge backed by excellent analytical and management systems pertaining to the water-related and environmental resources of the basin;*

- *Compiling a list of feasible and justifiable development projects that reflect the social and environmental aspirations of the riparian countries, and grouping priority projects into a basin-wide Kagera Program;*

- *Building awareness and understanding throughout the basin of the JKRBO as a world-class International River Basin Organization that contributes to poverty alleviation and sustainable development.*

Monitoring and evaluation system

An essential component for the implementation of the Strategy is the development of a suitable system for the monitoring and evaluation (M&E) of the JKRBO's progress and performance toward attaining the goals and objectives expressed in this document. It is recommended that immediately following adoption of this Strategy the JKRBO programs be directed to develop M&E systems with indicators to illustrate each program's progress and contribution toward attaining the goals and objectives in this Strategy.

Similarly, it is important that the JKRBO and its stakeholders arrange for an evaluation of the performance of the JKRBO system and institutions on a regular basis. The

purpose of such an evaluation is to identify institutional constraints in the operation of the JKRBO in order to develop constructive and mutually acceptable solutions to achieve the effective and efficient operation of the JKRBO. Such an evaluation should be conducted by an independent body. However, to reflect country ownership, the Council and Joint Committee should guide the design of the evaluation including terms of scope and composition of the evaluation team.

Implementation arrangements

The Joint Committee shall hold overall responsibility for ensuring the implementation of the Strategy. The JKRBO CEO and the Senior Management of JKRBO Secretariat will hold responsibility for taking and initiating required actions to ensure effective implementation of this Strategy. In particular, shortly after final approval and adoption, the CEO should make arrangements for the development of an effective and detailed monitoring system and Results Framework to measure and report on progress in implementing this Strategy. It may also be advisable to have an independent mid-term review conducted to ensure the Strategy stays up to-date and to facilitate development of the consecutive five-year Strategic Plans.

5. Resources Required for JKRBO Activities

5.1 Introduction

The goals of the JKRBO Strategic Direction specify an important role in all areas of river basin management. They also call for a greater focus on the JKRBO Programs through the role of promoting and coordinating planning and sustainable development at basin scale. An appropriate JKRBO has to be established as soon as possible and start showing significant efforts in consolidating an integrated program approach. The program approach considers JKRBO activities as part of comprehensive programs supporting basin-wide strategies of the JKRBO member countries. Based on an increased contribution from Kagera riparian countries and continuous support from the donor community, the JKRBO implements activities within a portfolio of 12 Programs:

- Basin Development Plan
- Water Utilization
- Disaster Management and Mitigation
- Information and Knowledge Management
- Integrated Capacity Building
- Environmental Monitoring and Assessment
- Environmental Awareness Creation
- Environmental Decision Support
- Water Supply and Sanitation
- Soil and Water Conservation
- Irrigation and Drainage Development
- Dams and Hydropower Development

In addition, a Multi-donor Water Management Trust Fund will be created in order to provide strategic and flexible support to JKRBO program development and implementation.

JKRBO Programs are driven by the principles of Integrated Water Resource Management and Development (IWRMD) and need to be administered through fully integrated programmatic structure of the JKRBO. The totality of programs supports the Kagera Partnership Program: a Regional Cooperation Program for Sustainable Development of Water and Related Resources in the Kagera River Basin owned by the riparian countries.

Projects that are identified and prioritized through the Basin Development Plan will support and ultimately form the Kagera Partnership Program. With close involvement of the funding agencies, Line Agencies, and the JKRBO Secretariat, the Kagera Partnership Program will be executed and implemented by the Member States in partnership with donors, development banks, and the private sector. JKRBO will implement basin-wide supporting activities mainly focusing on enabling projects.

Programming of JKRBO activities will be linked to the Basin Development Plan. Priority basin-wide and transboundary water resources related projects will be supported by JKRBO programs in a manner to contribute to the achievement of the JKRBO's goals and objectives.

5.2 Estimated Budget for JKRBO activities

Estimated average annual and total 20-year budgets for JKRBO programs and administration are given by Table 2.3 and 2.4, respectively.

The estimate of the budget requirement for JKRBO can be contrasted with the Mekong River Basin Organization (or Mekong River Commission, MRC)[17].

The Mekong River Basin includes parts of China, Myanmar and Viet Nam, nearly one third of Thailand and most of Cambodia and Lao PDR. With a total land area of 795,000 square kilometers, the Mekong River Basin is about 13 times the size of Kagera River Basin. The Lower Mekong River Basin served by MRC (Cambodia, Lao PDR, Thailand and Viet Nam) is home to approximately 60 million people which is about 2.4 times that of the Year-2030 projected population of Kagera River Basin.

The overall recent annual budget of MRC programs is about US$ 37.4 million. This budget is approximately US$ 3.0 million for the equivalent surface area of that of Kagera Basin. Similarly, the same budget is approximately US$ 15.6 million for the equivalent population of that of Kagera Basin for the Year-2030.

It can clearly be observed that the estimated budget for JKRBO programs which is US$ 7.22 million (see Table 2.3) is comparable to MRC standardized budget on the basis of basin area (from US$ 3.0 million) and population (US$ 15.6 million).

[17] More information about MRC is available at - http://www.mrcmekong.org/

Table 2.3: Average Annual Budgets for JKRBO Programs and Administration

Program Components	Budget (US$ 1000)
Planning and Technical Support Division (PTSD)	**1700**
Basin Development Plan Program (BDPP)	500
Water Utilization Program (WUP)	700
Disaster Management and Mitigation Program (DMMP)	400
Others	100
Environment Division (EVD)	**900**
Environmental Monitoring and Assessment (EMAP)	400
Awareness Creation Program (ACP)	300
Environmental Decision Support Program (EDSP)	100
Others	100
Operations Division (OPD)	**2500**
Water Supply and Sanitation Program (WSSP)	500
Soil & Water Conservation Program (SWCP)	500
Irrigation & Drainage Development Program (IDDP)	600
Dams & Hydropower Development Program (DHDP)	500
Others	400
Office of Chief Executive Officer (OCEO)	**2120**
Integrated Capacity Building Program (ICBP)	300
Information & Knowledge Management Program (IKMP)	300
Regular Budget	1000
Technical Cooperation Budget (10% Management Fee)	520
Total Budget	**7220**

Table 2.4: Average 20-Year Budgets for JKRBO Programs and Administration

Program Components	Budget (Million US$)
Planning and Technical Support Division (PTSD)	34.00
Environment Division (EVD)	18.00
Operations Division (OPD)	50.00
Office of Chief Executive Officer (OCEO)	42.40
Total Budget	**144.40**

5.3 Funding JKRBO activities

Funding approach

The approach of the Short and Medium Term Strategic Direction orients JKRBO funding towards two main types of support.

a) Support for sustainable development of water and related resources in the Kagera River Basin. This support is managed under the JKRBO Technical Cooperation Budget.

b) Support to strengthening the JKRBO as an International River Basin Organization. This support is managed under the JKRBO Regular Budget.

The funding strategy aims to achieve sustainability of the JKRBO's essential functions through contributions the riparian countries as well as through other financial mechanisms including cost sharing with donors. The JKRBO uses two separate budgets:

- The ***Regular Budget*** covers all costs of JKRBO Secretariat "essential" services. The Regular Budget provides for the functions that the JKRBO as a River Basin Organization should offer; such as international cooperation activities, program management and administration costs, core technical services and support to the NKCs.

- The Regular Budget mainly covers personnel costs related to JKRBO regular posts. Regular posts conduct the central corporate functions of the River Basin Organization. These include senior management, finance and administration, technical coordination, fundraising, international donor and stakeholder relationships, and an increasing number of technical services. Regular staff will drive the strategic planning so that programs are highly effective and focused. Staff members require strong management skills and expertise as they will perform policy and strategy development, planning, program and project design and management, and evaluation.

- The riparianization policy of the JKRBO for its professional staff positions will also allow for a gradual expansion of long-term technical services provided under the Regular Budget. An increasing number of technical functions will therefore be established through regular posts within the Regular Budget. The Operating Expense Budget (OEB) is a part of the Regular Budget. It does not include Regular Staff positions supported by donors.

- The ***Technical Cooperation Budget*** covers all program activities in which JKRBO plays an execution or co-execution role. This includes the costs of program coordinators and chief technical advisors. The Technical Cooperation Budget houses the JKRBO-executed technical assistance through projects required to address the development problems in the Kagera Basin. The Technical Cooperation cash expenditures will be 100 percent funded by Donors and are mainly used for personnel, subcontracting and training activities.

Riparian States provide significant in-kind contribution to JKRBO technical assistance. The development and maintenance of the knowledge base and GIS as well as the production of maps, technical reports and promotional documents will be included in the Technical Cooperation Budget.

- The Technical Cooperation Budget covers the program posts. Program posts coordinate and execute the program activities within the various divisions. The number and type of "program posts" will vary at any time depending on the availability of project support from donors and other investors. This will require a more flexible approach to executing the JKRBO operations as the number of program posts will fluctuate with donor agreements and greater use of outsourcing to country agencies, consulting companies, universities and other service providers. Funding of program posts will form a part of the agreement between the JKRBO Secretariat, partners from riparian States, donors and other funders.

The Technical Cooperation Budget is designed to expand and contract according to the volume of activities implemented by the JKRBO under its established programs for the sustainable development of water and related resources in the Kagera River Basin. Sustainability considerations for the Technical Cooperation Budget are relevant in terms of program and project design, but not in the JKRBO budget perspective. Staffing levels under programs, in terms of contracts and liabilities, will be limited in accordance with the duration and budgets of agreements and projects.

Essential functions of a world-class river basin organization need to be seen in the context of capacities of governments, much as any other organizational development process in developing countries. In the foreseeable future the present capacities will require international expert input and thus budgetary support by donors to these essential functions. In the medium-term, therefore, donor support to the Regular Budget will be required mostly to finance international positions. While the JKRBO riparian States need a world-class organization to build up capacity to peacefully develop and manage the Kagera, the costs for such an enterprise are beyond their capacity and budgetary realities.

This acknowledgement of the JKRBO as a long-term capacity building engagement of donors also requires a commensurate analysis of the engagement and ownership of riparian States. Their financial engagement, naturally, meets limitations, much as in any other technical cooperation project. This financial limitation, however, cannot be equated with a limited commitment to or ownership by the countries of the JKRBO. However, as the countries of the Kagera River Basin become more economically developed they will be able to contribute more to the running of the Secretariat.

In the interim, a sustainable funding approach will need to explore opportunities for increased revenue generation based on a three-tiered funding model comprising of

- JKRBO riparian State contributions;
- Program service charge; and,
- Any other source of income such as service provisions.

5.4 Resource Mobilization

The objective of the resource mobilization strategy is to institute measures which will attract more resources to the implementation of the Strategy. In order to achieve this objective JKRBO needs to follow the following strategic directions.

1) Building beneficiaries confidence,
2) Build donor confidence,
3) Position JKRBO strategically,
4) Expand the donor base, and
5) Develop appropriate mechanisms for awareness creation.

In order to implement its mandate JKRBO has to utilize appropriate and innovative methods for resources mobilizations for achieving each of these strategic directions areas. Accordingly the strategies to be used to achieve each of the strategic directions are indicated in the subsequent sections.

Building beneficiary confidence

JKRBO should

- Build confidence in the riparian countries, beneficiaries and donors through the efficient delivery of its commitments in the most efficient manner possible
- Provide information through transparent and regular reporting on the use of funds

Building donor confidence

JKRBO should seek to:

- Build donor confidence through the efficient delivery of JKRBO commitments with a definite and value-added outputs

- Provide information through transparent reporting on the use of funds. Investors desire not only attractive spending opportunities, but regular and accurate reporting on their contribution. Donors need to be provided with information on how resources are handled (budgeting, financial management, accounting), progress reviews (monitoring outputs, assessing outcomes), and given an understanding on the overall effectiveness of their investment (value-for-money, quality of impact, outreach of the beneficiaries). Regular dialogue needs to occur so that problems can be anticipated and solved.

Position JKRBO strategically

- Concentrate efforts on where JKRBO can add real value, strengthening partnership and ensuring complimentarity with other development partners;
- Publicize JKRBO's achievements and outreach through efficient Communication to the targeted audiences such as current donors and potential contributors, and

- Play catalytic role in mobilizing stakeholders' consultative meetings around critical integrated water resource management and development (IWRMD) issues.

Expanding the donor base

- *Broaden the donor base and develop a database of donor profiles, interest and needs.* Key organizations with potential interest for JKRBO need to be identified. In order to do this efficiently, criteria need to be developed to give guidance on which organizations should be approached for support. Donors with similar interests and aspirations as the AWF are more likely to provide support such as those involved in:

  (a) Implementing Integrated Water Resources Management and Development (IWRMD) plans;
  (b) Developing or strengthening effective management and development of shared waters,
  (c) Undertaking capacity building of water institutions;
  (d) Building or dissemination water information and knowledge; and
  (e) Support to development of country and region monitoring and evaluation systems.

Criteria will be developed to assess donors both for their ability to contribute and their estimated interest in contributing. For example, their ability to contribute depends on their budget and the amount of funds earmarked for water sector activities. Donors estimated interest in contributing may be related to factors such as: whether they have contributed previously to programs similar to JKRBO mandates, whether they have matching interests, and whether they have identified as priorities countries where JKRBO will be active. For the new emerging donors areas of intervention consistent with the interest of the donor will be developed jointly during dialogue.

Similarly, key individuals in organizations that may have an interest in and/or resources for JKRBO need to be identified.

- *Targeting potential donors*. The management and staff of JKRBO should engage themselves in identifying potential donors through their interaction with stakeholders in meeting, workshops and conferences. The traditional donors that are not already contributing to JKRBO should be especially targeted in this effort. The indicative list of potential donors is provided in Section 9.4.3.

- *Targeting new emerging donors.* There are several countries emerging as economic forces in the world. These include China, Russia, India, Brazil etc. These countries have emerged at the forefront of donor list in recent years. These countries have capacity and the willingness to contribute to the development efforts in Africa. However, there is a need to engage with them to identify the nature of development assistance they are willing to support JKRBO.

Awareness creation

- Elements of JKRBO Communications Strategy to target potential donors with professionally couched information attractive to donors;
- Develop JKRBO information support items such as print products, special program initiatives, reports, publications, campaigns, etc., should be professionally designed to be attractive to the general public around the world;
- Harmonize multi-level public awareness and resource mobilization activities, including a recognizable corporate image of JKRBO and stimulate interest in and support for JKRBO initiatives;
- Strengthen the relationships with current donors so as to maintain their support and commitment. Potential donors should be sent communications and advocacy material to raise their awareness of JKRBO;
- JKRBO should also be put on the donor agenda at bilateral donor consultations or in upcoming gatherings whenever possible;
- Increase the visibility and prominence of JKRBO through participation in conferences workshops and seminars and presentation of relevant materials; and
- Increase the visibility and prominence of JKRBO through an interactive Website to send out information and receive feedback.

Funding partners

Besides SIDA of Sweden, CIDA of Canada, NORAD of Norway and European Union, JKRBO is likely to receive financial support from the country governments of Australia, Belgium, Denmark, Finland, France, Germany, Japan, the Netherlands, USA, etc. through their development agencies; through development banks including African Development Bank (ADB) and World Bank; and international organizations such as European Commission, but it also should have relationships with many other partners and institutions.

Cooperation agreements (Partners)

The JKRBO should be able to work with many different partners under jointly funded projects, under formal Memoranda of Understanding. The following list includes possible partners:

- AFD Francaise De Developpement
- Australian Centre for International Agricultural Research (ACIAR)
- Australian Agency for International Development (AusAID)
- Consultative Group on International Agriculture Research
- Canadian International Development Agency (CIDA)
- Canadian Space Agency and the Natural Resources Canada
- Danish Hydraulic Institute

- European Commission
- Food and Agriculture Organization of the UN
- German Technical Cooperation (GTZ)
- International Network of Basin Organizations
- International Network for Water and Ecosystems in Paddy Fields (INWEPF):
- International Water Management Institute (IWMI)
- IUCN - The World Conservation Union
- Japan Water Agency
- Japanese Institute of Irrigation and Drainage
- Japan International Cooperation Agency (JICA)
- National Center of Competence in Research North-South, Center for Development and Environment; University of Berne
- National Institute of Rural Engineering (NIRE), Japan
- Norwegian Agency for Development Cooperation (NORAD)
- Nordic Development Fund
- Swedish International Development Agency (SIDA)
- United Nations Development Program
- United Nations Environment Program
- UNESCO/IHE Institute for Water Education Cooperation
- US Agency for International Development (USAID)
- WorldFish Centre
- World Meteorological Organization (WMO)
- World Wide Fund for Nature

6. Short-Term Activities

The Short-Term (2010 – 2015) activities focus on issues that need be addressed by the newly established JKRBO.

6.1 Divisions and Programs of JKRBO

The following Divisions and Programs of JKRBO need to be established within the Short-Term (2010-2015) period.

- Office of Chief Executive Office (OECO)
- Planning and Technical Support Division (PTSD)
- Environment Division (ED)
- Operations Division (OPD).
- Integrated Capacity Building Program (ICBP)
- Information and Knowledge Management Program (IKMP)
- Basin Development Plan Program (BDBP)
- Water Utilization Program (WUP)

Integrated Capacity Building Program

The Integrated Capacity-Building Program (ICBP) will provided support to the Secretariat and National Kagera Committees in each riparian country for improved

systems of administration, management and communications through a regional training program involving a network of leading education and training institutions in the region and worldwide. This training is also expected to increase regional cooperation and integration.

The ICBP will comprise several components:

- Training in Project Management
- Training in Information Management and Communication
- Training in Environmental Governance
- Junior Riparian Professional Program
- Strengthening Core Activities of JKRBO
- Research Coordination
- Gender Mainstreaming

The Junior Riparian Professional (JRP) Program, which could start operating as early as the establishment of JKRBO. JRPs are young professionals who work at the Kagera River Basin Organization Secretariat rotating among the Basin Development Plan program, Water Utilization Program, Environment Program and Disaster Management and Mitigation Program, gaining first-hand experience of the day-to-day planning and administration needed for effective river basin management.

They will attend training sessions on key aspects of basin management, including project planning and evaluation and legal, social, economic and environmental issues. They will engage in research, report-writing, making presentations and attending workshops and meetings with government officers, donors and civil society representatives and learn hands-on project management by taking on appropriate responsibility within a team of regional and international staff.

The JKRBO programs through ICBP will play an active role in increasing knowledge within the basin. ICBP team will develop training curriculum (with other JKRBO Programs and International Technical Assistance) to increase the knowledge of river basin planners of the future. It will also conduct study tours of the basin to learn how to deal with issues such as decision making proceeds stakeholder involvement and dealing with conflict.

Information and Knowledge Management Program

The JKRBO's Information and Knowledge Management Program will be designed to facilitate access to and use of the data, information and decision support tools necessary to promote and co-ordinate sustainable development of water and related resources in the Kagera Basin. As part of its hydrological information it monitors a network of measuring stations along the Kagera which transmit real-time information on water levels for river monitoring and other uses.

The JKRBO's Information and Knowledge Management Program has four separate, but interlinked, program components.

- *Data Exchange and Sharing*: This component promotes and facilitates exchange and sharing of data on Water Resources, Hydrology and Meteorology as well as all other resources required to implement the work of the JKRBO's programs.

- *Information Management*: Primary data will include a set of high quality and integrated JKRBO-IS databases, including, but not limited to, spatial (GIS), socio-economic, hydrological, meteorological and water quality data. The Program's JKRBO-IS Portal web service will provide a gateway to data and information on the Kagera Basin.

- *Decision Support Framework:* The Decision Support Framework (DSF) is a state-of-the-art computer based system providing the JKRBO with the capability to investigate the environmental and socio-economic impacts of changes in the quantity and the quality of flows in the Kagera river system brought about by changing circumstances within the river basin. Developed through a participatory process with the four countries of the JKRBO with funding assistance from donors, the DSF provides a powerful analytical basis to understanding the behavior of the river basin and thus to making appropriate planning decisions on how best to manage its water and related natural resources. The DSF has been developed with a modular structure that will enable the JKRBO to continue to add new functionalities and models as needs arise. Similarly, the data in the DSF can be readily updated and added to.

- *Decision Support Systems:* This component will focus on maintaining the technical capacity and systems needed to analyze and interpret the primary data and results of models or scenario simulation and includes modeling of water and related resources and use of analytical tools, such as spatial (GIS/Remote Sensing) and time-series.

6.2 Planning and Technical Support Division

Basin Development Plan Program

Despite reasonable economic growth over the past decade, the Kagera Basin remains among the world's poorest areas. By the year 2030, the population of Kagera Basin is estimated to be about 25 million, meaning that pressure on natural resources will increase, as will demand for food, water and energy.

Water resource development in the Kagera Basin is still limited if compared with most other large river basins. The governments of the basin countries are increasingly recognizing that sustainable development of the economic potential of the Kagera river system - for domestic use, irrigation, hydropower, fisheries and flood management - can alleviate poverty and improve livelihoods. Such development must be undertaken with equal consideration to conserve riverine ecology. The planning process requires a strong partnership of basin stakeholders to effectively link water resource development with conservation of the basin's rich riverine ecology.

The BDPP of JKRBO provides such a planning process, designed to help the Burundi, Rwanda, Tanzania and Uganda achieve their goals of economic prosperity, environmental sustainability and social equity. The development and management of water and related resources will be vital to attaining these goals.

The centre piece of the JKRBO's strategy will be a 'rolling' plan for developing and managing the Basin's water resources, founded on IWRM principles, and with a socially and environmentally sound agenda to promote regional cooperation. The BDPP will provide this basin-wide planning process plus opportunities to build a strong partnership of stakeholders who can effectively link development and natural resource conservation.

Program outputs will contribute to the achievement of all JKRBO strategic goals. The BDPP will assist implementation of the JKRBO Strategic Plan by supporting:

- Improvement of the coordination and programming of other JKRBO programs towards achieving the organization's strategic goals;
- The visible engagement of the JKRBO in transboundary assessment, based on IWRM.

The Basin Development Plan (BDP) will be prepared by the Basin development Plan Program (BDPP) of JKRBO with substantial support from the National Kagera Committees, national line agencies, and other JKRBO programs.

Water Utilization Program

The Water Utilization Program (WUP) will develop 'procedures' for water use that could be agreed upon by the four governments of the Kagera Basin. In designing these procedures the WUP will focus shared water use and management in the basin while promoting appreciation of the importance of ecological balance. This will be accomplished through creation of an integrated knowledge base, provision of data and decision support, plus a comprehensive hydrological modeling package.

6.3 Environment Division

The Environment Division's main aim is to assist the member countries to protect the environment and maintain the ecological balance of the basin and to ensure environmental and social sustainability of economic development undertaken within the region. The livelihood and prosperity of a growing population living in the Kagera River Basin depends on a healthy environment.

The Kagera River Basin has a population of approximately 15 million and the great majority of the inhabitants are farmers depending directly on the natural resource base. The integrity of the Basin's ecology is thus vital to their social, cultural and economic well-being. Although the Basin is relatively unpolluted, rapid economic development coupled with increasing population pressure is degrading the environment and the Basin's resources at an increasing rate. It is imperative to do something now to have a positive impact on the future. This is why the environment program aims to maintain the health of the river through a strategy of monitoring, management and education.

The Environment Division has the following main objectives:

- To improve monitoring of the environmental state of the basin, focusing on water quality, ecological health and social development.
- To increase environmental and socio-economic knowledge in the Kagera River basin.
- To improve the dissemination and accessibility of environmental information (within the basin and between the basin and elsewhere).
- To ensure that social, economic and ecological concerns are incorporated in basin-wide environmental policies and procedures.
- To improve awareness and capacity of JKRBO and riparian government personnel to address transboundary and basin-wide environmental issues.
- To ensure that development initiatives are planned and implemented with a view to minimize negative environmental impacts in the Kagera River Basin.

One of the components of the Program is ***Environmental Flow Management*** that aims to improve management of water flows, maintaining the ecological balance of the Kagera River basin. It is working in close collaboration with the JKRBO's water Utilization Program, in developing environmental flows assessment to support the development and agreement on procedures for water use.

The Environment Program supports the other JKRBO programs with environmental data and tools for environmental planning and management such as:

- A wetland inventory and a map over the aquatic ecosystems in the basin
- Bio-assessment data which provides information on ecological health of the river and the basin.
- Information on environmental flows to assist in determining the trade offs between water use and river condition so that water use will not affect the river, its tributaries and its environment in ways unacceptable to the member countries.
- The economic value of wetlands.
- Water quality data from selected sites within the basin to allow assessment of present water quality and trends over time.
- Information on toxic chemicals in water and sediments within the basin.
- Identification of ecologically sensitive areas.
- Development of informal procedures to address waterborne transport pollution and accident risks, as well as further development of EIA procedures for river transport infrastructure in a transboundary context.

Working with partners: Environmental issues are cross-sectoral and, as such, transboundary environmental concerns cannot be dealt with in isolation. The JKRBO, as the only wholly riparian structure representing riparian interests, is in a position to ensure a balance is maintained between economic development and a healthy Kagera Basin environment, supporting the natural resources diversity and productivity critical to the livelihood of its people. The Environment Program, in concert with all other JKRBO programs, focuses on the issues that need to be addressed by the JKRBO over the next decades in order to ensure a balance between economic development and environmental concerns.

6.4 Operation Division

The Operation Division (OPD) will focus on the following components which shall be established as programs within the Medium-Term and Lon-Term activities. OPD focuses on supporting line agencies in the areas of irrigation and drainage development, dams and hydropower development, soil and water conservation, water supply and sanitation, fishery, and others

Irrigation and Drainage Development

The goals of the JKRBO's Irrigation and Drainage Development Program (IDDP) are to ensuring that sound watershed management will preserve the natural resource benefits of watersheds for the future, to develop improved irrigation and water use methods.

Since rice is the single biggest consumptive user of fresh water in the region, effective water use on paddy field irrigation is vital for both further agricultural development and development in other water related sectors.

In this regard, the most urgent issue is to establish water consumption rate of rice for planning purposes. The second issue is to improve irrigation efficiency on paddy fields in the Kagera Basin. The IDDP should address these two issues as soon as it is established.

Dams and Hydropower Development

Hydropower brings with it several concerns regarding the potential for impact on the environment, fisheries and people's livelihoods. These concerns need to be balanced with the economic and poverty alleviation priorities of the JKRBO Member Countries. The JKRBO is working with Kagera governments to develop coordinated and integrated impact assessments,

An immediate priority for the JKRBO will be to assess the long-term implications of mainstream dam proposals and provide a broader understanding of the risks and opportunities. While the benefits of hydropower are potentially considerable for Kagera countries, the construction of one or more of the hydropower schemes currently under consideration would have profound implications for the sustainable development of the basin. To identify and assess these implications the JKRBO should launch Strategic Environmental Assessment process.

While Implementation of the proposed hydropower schemes on the mainstream Kagera brings potential opportunities for economic development, mainly with improved electricity supply and navigation, the projects will inevitably be accompanied by major risks in the four riparian countries. One of the ways that the JKRBO is helping to assess the balance between opportunity and risk for these proposed projects is to highlight a range of key issues that need to be considered by developers at the project design stage as well as by JKRBO bodies, government line-agencies and other stakeholders when any proposed hydropower scheme is submitted for the JKRBO prior consultation

process. This preliminary guidance includes a range of minimum standards, performance targets and best practices for reducing the environmental and social risks posed by hydropower schemes.

Soil and Water Conservation

The goals of the JKRBO's Soil and water Conservation (SWCP) are to ensuring that sound soil and water conservation measures will preserve the natural resource benefits of watersheds for the future.

Maintaining adequate water availability and quality requires, among others, the appropriate and sustainable management of watersheds. In this context, applying the precautionary principle is of key importance in the Kagera region, because many watersheds, at least from a water resources point of view, have presently only minor or no problems with sustainable management. However, it can be predicted that the presently still favorable situation will deteriorate rapidly, particularly due to rapid population growth and accelerating agricultural intensification. The core issue of the Soil and Water Conservation Program (SWC) is hence sustainable management of watersheds.

In addressing this issue, the WSCP will focus in supporting the national sector line agencies (ministries, National Kagera Committees). Accordingly, WSCP will provide services in the following core areas:

- *Policy analysis and advice*: Support to national and local working groups, introduction to and further development of methods and instruments for improved analysis, planning and implementation of sustainable soil and water conservation and support of a regional policy dialogue.

- *Information and Knowledge Management*: Documentation of experiences made in pilot watersheds, and in riparian countries, and their exchange at regional level through workshops, meetings, and Intra- and Internet-based information systems.

- *Capacity Development*: Logistic and organizational support, seminars, workshops, training courses. SWCP will also maintain the Kagera Information database.

6.5 Human Resource Requirement

The following figures (Tables 3.5 and 3.6) provide an overview of the proposed staffing situation of the Short-Term plan and Long-Term target per category.

Table 2.5: JKRBO Staff Requirement

Staff Category	End of Short-Term		Long-Term Target	
	Number	(%)	Number	(%)
1. Senior Managing Staff	4	3.2	4	2.5
2. Intern. Chief Technical Advisors (CTAs)	4	3.2	4	2.5
3. Senior Riparian Professional Staff	24	19.2	48	30.0
4. Junior Riparian Professional Staff	48	38.4	48	30.0
5. General Support Staff	48	36.0	56	35.0
Total	**125**	**100**	**160**	**100**

Table 2.6: Average Annual Budgets for Short-Term JKRBO Activities

Program Components	Budget (US$ 1000)
Office of Chief Executive Officer (OCEO)	**2140**
Integrated Capacity Building Program (ICBP)	300
Information & Knowledge Management Program (IKMP)	300
Regular Budget	1200
Technical Cooperation Budget (10% Management Fee)	340
Planning and Technical Support Division (PTSD)	**1500**
Basin Development Plan Program (BDPP)	800
Water Utilization Program (WUP)	500
Others	200
Environment Division (EVD)	**700**
Environment Division (EVD)	700
Operations Division (OPD)	**600**
Operation Division (OPD)	600
Total Budget	**4940**

6.6 Logframe Matrix of JKRBO's Short Plan (2010 – 2015)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Goal 1: To establish an effective JKRBO, capable to promote, in partnership with other institutions, basin-wide development and coordination	***A Kagera River Basin Organization (JKRBO) in place.***	***Corporation agreement signed by the riparian countries/States***	***Support from governments and the development partners available***
Objective 1.1: Establish a Kagera River Basin Organization (JKRBO) that can operate as a highly effective, transparent and innovative International River Basin Organization.	• ***JKRBO staff recruited*** • ***Adequate premises, equipment and support services provided*** • ***Resource mobilization strategy and co-funding plan regularly updated and shared with partners*** • ***JKRBO, NKCS and Line Agencies functioning***	***Reports by JKRBO***	***Adequate human and financial resources are available.***
Action: • Formulation of organizational management policies, systems and manuals.	• JKRBO Secretariat established and functioning • Management systems, policies and manuals in place.	• Number of appropriate policies, manuals and systems.	• Adequate human and financial resources available.
Objective 1.2: To establish a technical coordination capacity for preparing and coordinating the implementation of JKRBO's Work Program applying IWRM principles.	***Technical coordination capacity put in place and IWRM principles utilized.***	***Reports by JKRBO***	***Adequate human and financial resources available.***
Action: • Establishing technical coordination advisory system and efficient coordination mechanisms.	• JKRBO divisions and programs established and functioning • Periodical work plans. • Project progress reports.	• Number of project progress reports by the Office of Chief Executive Officer (OECO)	• Adequate human and financial resources available.
Objective 1.3: To establish key water quantity	***Information and Knowledge***	***Reports by JKRBO***	***Adequate human and financial***

and quality monitoring stations and assist the basin-wide process of meteorological and hydrological data collection, analysis and reporting systems.	***Management Program (ICBP) established and functioning***		***resources available.***
Action: • Support to line agencies in the site selection, instrumentation, data collection, analysis and reporting process. • Establishment of a Hydro-meteorological data base. • Establishment of a Hydro-meteorological year book (bulletin, CD ROM)	• Monitoring stations in place • The three items under "*Action*" in place.	• Data base established. • Periodic climatic assessment reports by Information and Knowledge Management Program (IKMP)	• Adequate human an financial resources available
Objective 1.4: To establish and maintain a GIS system to support all the JKRBO activities.	***GIS in place. Operational GIS system and dissemination tools.***	***GIS based information available. GIS based Reports. Number of information and datasets provided to outsiders.***	***Adequate human and financial resources available. Appropriate GIS available.***
Action: • GIS compilation and map production	• GIS in place. Operational GIS system and dissemination tools.	• GIS based information available. • GIS based Reports. • Number of information and datasets provided to outsiders.	• Adequate human and financial resources available. .
Objective 1.5: To establish and maintain partnership with development partners, Academic Institutions and Civil Society.	***Partnerships in place.***	***Network of partners established. Signed Memorandum of Understanding (MOUs).***	***Self conviction by the partners. Adequate human and financial resources available.***
Action: • Establish network of partners	• Partnerships in place.	• Network of partners established. • Signed Memorandum of Understanding	• Self conviction by the partners. • Adequate human and financial resources available.

		(MOUs).	
Objective 1.6: To strengthen organizational capacity building.	***Training materials developed and used in training***	***Capacity needs assessment reports. Training modules and toolkits.***	***Adequate human and financial resources available. Corporation from the stakeholders.***
Action: • Carry out appropriate training. • Provide appropriate training modules.	• Training modules and toolkits in place.	• Capacity needs assessment reports by the Integrated Capacity Building Program (ICBP).	• Adequate human and financial resources available. • Corporation from the stakeholders.
Objective 1.7: To develop and update assessment tools for all development projects in Kagera River Basin.	***New assessment tools in place.***	***Number of developed assessment tools in place. Number of projects assessed.***	***Adequate human and financial resources available.***
Action: • Training of the human resources on the use of the assessment tools.	• Training guidelines in place. • Complexity of the assessment tools in place.	• Number of developed assessment tools in place. • Number of projects assessed. • Number of people trained.	• Adequate human and financial resources available.
			Precondition **Establishment of JKRBO**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Goal 2: To enhance effective regional cooperation	***Increased use of the JKRBO by the riparian States as the key mechanism for joint planning, cooperation, and resolution of transboundary water-related issues.***	***Reports by JKRBO***	***Riparian Governments affected by Kagera basin water resources issues are open to cooperation***
Objective 2.1: To initiate and strengthen JKRBO's function as a transparent and effective cooperation mechanism among riparian countries and develop and demonstrate enhanced linkages, compatibility and complementarities of partnerships with other regional organizations and initiatives.	• ***Priority policy, legal and transboundary issues at Kagera river basin level identified.*** •	***Reports by JKRBO*** '	***Adequate human and financial resources are made available***
Action: • Review and harmonize water laws and policies among riparian countries. • Partnership agreements (MoUs) with development partners, International River Basin Organizations, and research institutions. •	• Planning and Technical support Division (PTSD) established and functioning • Commitment among riparian countries to share information (e.g. data, technologies, develop webpage). • Continuous and increased cooperation.	Reports by Planning and Technical support Division (PTSD) and Line Agencies	Adequate human and financial resources are made available
Objective 2.2: To initiate, adopt and make applicable mechanisms, procedures and guidelines required to facilitate cooperation of riparian countries.	***Supporting policy decisions, regulatory mechanisms and community bye-laws for improved harmonization and application are put in place.***	***Reports by JKRBO***	***Adequate human and financial resources are made available***
Action: • Avail guidelines for transboundary environmental impact assessment. • Avail technical guidelines/procedures for	• Common regional environmental standards are adapted. • Adopted procedures/guidelines are implemented.	Reports by Water Utilization Program (WUP) and Line Agencies	Adequate human and financial resources are made available

maintenance of sustainable (minimum) flows in the mainstream. • Avail technical guidelines/procedures for water quality.			
Objective 2.3: To identify potential transboundary issues for negotiation, mediation and conflict prevention; and develop mediation and conflict management capacity.	***Recommendations to harmonize policies, laws and regulations and address transboundary issues developed by an ad-hoc basin-wide task force with stakeholders and mechanisms in place***	***Reports by JKRBO***	***Adequate human and financial resources are made available***
Action: • Put in place Regional Organ for mediation and conflict management. • Inventory of issues and areas with potential for conflicts in use and impacts related to water. • Put in place capacity building and awareness mechanism.	• Increased capacity for managing transboundary issues. • Awareness tools and approaches to mediation and conflict management in natural resources issues developed. • Mechanisms to address environmental issues developed and implemented.	Reports by Water Utilization Program (WUP) and Line Agencies	Adequate human and financial resources are made available

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Goal 3: To promote coordinated, sustainable, and pro-poor development	***A significant increase of sustainable development based on basin-wide planning guided by the IWRM Strategic Directions, for poverty alleviation and more effective water use.***	***Reports by JKRBO***	***Public and political will towards Integrated Water Resources Management (IWRM).***
Objective 3.1: To establish a system for analyzing water demand, water supply and water use in the basin to support the basin development planning process.	***WUP of JKRBO established and functioning***	***Reports by JKRBO***	***Adequate human and financial resources are made available***
Action: • Identify a series of water accounts and verifiable water use indicators to guide decision-making and development strategy formulation. • Produce water supply and demand maps with projections on future population changes and sectoral needs. • Establish basin-wide water resources development scenarios and options.	Upgraded modeling toolkit and decision support framework (DSF) in place.	Reports by Water Utilization Program (WUP)	Adequate human and financial resources are made available
Objective 3.2: To establish processes and mechanisms enabling the balancing of trade-offs between economic and political net benefits of different sectors, areas, and regions; and benefits from environmental and social protection.	***BDPP of JKRBO established and functioning***	***Reports by JKRBO***	***Adequate human and financial resources are made available***
Action: • Produce baseline thematic maps of water and related resource and beneficiaries. • Prepare consolidated trade-off analysis of	Process of discussions on trade-offs and mutual benefits in basin development, including forum/ policy dialogue meeting in place.	Reports by Basin Development Plan Program (BDPP)	Adequate human and financial resources are made available

development scenarios based on assessed and quantified net impacts on economic, ecological and social values.			
Objective 3.3: To produce regularly updated rolling plans applying the planning process for identification, categorization and prioritization of projects and programs.	***Basin Development Plan in Place.***	***Reports by JKRBO***	***Adequate human and financial resources are made available***
Action: • Establish collaborative basin development planning processes for project identification and prioritization in water resources related sectors. • Establish an Integrated Water Resource Management and Development (IWRMD) rolling plan. • Cumulative impact assessment studies of development scenarios. • Update Integrated Water Resource Management (IWRM) Strategy supported by assessed development scenarios and options. • Establish JKRBO projects and programs database.	• Collaborative basin development planning processes for project identification and prioritization in water resources related sectors is established. • Integrated Water Resource Management and Development (IWRMD) rolling plan is established. • JKRBO projects and programs database is established.	Reports by Basin Development Plan Program (BDPP)	Adequate human and financial resources are made available

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Goal 4: To support sustainable pro-poor development efforts of other agencies	***Increase in quantity and quality of basin-wide sustainable developments that have significant contribution for poverty alleviation.***	***Reports by JKRBO***	***Cooperation with Line Agencies of riparian countries defined by memorandum of understanding (MoU)***
Objective 4.1: To screen, formulate and promote wise development options at the transboundary and basin levels for preparation and implementation by other appropriate development agencies.	***Increased water development process based on scientific and rational approach.***	***Reports by Operation Division (OPD) and Line Agencies***	***Adequate human and financial resources are made available***
Action: • Support to identification and preparation of balanced sustainable development options in partnership with donors, development partners and investment banks. • Support to Line Agencies with knowledge and expertise in preparation of project proposals, focusing on joint and basin-wide projects and national projects with significant basin impacts. • Support efforts of project promotion and fund-raising services for joint and basin-wide projects.	• Identification and preparation of balanced sustainable development options are supported. • Preparation of project proposals, focusing on joint and basin-wide projects and national projects with significant basin impact are supported. • Efforts of project promotion and fund-raising services for joint and basin-wide projects are supported. •	Reports by Operation Division (OPD)	Adequate human and financial resources are made available
Objective 4.2: To support sustainable use of land and water through development of effective and integrated utilization of irrigation and drainage systems.	***Increased food and fiber production, high value and high employment generated by efficient irrigation water use.***	***Reports by Operation Division (OPD) and Line Agencies***	***Adequate human and financial resources are made available***
Action: • Review and update basin-wide irrigation & drainage efficiency improvement strategy. • Support to line agencies in identification and	• Basin-wide irrigation & drainage efficiency improvement strategy are reviewed and updated. • Identification and preparation of	Reports by Operation Division (OPD)	Adequate human and financial resources are made available

preparation of BDP priority irrigation & drainage development and rehabilitation projects. • Prepare institutional and managerial guidelines to improve irrigation & drainage efficiency. • Assess irrigation & drainage efficiency in the Kagera basin. • Prepare guidelines for irrigation & drainage planning, development and management.	BDP priority irrigation & drainage development and rehabilitation projects are supported. • Institutional and managerial guidelines to improve irrigation & drainage efficiency are in place. • Irrigation & drainage efficiency in the Kagera basin is assessed. • Guidelines for irrigation & drainage planning, development and management are in place.		
Objective 4.3: To support sustainable land and water management through more effective and integrated implementation of soil and water conservation systems.	***Increased soil and water conservation in accordance with the maintenance of relevant agricultural, ecological, economic and social benefits.***	***Reports by Operation Division (OPD) and Line Agencies***	***Adequate human and financial resources are made available***
Action: • Review and update basin-wide soil and water conservation improvement strategy. • Support to line agencies on identification and preparation of BDP soil and water conservation projects. • Prepare soil and water conservation policy guidelines and proceedings. • Prepare guidelines for best practices on soil and water conservation management and technologies. • Preparation of guidelines for soil and water conservation planning, implementing and management.	• Basin-wide SWC improvement strategy are reviewed and updated. • Identification and preparation of BDP priority SWC projects are supported. • SWC soil and water conservation policy guidelines and proceedings are prepared. • Guidelines for best practices on soil and water conservation management and technologies are prepared. • Guidelines for SWC planning, development and management are in place.	Reports by Operation Division (OPD)	Adequate human and financial resources are made available

Objective 4.4: To support the development of the basin's hydropower potential to ensure safeguarding of the environment and social interests while meeting the Basin's increasing need for energy.	***Increased affordable electric energy with minimal negative impacts on the environment and local people is produced.***	***Reports by Operation Division (OPD) and Line Agencies***	***Adequate human and financial resources are made available***
Action: • Review and update assessment of hydropower potential in the Kagera Basin. • Review and update basin-wide hydropower development strategy. • Review and update hydropower database of planned dams. • Carry out impact assessments of hydropower projects. • Prepare guidelines for best practices to mitigate negative impacts of hydropower focusing on environmental and social impacts.	• Assessment of hydropower potential is reviewed, basin-wide hydropower development strategy, hydropower database of planned dams reviewed and updated. • Impact assessments of hydropower projects are carried out. • Guidelines for best practices to mitigate negative impacts of hydropower focusing on environmental and social impacts are in place.	Reports by Operation Division (OPD)	Adequate human and financial resources are made available
Objective 4.5: To assist in the domestic water supply and sanitation efforts to ensure adequate protection and improvement of peoples' lives and the environment.	***Water available to the people in sufficient quality and quality Reduced environmental pollution from human and livestock excreta.***	***Reports by Operation Division (OPD) and Line Agencies***	***Adequate human and financial resources are made available***
Action: • Review of water supply and sanitation development strategy. • Support to identification of BDP priority water supply and sanitation projects.	• Review of water supply and sanitation development strategy is reviewed. • Identification of BDP priority water supply and sanitation projects are supported.	Reports by Operation Division (OPD)	Adequate human and financial resources are made available
Objective 4.6: To assist in the efforts of maintaining sustainable economic productivity (fishery, aquaculture, tourism, navigation, …) of the Kagera river basin.	***Increased sustainable economic productivity of the Kagera river basin due to fishery, tourism, etc.***	***Reports by Operation Division (OPD) and Line Agencies***	***Adequate human and financial resources are made available***

Action: • Review and update fisheries development strategy. • Support to line agencies in identification and preparation of BDP priority sustainable fisheries and tourism development projects. • Formulate tourism development strategy to benefit local people development of tools and best practices to reduce negative impacts of tourism on environment and social conditions.	• Increased fish production from natural and man-made lakes. • Additional income to improve the livelihood of the poor people.	Reports by Operation Division (OPD)	Adequate human and financial resources are made available
Objective 4.7: To build regional water disaster management capacity for prevention, minimization or mitigation of people's suffering and economic losses due disasters.	***Increased preparedness for water-related disasters and improving response capacity among all sectors of society.***		***Adequate human and financial resources are made available***
Action: • Establish disaster forecasting and early warning system based on detailed data. • Prepare drought risk maps, flood risk maps and pollution risk maps. • Prepare disaster management and mitigation policy guidelines. • Formulate Climate Change mitigation strategy.	Floods, droughts and climate change mitigation policy guides and strategies are in place.	Reports by Planning and Technical support Division (PTSD) and Line Agencies	Adequate human and financial resources are made available

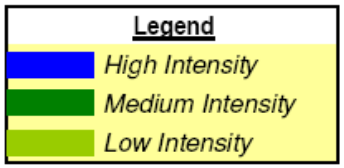
Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Assumptions
Goal 5: To establish and promote basin-wide environmental and socio-economic monitoring and impact assessment systems, recommendations, and policy guidelines	***Operational basin-wide environmental monitoring and impact assessment systems.***	***Reports by JKRBO***	***Public and political will towards sustainable water-related environmental management and socio-economic development***
Objective 5.1: To harmonize and to improve monitoring of the environmental condition of the Kagera River Basin, focusing on water quantity and quality, ecological health and social impact.	***Information and Knowledge Management Program (ICBP) supported by a GIS and RS tools and linked with Line Agencies of riparian countries, LVBC and NELSAP databases established and functioning.***	***Reports by JKRBO and Line Agencies***	***Adequate human and financial resources are made available***
Action: • To establish Environmental water quality monitoring system. • To improve and to harmonize and establish socio-economic impact monitoring system. • To establish Kagera River ecological health monitoring system. • To develop modeling of the Kagera Basin's aquatic ecosystems.	• Environmental water quality and quantity monitoring system in place. • Social and economic impact monitoring system in place. • Kagera River ecological health monitoring system in place. • Model of the Kagera Basin's aquatic ecosystems in place.	Reports by Environment Division (EVD)	Adequate human and financial resources are made available
Objective 5.2: To regularly report on the environmental condition of the Kagera River Basin and disseminate this information widely	***Monitoring, evaluation and reporting system is in place.***	***Reports by JKRBO and Line Agencies***	***Adequate human and financial resources are made available***
Action: • Establish base line information on environment condition. • Develop guidelines on best environmental management practices.	• Updated environmental status report (at least annually). • Updated basin reports on environmental and social conditions. • Updated state of the basin report (every 2 years).	Reports by Environment Division (EVD)	Adequate human and financial resources are made available

Objective 5.3: To raise awareness of the JKRBO, NKCs, and line agencies on transboundary and basin-wide environmental issues and to increase the capacity to address them.	***Awareness and implementing capacity on transboundary and basin-wide environmental issues is increased.***	***Reports by JKRBO and Line Agencies***	***Adequate human and financial resources are made available***
Action: • Create environmental awareness on transboundary issues. • Develop and disseminate environmental educational kits. • Develop the modules and training on the use of EIA, SEA, and other tools.	• Training modules on the use of EIA, SEA, and other tools in place. • Environmental educational kits in place.	Reports by Environment Division (EVD)	Adequate human and financial resources are made available
Objective 5.4: To ensure that development initiatives are planned and implemented with a view to minimize negative environmental impacts.	***Minimizing negative environmental impacts is considered in development initiatives are planned and implemented.***	***Reports by JKRBO and Line Agencies***	***Adequate human and financial resources are made available***
Action: • To support line agencies (upon request) in identification and preparation of BDP priority environmental management projects and protection. • Screening of projects for environmental impacts (technical support to project level SEA, independent review of EIA) upon request of riparian States. • Promote and support the implementation of transboundary EIA.	• Sport in identification and preparation of BDP priority environmental management projects and protection is provided. • Support in screening of projects for environmental impacts is provided. • Implementation of transboundary EIA is promoted and supported	Reports by Environment Division (EVD)	Adequate human and financial resources are made available
Objective 5.5: To ensure that social, economic and environmental concerns are incorporated into basin-wide water resources development strategies.	***Social, economic and environmental concerns are always incorporated into all basin-wide water resources development strategies.***	***Reports by JKRBO and Line Agencies***	***Adequate human and financial resources are made available***

Action: • To put in place or strengthen basin wide standards or benchmarks for strategic environmental impact assessment (SEA) and environmental impact assessment (EIA). • Promote stakeholder discussions to identify valuable assets in water resources which are to be protected. • Provide information and knowledge to decision makers through the IBFM process on economic benefits and environmental and social impacts of development as related to changes in the flow regime. • Develop and disseminate relevant tools to enable planners to take into consideration environmental and social aspects of development plans and projects (focusing on wetlands, protected areas, vulnerability and dependence on aquatic resources).	• SEA and EIA standards are put in place. • Stakeholder discussions to identify valuable assets in water resources which are to be protected are promoted. • Information and knowledge to decision makers through the IBFM process is provided. • Relevant tools to enable planners to take into consideration environmental and social aspects of development plans and projects are developed and disseminated.	Reports by Environment Division (EVD)	Adequate human and financial resources are made available

6.7 Implementation Schedule Chart of JKRBO Short-Term Activities

Activities/Actions		Period (years)					
1. Establishment KRBO	Resp.	2010	20111	2012	2013	2014	2015
1.1: Establishing Kagera River Basin Organization (KRBO	OECO						
1.1.1 Formulation of policies, systems and manuals	OECO						
1.2: Establishing technical coordination capacity for IWRMD application	OECO						
1.2.1 Establishing technical coordination system	OECO						
1.3: Establishing water quantity and quality monitoring system	IKMP						
1.3.1 Supporting to LAs in data collection, analysis and reporting process	IKMP						
1.3.2 Establishing a hydro-meteorological data base	IKMP						
1.3.3 Preparation of a hydro-meteorological year book (bulletin, CD ROM)	IKMP						
1.4: Establishing and maintaining a GIS system to support KRBO activities.	IKMP						
1.4.1 GIS compilation and map production	IKMP						
1.5: Establishing and maintaining partnership	OECO						
1.5.1 Establishing network of partners	OECO						
1.6: Strengthening organizational capacity building.	ICBP						
1.6.1 Carry out appropriate training.	ICBP						
1.6.2 Providing appropriate training modules.	ICBP						
1.7: Developing and updating assessment tools for development projects	OECO						
1.7.1 Training of the human resources on the use of the assessment tools.	OECO						

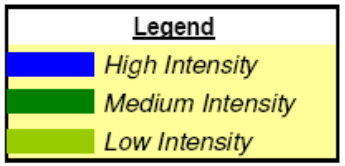


2: Enhancing effective regional cooperation	Resp.	2010	20111	2012	2013	2014	2015
2.1: Initiating and strengthening KRBO's function							
2.2.1 Reviewing and harmonizing water laws and policies	KRBO						
2.2.2 Partnership agreements (MoUs) with development partners	KRBO						
2.2: Facilitating the cooperation of the riparian countries.							
2.2.1 Availing guidelines for transboundary environmental impact assessment	WUP						
2.2.2 Availing procedures for maintenance of sustainable streamflows	WUP						
2.2.3 Availing technical guidelines/procedures for water quality monitoring	WUP						
2.3:Identifying key transboundary sensitive issues							
2.3.1 Establishing Regional Organ for mediation and conflict management.	WUP						
2.3.2 Inventorying of issues and areas of potential conflicts related to water	WUP						
2.3.3 Putting in place capacity building and awareness mechanism	WUP						

3: Promoting coordinated, sustainable, and pro-poor development	Resp.	2010	20111	2012	2013	2014	2015
3.1: Establishing a system for analyzing water demand, supply and use	WUP						
3.1.1 Identify a series of water accounts and verifiable water use indicators	WUP						
3.1.2 Producing water supply and demand maps	WUP						
3.1.3 Establishing basin-wide water resources development scenarios	WUP						
3.2: Establishing processes and mechanisms for balancing of trade-offs	BDPP						
3.2.1 Producing baseline thematic maps of water resource and beneficiaries	BDPP						
3.2.2 Preparing consolidated trade-off analysis of development scenarios	BDPP						
3.3: Producing regularly updated rolling plans of projects and programs.	BDPP						
3.3.1 Establishing collaborative basin development planning processes	BDPP						
3.3.2 Establishing KRBO projects and programs database	BDPP						
3.3.3 Establishing an IWRMD rolling plan	BDPP						
3.3.4 Studying cumulative impact assessment of development scenarios	BDPP						
3.3.5 Updating IWRM Strategy supported by assessed development scenarios	BDPP						

4: Supporting sustainable pro-poor development efforts of other agencies	Resp.	2010	20111	2012	2013	2014	2015
4.1: Screening, formulating and promoting basin-level projects	OPD						
4.1.1 Supporting identification of balanced sustainable development options	OPD						
4.1.2 Supporting LAs in preparation of project proposals	OPD						
4.1.3 Supporting efforts promotion for joint and basin-wide projects	OPD						
4.2: Supporting irrigation and drainage (I&D) projects/programs	OPD						
4.2.1 Reviewing irrigation & drainage efficiency improvement strategy	OPD						
4.2.2 Supporting LAs in identification of BDP priority I&D projects	OPD						
4.2.3 Preparing guidelines to improve I&D efficiency	OPD						
4.2.4 Assessing I&D efficiency in the Kagera basin	OPD						
4.2.5 Preparing guidelines for I&D implementation process	OPD						
4.3: Supporting soil and water conservation (SWC) projects/programs	OPD						
4.3.1 Reviewing and updating basin-wide SWC improvement strategy	OPD						
4.3.2 Supporting LAs in preparation of BDP SWC projects	OPD						
4.3.3 Preparing SWC policy guidelines and proceedings	OPD						
4.3.4 Preparation guidelines on SWC management and technologies	OPD						
4.3.5 Preparation of guidelines for SWC implementation process	OPD						
4.4: Supporting hydropower projects/programs .	OPD						
4.4.1 Reviewing and updating assessment of hydropower potential	OPD						
4.4.2 Reviewing and updating basin-wide hydropower development strategy	OPD						
4.4.3 Reviewing and updating hydropower database of planned dams	OPD						
4.4.4 Carry out impact assessments of hydropower projects	OPD						
4.4.5 Preparing guidelines to mitigate negative impacts of hydropower	OPD						
4.5: Supporting domestic water supply and sanitation projects/programs	OPD						
4.5.1 Reviewing WSS development strategy	OPD						
4.5.2 Supporting in identification of BDP priority WSS sanitation projects	OPD						
4.6: Supporting fishery, tourisms, etc. projects/programs	OPD						
4.6.1 Reviewing and updating fisheries development strategy	OPD						
4.6.2 Supporting to LAs in preparation of BDP priority sustainable projects	OPD						
4.6.3 Formulating pro-poor tourism development strategy	OPD						
4.7: Building regional water disaster mitigation and management system	PTSD						
4.7.1 Establishing disaster forecasting and early warning system	PTSD						
4.7.2 Preparing drought risk maps, flood risk maps and pollution risk maps	PTSD						
4.7.3 Preparing disaster management and mitigation policy guidelines	PTSD						
4.7.4 Formulating climate change mitigation strategy	PTSD						

5: Establishing basin-wide environmental and socio-economic systems	Resp.	2010	20111	2012	2013	2014	2015
5.1: Improving the basin's environmental monitoring system	EVD						
5.1.1 Establishing environmental water quality monitoring system	EVD						
5.1.2 Improving and harmonizing and establishing SEA monitoring system	EVD						
5.1.3 Establishing Kagera River ecological health monitoring system	EVD						
5.1.4 Developing the modeling of the Kagera Basin's aquatic ecosystems	EVD						
5.2: Reporting on the environmental condition of the Kagera River Basin	EVD						
5.2.1 Establishing base line information on environment condition	EVD						
5.2.2 Developing guidelines on best environmental management practices	EVD						
5.3: Raising awareness on basin-wide environmental issues	EVD						
5.3.1 Creating environmental awareness on transboundary issues	EVD						
5.3.2 Developing and disseminating environmental educational kits	EVD						
5.3.3 Developing the modules and training on the use of EIA, SEA, etc.	EVD						
5.4: Minimizing negative environmental impacts	EVD						
5.4.1 To support LAs in preparation projects of BDP environmental projects	EVD						
5.4.2 Screening of projects for environmental impacts	EVD						
5.4.3 Promote and support the implementation of transboundary EIA	EVD						
5.5: Incorporating SEA and EIA into development strategies.	EVD						
5.5.1 Establishing basin wide standards or benchmarks for SEA and EIA	EVD						
5.5.2 Promoting stakeholder discussions to identify resources to be protected	EVD						
5.5.3 Providing I&K as related to changes in the flow regime	EVD						
5.5.4 Developing and disseminating relevant SEA and EIA tools	EVD						



ANNEXES