7. Environmental Beneficial Uses

7.1 An Overview of the Environment – Poverty Linkage

7.1.1 Environment – Poverty Linkages

Development of water and related resources is required alleviate poverty, but it should not lead into environmental degradation, hence negatively affecting the poor people who largely depend on the environment for their livelihood. As well, maintaining acceptable environmental conditions should also encourage poverty reduction among the local communities. The environment should thus be considered a valuable *beneficial use* alongside other uses of water and related resources in the Kagera River basin.

The maintenance and improvement of environmental conditions can result into improved health, increased opportunity for economic growth and guarantee security to the poor. The scope for environmental concerns should focus on diverse issues such as water supply and sanitation, air pollution, natural resource (e.g. land degradation, deforestation, loss of wetlands and fisheries).

The emphasis of the poverty-environment linkage should be to ensure sound environmental management so as to provide opportunities to build sustainable livelihoods, not to restrict nor prevent development or utilization of natural resources. The purpose of development should be to put water and natural resources to productive and sustainable uses to alleviate poverty rather than contributing to unsustainable environmental degradation. In other words, the purpose should be to reduce poverty among the local communities by allowing them to have access to and utilize/exploit the existing natural resources in a sustainable manner, without compromising the environment for future generations. That means the local communities should be empowered to enable them get access and exploit the existing natural resources so that they can get opportunity to economically develop. That can only be possible if income generating activities (economic empowerment) are combined with measures to minimize environmental degradation by mitigating environmental impacts arising from those economic activities.

Apart from income levels and consumption patterns, the dimensions of poverty also include health, education and vulnerability – which in turn affect elements of well-being (security, empowerment and opportunity). The relationship between opportunity, security and empowerment with various dimensions of poverty and its interaction with environmental determinants is shown in Figure 2.17[138].

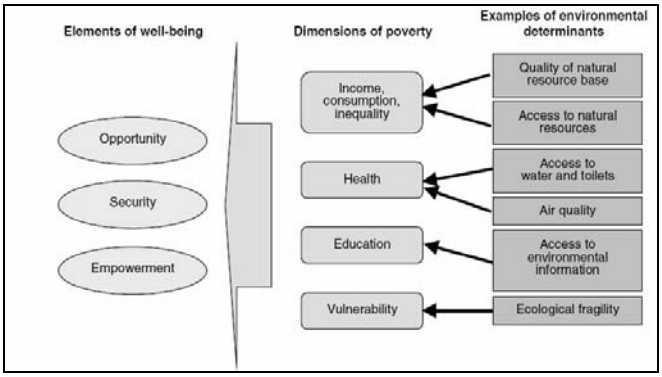

Figure 7.1 - Dimensions and Determinants of Environment – Poverty Linkage

[138] Bucknal, Kraus and Pillal (2001). Cited by Bojö et al., (19__).

7.1.2 Mainstreaming of environment into the national PRSPs

The primary objective of IWRM is to reduce poverty and protect the environment by minimizing environmental degradation. We seek to do this through joint management of shared water resources. Thus, it is important that the management and development of environmental resources in the Kagera basin should be seen in the context of Poverty Reduction Strategy Programmes (PRSPs) of the four riparian countries. Also, the integration of environmental considerations into the PRSPs is an important because, as noted above, there is a linkage between the quality of environment and the quality of life for the poor people. Thus, the purpose of this section is to review and assess the extent of environmental mainstreaming in the PRSPs.

(a) Burundi

Burundi's PRSP (Interim – March 2002) has set priority activities for the period 2002 – 2006 with six broad strategic themes. Strategic theme 2: *Stabilizing the macro-economic framework and promoting faster, high-quality growth that will help to reduce poverty*, also addresses environmental issues.

The PRSP recognizes the impact of rapid population growth on the environment, hence the need to adapt its productive system to the demographic pressures as it states: *"…new needs have resulted in the deterioration of farmlands, pasture and woodlands, acute deforestation and the disruption of ecosystem such as wetlands"* (p.20).

The strategy seeks to promote rural development and protection of the environment and its strategies are geared, among others, towards decentralization of development and protection of environment (p.39-40). Rationalization of natural resource management and environmental protection is another strategy being proposed by the paper (p. 45-46). It recognizes the impact of demographic growth and bad economic policies on the natural resource base. The paper identifies damaging land use practices the major causes of environmental degradation.

(b) Rwanda

Rwanda's PRSP (June 2002) identifies environment as one of the cross-cutting issues and environmental degradation, drought, loss of soil fertility, poor water quality and deforestation as some of the micro-economic structural problems. The strategy recognizes the relationship between water quality degradation, soil erosion and biomass to other sectors such as water, energy and agricultural practices; hence the need for treating environment as one of the cross-cutting issues. For example, it requires the government to support positive interventions to ensure that environmental protection measures are taken into consideration (integrated) within other sectors.

According to the strategy the primary objective of environment policy is to ensure that economic development is sustainable and does not destroy the natural resource. Thus, the paper proposes macro-economic reforms, such as tax reforms (i.e. reductions) on cooking fuels as one of the strategies to promote environmental protection.

The continued decline in environmental protection works since 1990s has resulted into absence of environmental conservation practices in farming systems by the local communities. One of the strategies to reverse the trend is to promote sustainable agricultural development by carrying out soil erosion control methods such as restoration of terracing, better management of marshlands, water catchments and reforestation on the hillsides.

According to the paper, involvement of the local communities in the environmental infrastructure building activities such as reforestation, terracing, marshes management will not only create environmentally sustainable labour intensive public works but also it will reduce unemployment.

For example, the paper proposes the promotion of environmentally sustainable labour intensive works for the development of soil and water management and forestry management programme include terracing and bunding, wetland and watershed soil erosion control. The paper also recognizes the importance of promoting environmental sanitation and hygiene among the general public in both urban and rural areas as one of the strategies to improve community health.

(c) Tanzania

Tanzania's PRSP (February 2000) recognizes the heavy dependence of the poor people on the environmental resources for income generation. For example, according to the paper the rural households depend on selling forest products such as fuel wood, charcoal, honey and wild fruits. Thus, the paper requires the government to incorporate environmental quality indicators in the poverty monitoring systems. The intention is to capture the levels of dependence and the linkage between poverty and environmental resources, so that a consistent framework is established for managing activities that are aimed at environmental protection.

(d) Uganda

Uganda's PRSP (2000) considers the serious declining soil fertility and deforestation as major environmental problems in the country. Thus, it seeks to develop sector-wide approaches for the environment and natural resource sector. The strategy is gender sensitive and pro-poor as it proposes land reform by classifying land rights and strengthening land rights for the poor people, especially women.

According to the strategy there is an urgent need to reduce deforestation to reduce the increasing long distances being walked by women in search for fuel wood, hence causing negative impact on them due to time wasted by women. Therefore, the strategy finds loss of soil fertility and deforestation as a threat to the livelihood of the poor people who depend on forest products.

Another strategy is to encourage private sector participation in the forestry activities and provide support to the districts in providing forestry services to promote community initiatives, while at the same time protecting the national forest reserves.

The strategy recognizes the importance of continuing with on-going programmes geared at protecting wetlands and wildlife resources. It also recognizes the linkage between environmental / natural resource management and utilization and the sustainable economic growth. For example, the paper relates the rapid economic growth with increasing stress on environment and natural resource base, hence resulting into environmental degradation. It considers the declining quality and quantity of natural resource to have some implication on the sustainable economic growth and poverty reduction.

7.1.3 Environmental indicators – poverty linkages in the Kagera Basin

There is a linkage between environmental degradation and poverty in the Kagera River basin. This linkage can be seen in terms of land degradation, pollution of water sources, lack of technical know how on sustainable utilization of environmental resources such as land, forest, wildlife and water resources. However, the problem of environmental degradation could also be linked to population pressures. The current population in the Kagera basin is estimated to be nearly 15 million people – representing about 40% of the existing 35 million people within the Lake Victoria basin (NBI, 2004). The population growth rate is also high in the four riparian countries and poverty level is also high (ref. Section 4).

Environmental degradation leads to loss of biodiversity in the terrestrial and aquatic ecosystems. All these threaten the sustainability of the strategic environmental resources such as land, water, forest, wildlife and fisheries. Thus, an important component of poverty alleviation should be achieved through sustainable utilization of these environmental resources.

The Kagera basin provides support to the poor rural and urban population who depend on multiple livelihood activities such as agriculture, fishing, exploitation of forest products – fuel wood and timber. For example, the majority of people in both rural and urban areas depend on biomass energy (fuel wood and charcoal) for cooking, preservation of fish (smoking) – which means continued consumption of forest products. So far there is no alternative source of energy for cooking to the rural and urban population. Due to high tariffs electricity is still mainly used for lighting in urban areas but not for cooking, hence there is a continued dependence on fuel wood and charcoal.

In general, the Kagera basin is characterized by high dependence on agricultural but low productivity – which tends to perpetuate poverty. Furthermore, low agricultural productivity is compounded by a vicious circle of increasing land degradation and loss of soil fertility – which in turn is the result of increasing population pressure and poor farming practices.

As result of population pressure, degradation of wetland areas and river bank vegetation is taking place in the basin resulting into reduction of buffers against environmental disasters, such as floods and gradual disappearance of environmental functions of wetlands as breeding ground for fish, leading into food scarcity – hence poverty. The degradation of watershed and soil erosion results into increased nutrient loads in the river, leading into invasion by water hyacinth and eutrophication – which in turn leads into reduced fish catch, hence low income to the fishing communities and ultimately leading into poverty.

The degradation of watershed and water resources results into adverse impacts including reduced agricultural output of downstream farming communities and damage to their crops due to floods. For example, upland watershed degradation resulted into landslides and floods in the recent years in Rwanda, resulting into serious property damage and loss of lives.

Since the majority of the people in the basin depend on biomass for energy more land areas are being cleared due to over-exploitation of forest products, especially fuel wood and charcoal for cooking. Thus, apart from continued deforestation the problem of land degradation is also increased by lack of reforestation activities and/or agro-forestry practice and lack of alternative source of energy as people continue to depend on fuel wood and charcoal.

The problem of land degradation has also been exacerbated by civil wars in the past and the movement of refugees, displacement of people / soldiers and unrestricted cultivation of wetland areas and river banks. Therefore, as population pressure increases more land is cultivated, including steep slopes, hence causing severe soil erosion in the watershed areas.

Again, due to poverty the majority of the rural people cannot afford to construct good quality latrines. As a result the lack of sanitary facilities in the heavily populated areas (urban and rural) within the basin results into flow of untreated sewage into many drinking water sources, hence pollution and degradation of water quality, creating a serious health risk to the majority of the people in the basin. In addition, lack of access to potable water supply is attributed in most areas to the topography – whereby many settlements are located on hilly areas. As a result water borne diseases like diarrhoea are endemic in the basin due to drinking of contaminated water and many people suffer from gastrointestinal diseases.

The traditional land inheritance system is also linked to environmental degradation and ultimately poverty because it creates land fragmentation and perpetuates disputes within families and encroachment into protected areas. In addition, small land holdings do not ensure food security, hence poverty among the local communities.

Inadequate pasture lands makes livestock keepers to migrate and cross into neighbouring countries to obtain pasture and water for their livestock, leading into transfer of animal diseases such foot and mouth disease. Also, large number of livestock leads into increased land degradation and soil erosion – hence poverty.

The livestock-keepers are also associated with haphazard bush fires as they usually burn vegetation to stimulate growth of new green pastures for their cattle. Lack of peace in the basin is another factor contributing to poverty as livestock keepers usually came into conflict with natural predators, park warden and local farmers.

7.2 Beneficial Uses of Environmental Resources in the Kagera River Basin

The understanding and appreciation of the functions and beneficial uses of the existing environmental resources in the Kagera basin by various stakeholders and policy makers is an important strategy to influence decision-making on the sustainable development in the basin. The important environmental resources in the Kagera basin include natural forests, wetlands and fresh waters, which occupy about 29% of the total basin area (ref. Figure 2.15).

The existing environmental resources have both direct and indirect values. ***Direct values*** can be in terms of production and consumption of goods such as water, crops, fish, wild foods, medicines, handcraft materials, building materials, timber, fuel wood, charcoal, sand, clay salt, etc. The existing forests, woodlands and wetland ecosystems contain numerous plants that can be directly harvested to provide food, medicine, building materials/handicrafts, timber, fuel wood and charcoal for the local people. The wetland areas can also be used to obtain sand, clay and gravel for housing construction purposes.

Indirect values occur in terms of provision of ecological goods and services by wetlands and natural vegetation. The wetlands ecosystems act as buffering systems in controlling flood hazards, regulation of water flows, purification of water, ground water recharge, and amelioration of sediments and retention of nutrients/toxins. The wetlands also help to stabilize micro-climates through the hydrological cycle and provide natural habitats for wildlife and biodiversity conservation.

7.2.1 Forest and Woodlands

Natural forest and woodlands resources can provide multiple benefits, which can be ecological, economic, social and/or cultural to the local communities of an area (UN, 1992). The distinction between forests and woodlands is that forests are dominated by tall trees and dense canopy cover with herbaceous vegetation but without grass underneath (Hamilton, 1994). On the otherhand woodlands are characterised by short trees with less dens/open canopy and undergrowth is comprised of mixture of grass and herbaceous vegetation.

The contribution of the forests and woodlands ecosystems in the Kagera basin could be substantial but so far there is no evidence of the valuation of their contributions to the economic development and well-being of the population and the basin countries. Studies carried out in Uganda indicates that the forests and woodlands contribute about 6% of the country's GDP in 1994, with an annual turnover of about US D 356 billion and annual value estimated at US D 112 billion was attributed to environmental services (NEMA, 2000). It is therefore evident that forests and woodlands have significant economic benefits and can therefore provide opportunities for poverty alleviation. The important benefits provided by forests and woodland resources include energy (fuel wood, charcoal), employment, provision of environmental services and biodiversity conservation, including unique genetic resources and maintenance of diverse ecosystems. They also provide a potential source of eco-tourism as they act as natural habitat for many variety of wildlife and provide natural beauty on a landscape.

7.2.2 Wetlands

The Kagera River basin is comprised of two types of wetland ecosystems, those associated with lakes (*lacustrine*) –such as Lake Rweru, Cyohoha and Ihema swamps and those associated with rivers (*riverine*) such as the Nyabarongo, Mugesera and Akanyaru swamps as well as Upstream of the Rusumo Falls on the Kagera River. The wetlands provide potential areas for hunting / fishing, cultivation, livestock grazing and source of raw materials for construction and handcrafts. The wetland areas also play an important role in protecting the river and lakes from siltation/sedimentation and/or pollution due to their ability to filter sediments and retain nutrients and pollutants. They also help in the prevention of flood hazards, water flow regulation, drought alleviation, stabilization of the hydrological cycle, ground water recharge and maintaining the micro-climate. In addition, the wetlands provide a natural habitat for biological diversity and act as a source of genetic material for developing disease resistant varieties of crops through hybridisation. Wetlands ecosystems can also be utilized for waste water treatment, recreation and eco-tourism purposes.

For example, a household in rural areas in Uganda has been estimated to get up to USD 200 per year by harvesting papyrus grass for a wetland area, and in commercial terms wetlands have been found to provide potable water supplies valued at about USD 25 million per year (NEMA, 2000).

7.2.3 Water resources

The Kagera River basin contains an abundant water resource that can be utilized for economic development. Most of the water in the basin is recharged through seasonal rainfall. The surface water resource provide a potential source of water for domestic use, livestock and agriculture (irrigation), as well as industrial and hydropower production.

There are no sufficient data on ground water potential in the basin but in Rwanda ground water potential, which is still under-utilized has been estimated to be about 66 cubic metres per second (m^3/s) and about 22,000 sources with discharge rate of about 9.0 m^3/s.

The use of water resource for irrigation is still not well developed in the Kagera basin and there is still limited involvement of private sector in water supply development for irrigation. However, when fully developed, irrigation can result into degradation of aquatic ecosystems such as wetlands, leading into loss in their productivity and biodiversity as well as fisheries activities. Thus, it is important to develop a highly productive irrigation of small areas that can replace marginal lands for growing crops but at the same time improving the environmental performance to ensure long-term sustainability.

7.3 Development and Protection of Environmental Resources in the Kagera Basin

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.

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

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.

The 1994 genocide in Rwanda resulted into huge population disruptions – including about 3 million internally displaced people – which seriously exacerbated the environmental problems in the agricultural sector and contributed to increase in poverty levels.

The massive return of refugees from Burundi, Tanzania, Uganda and the DRC further increased land scarcity, accelerated land degradation and deforestation. This has resulted into significant reduction of Giswati Forest Reserve from 417,000 ha before 1994 to about 226,000 ha and Akagera National Park to about 85,000 ha - less than one-third of its original size. This has led to significant loss of biodiversity in the area. Also, poor soil fertility in areas adjacent to the protected areas and forest reserves has contributed to encroachment into the protected areas. The impacts of deforestation are many, including destruction of habitat, reduction in water catchment potential, soil erosion, and land slides, siltation of water bodies, forest degradation, reduced agricultural production and loss of other environmental functions (World Bank, 2005).

7.3.2 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.

For example, significant wetland degradation has already occurred upstream of Rusumo Falls, in the vicinity of several lakes south of Akagera National Park (Lakes Rweshikana, Ihema, Hago). Lake Rwihinda – which contains variety of migratory and sedentary birds - has been affected leading into destruction of avifauna due to agricultural activities, leading into complete degradation of *Combretum* species. Increasing human waste loads are also resulting into reduction in the buffering and filtering capacity of the existing wetlands, because the basin is receiving significant quantities of raw sewage and possibly industrial effluents from rapidly expanding urban 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.

7.3.3 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.

7.3.4 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. For example, studies of important species of fish in Lake Ihema indicated *Clarias ganepinus* and *Haplochromis* to be more exploited that other species, hence threatening their existence (Mughasha, 1989). Selective harvesting/logging of hard wood tree varieties like “mvule” (*Melicea excelsa*) and the introduction of exotic trees monoculture (e.g. euclyptus, pines, etc.) can also result into significant loss of biodiversity.

Introduction of new varieties with ability to outcompete indingenous and traditional varieties is also a biodiversity concern. The introduction of exotic species of fish (*Lates niloticus*) in Uganda in 1950s and 1960s reduced the number and size of the indigenous fish population of Tilapia (*Oreochromis niloticus* and *Oreochromis macrochir*) in Lake Victoria (NEMA, 2000). Again, the introduction of *Astatoreochromis alluandi, Schilbe mystus* and *Cyprinus carpio* in 1972 into Lake Ihema was found (Mugasha, 1989) to threaten the existence of indigenous species of fish such as *Tilapia leucosticta, Tiliapia variabilis,* and *Tilapia esculanta*. The introduction of alien species can also cause biodiversity loss and attract disease transmitting vectors. For example, the introduction of exotic ornamental plants like *Lantana camara* resulted into colonization of large area of land in Uganda (NEMA, 2000) –replacing the indigenous shrubs and became a suitable habitat for tsetse fly, which transmit *Tryponosomiasis* to livestock and possibly sleeping sickness to human being.

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 favours 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, hybridisation 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).

7.3.5 Water hyacinth infestation

(a) Distribution in the Kagera River basin

The water hyacinth plant (*Eichhornia crassipes*) is the world's worst *aquatic weed* species - which was originally native to the neotropics of South America. The term *aquatic weed* has been defined as an aquatic plant (or group of plants) which is not desired by the manager(s) of the water body where it occurs; either when growing in abundance or when interfering with the growth of crop plants or ornaments (Pieterse, 1990).

Thus, water hyacinth can be regarded as a floating aquatic weed species due to its bulbous air filled petioles - which allow the plant to freely float on water surface. When introduced into the new area it leads into rapid infestation causing serious environmental, social and economic damage to the area. The weed was officially recognized in the Kagera River in Rwanda in 1991 (Taylor, 1991).

The major problems associated with water hyacinth is that it forms a dense mat of enlarged plants which impede light penetration to the water below and thus affects growth of other aquatic plants. The decaying water hyacinth plants tend to reduce oxygen for other aquatic flora and fauna, hence contribute to loss of biodiversity. The presence of a dense mat of water hyacinth also leads to increased evapotranspiration – causing more water to be lost from the river or lake. The other problem with water hyacinth is that it negatively affects navigation, fishing, hydropower generation, water supply and tourism/recreational activities. The problem of water hyacinth is already evidenced in the Lake Victoria – which gets most of it from the Kagera River. The estimated flow of water hyacinth into Lake Victoria from the Kagera River is between 0.2 ha/day and more than 1.5 ha/day (an average of about 0.75 ha/day or 300 ha/year), depending on seasonal river volume fluctuations (Moorhouse et al., 2001).

The Kagera River basin at the border between Tanzania and Rwanda contains a large number of small to medium sized lakes. Since most of these lakes are close and/or connected to the Kagera River they are likely to be affected by the water hyacinth from the River, than those lakes that are far from or not connected to the River. For example, water hyacinth infestation has been observed in Lakes Nasho, Cyambwe, Ihema, Mpanga and Lake Mihindi (large amount) but not in Lakes Lwelo, Bisonga or Rwanyakizinga. However, the degree of infestation varies along the river system as follows:

- Upper most near Ruhengeri to the south of Kigali (light infestation);
- Middle portion to border with Tanzania (moderate infestation) and;
- Lower portion – most of the Akagera National Park (heavy infestation).

The distribution of the water hyacinth indicates that it has infested the Lake Victoria shores and up to the headwaters of the Kagera River in the highlands of the northern Rwanda. In Rwanda it has been identified in the upper reaches of the Mukungwe River, south of Ruhengeri Town at an elevation of 1,645 m.

In the Kagera River basin, water hyacinth has spread southwards along the Mukungwe River until Nyabarongo River confluence, where it continues in a southerly direction, where it joints a small river leading out of Lake Rweru – a transboundary Lake shared by Burundi and Rwanda. From there the River becomes known as the Akagera River – which then flows in an easterly direction passing over the Rusumo Falls along the Rwanda - Tanzania border, where the aquatic weed becomes severely damaged.

The Akagera takes a northerly direction along the Rwanda – Tanzania border passing through the lakes and swampy valley of the Akagera National Park. This leads into infestation of several lakes by water hyacinth – most significantly the Lake Mihindi at the northern end of the Park. However, most of the water hyacinth becomes trapped in the large swamp/lake complex of the Akagera River along the Rwanda-Tanzania border - leading into significant reduction of the amount of water hyacinth travelling downstream to Lake Victoria.

As the Kagera River continues north until it arrives at the Uganda border, whereby it turns eastwards and passes through the Tanzania-Uganda border area. The river flow becomes turbulent near Kikagati in Uganda – where the water hyacinth becomes damaged again (Moorhouse et al., 2000). However, a significant part of the Kagera River (160 km) flows through the flatter areas of Tanzania, which provides a good condition for water hyacinth infestation.

(b) Control Efforts

The control efforts have been on-going in some parts of the Kagera River and the Lake Victoria waters. The first attempt was in 1990 in the upper Kagera River of Rwanda – which was primarily based on manual removal in conjunction with some public awareness campaigns. However, the manual removal was not very successful due to high tonnage of the water weed (>400 tonnes/ha). This was followed by application of biological control methods though introduction of the *Neochetina* weevil species (*Neochetina eichhorniae* and *Neochhetina bruchi*) in Lake Victoria by the Ugandan Government in 1995, then Kenya (January 1997) and Tanzania (August 1997).

The water weeds started to significantly decline in late 1998 and early 1999 due to rapid increase in the population of weevils and the effects of the El Niño rains in late 1997 to early 1998. The El Niño rains resulted into increases in the level of water in the lake – which created high wind and wave action that supported the breakdown of the plants. In addition, some pathogens have been isolated from the plants, which could be linked to the reduction of the plant populations (Godonou, 2000).

The biological control of water hyacinth in the Kagera River system helped to ensure long term control of the aquatic weed in Lake Victoria basin by reducing biomass in source waters. The control efforts in the Kagera River started with funding and technical support from Clean Lakes Inc. (CLI) in collaboration with USAID and the Greater Horn of Africa Initiative (GHAI) through Lake Victoria Water Hyacinth Management Programme and Institut des Sciences Agronomiques du Rwanda (ISAR). In Rwanda the implementation of *Neochetina* weevil species rearing and release efforts started in 2000. Other efforts to control water hyacinth infestation in the Kagera River basin and Lake Victoria are indicated by the formation of the following organs and the corresponding actions taken:

- Inclusion of Rwanda and Burundi in efforts of Lake Victoria basin water hyacinth management activities and formation of East Africa Community (EAC) Ministerial Committee on Water Hyacinth in 1998 – Regional Strategy and Action Plan to further management and coordination of control activities by mid-1999.
- Signing of memorandum of understanding (MOU) in 1997 between Rwanda and Uganda Governments on common agricultural issues to cooperate on water hyacinth management.

- Kagera Agricultural and Environmental Management Programme (KAEMP) of Tanzania – which began weevils rearing, followed by release at several points in the middle Kagera River system in December 1999.
- Establishment of weevil rearing site in September 2000 at Karama Animal Husbandry and Fisheries Unit (An ISAR Branch), about 70 km south of Kigali (Goshoro Commune on shores of Lake Kilimbi near Nyabarongo River. The programme was supported by Clean Lakes Inc. in collaboration with USAID.
- Training of Rwanda and Burundi Government Officials under CLI and USAID cooperation agreement. The training was carried out by Uganda National Agricultural Research Organization (NARO) - Namulonge Agricultural and Animal Production Research Institute (NAAR) and Ministry of Agriculture, Animal Industries and Fisheries / Water Hyacinth Unit (MAAIF/WHU) in 1999.

7.4 Conclusions and Recommendations

7.4.1 Conclusions

The Kagera River basin provides a potential for economic development due to its abundant wetland areas, forests ecosystems which provide important socio-economic benefits to its people. However, the existing environmental resources in the basin are under threat due to a number of problems.

To-date the basin is characterized by high population pressures, low productive peasant agriculture, poor farming technologjes – which together exacerbate land degradation, loss of soil fertility and deforestation due to biomass exploitation (fuel wood and charcoal, timber, etc.). The human encroachment into fragile watersheds is increasingly resulting in loss of natural forests, soil erosion and loss of biodiversity.

The dense settlements and intensive cultivation in the fragile watersheds of the Kagera River basin is increasingly resulting in soil erosion and transfer of nutrients/heavy pollution loads into the rivers. This in turn leads in accumulation of nutrients/pollutants and sediment loads transferred to the Kagera River and ultimately in Lake Victoria, which feeds the Nile River. The resultant effect is increased infestation of the Kagera River, Lake Victoria and Nile River ecosystems by water hyacinth and algal blooms due to eutrophication.

The continued degradation of environmental resources has links with poverty levels of the local communities in the Kagera River basin. These linkages are based on the fact the poor people not only depend on these resources for their livelihood but also are more vulnerable to environmental changes as they live in marginal lands, which are more prone to natural disasters. Thus, understanding of the environment-poverty linkages should help the policy and decision-makers to ensure that development projects in the basin incorporate environmental and social concerns for sustainable livelihood of the poor people in the basin. That means the existing environmental resources should be put into productive use to alleviate poverty among the basin population without compromising their economic, social and environmental sustainability.

There is an indication that the four riparian countries have become aware of environment-poverty linkages, through the mainstreaming of environmental considerations in their PRSPs. For example, the Burundi PRSP has a number of strategies that address poverty and environmental issues. The strategy gives priority to rural development and protection of environment through decentralization and rationalization of natural resource management and environmental protection.

In Rwanda the PRSP considers environment as a cross-cutting issue and environmental degradation is seen as one of the micro-economic structural problems. The strategy requires the government to support positive interventions to ensure environmental protection measures are taken into consideration within various sectors. It proposes micro-economic reforms as one of the strategy to promote environmental protection and ensure sustainable economic development. The involvement of the local communities in labour intensive environmental infrastructure development activities is another strategy to protect environment and create employment – hence poverty alleviation.

The Tanzania PRSP is straight-forward about the environment-poverty linkage as it considers the heavy dependence of the poor on environmental resources. The strategy recognizes the need to incorporate environmental quality indicators in the poverty monitoring systems. In that way it should be possible to identify these levels of dependence and linkages between environment and poverty. Ultimately, it should be possible to identify areas of interventions during implementation of poverty alleviation programmes to ensure environmental protection and sustainable economic development.

In Uganda, the PRSP treats increasing soil fertility loss and deforestation as one of the major environmental problems. The strategy addresses environmental concerns through a sector-wide approach. The strategy seeks to empower the poor on land ownership through land reforms and therefore ensure environment and natural resource protection. The linkage between environmental resources and sustainable economic growth is also taken into consideration.

7.4.2 Recommendations

The important question is how to undertake economic development in the basin without undermining the existing natural resource base. The intention is to carry out environmentally sustainable economic investments, which are geared towards poverty alleviation poverty among the local communities and also to recognize the valuable goods and services provided by the environment to the people of the basin.

Environmental problems are currently reflected in terms of land and water resource degradation (quality and quantity), biodiversity losses and wetland degradation. The major factors leading in these environmental problems include over-grazing, bush fires, use of agrochemicals, soil erosion on steep slopes caused by poor agricultural practices, lack of proper solid and liquid wastes disposal (industrial and domestic), encroachment into protected areas and wetland ecosystems.

The sensitivity of the PRSPs of the four riparian countries on the environment-poverty linkage is a good indication that the environment is being given due consideration in the national development policies. That means the environment is being mainstreamed as one of the cross-cutting issues in the various development sectors. However, the mainstreaming of environmental issues needs to go beyond PRSPs. That means the environment should be treated as a cross-cutting issue in all sectors of the economy at both micro and macro levels. For example, environmental expenditure should be reflected in the Public Expenditure Reviews and Medium Terms Frameworks (MTFs) of all countries. The environmental mainstreaming should be reflected in the budgetary allocations of various sectors of the economy at micro and macro levels. However, to ensure that there should be a review of the current policy, legal and institutional framework to incorporate environment as a cross-cutting issue with budget allocation. Such a budget should help the institutional strengthening and capacity building for various environmental agencies to ensure effective implementation of environmental management and monitoring as well as enforcement of existing environmental laws and by-laws. In addition, the local communities in the basin should be sensitised on environmental issues, especially on the relationship between environmental degradation and poverty. The existing national policies and legislations, including environmental standards and guidelines among the four riparian countries should be harmonised.

From the above observation it seems all national development programmes in the basin incorporate environmental protection and natural resource conservation concerns. In this case, it is important to identify development programmes and strategies that create the enabling environment for economically and environmentally sustainable development investments. In order to achieve that the following specific recommendations are proposed:

Kagera River Basin Environmental Management and Information System

Support the establishment of an *Environmental Management Information System* for the Kagera River Basin in a manner which is integrated into the *Management Information System* for whatever institutional arrangement is finally agreed for management of the basin (ref. discussion and recommendations on institutional arrangements in section 5.4.2. This will include establishment of a *water resources development and environmental monitoring programme* responsible for surface and groundwater surveys and water quality monitoring, which should also include establishment of one or more water quality laboratories.

Carry out detailed survey to develop inventory of the existing protected areas and biodiversity *hotspots* and establish their legal status and boundary demarcations to prevent future encroachment into these areas. In addition, all important wetlands must be surveyed documented and declared protected areas.

Carry out environmental-economic valuation of the existing environmental resources such as pasture / rangelands, wildlife, water resource, wetlands, etc., to determine / establish their real economic values. This information should be used as one of the criteria for economic investment and trade-off discussions in the basin.

Harmonization of Regional Environmental Management and Quality Standards

Develop and harmonise policy, legal and institutional mandates regarding implementation of environmental management and economic investments in the basin. This should include environmental quality standards and Environmental Impact Assessment (EIA) guidelines for all investment projects in the basin. An effective river basin organization or management unit for the Kagera River basin could facilitate the negotiation of agreed transboundary EIA guidelines.

Support to the Integrated and Community-based Watershed Management Programme

The following activities will support the implementation of the Integrated and Community-based Watershed Management Programme presented in Section 0:

Promote pasture management through introduction of ranch system and zero grazing to discourage the current system whereby pasture / rangelands are being over-grazed by nomadic pastoralists, searching for good pasture and water for their livestock. This should also go in parallel with promotion of livestock auctioning / marketing to reduce number of livestock, improved internal and external market for livestock products.

Agriculture in the basin is still largely rain-fed, the land and soils are heavily cultivated and the majority of farmers are technically ill-equipped to maximise production under these circumstances. It is therefore proposed that agricultural extension services should be improved to assist farmers develop good cultivation and irrigation practises that can increase yield per hectare in a small land. This programme should include activities like agro-forestry and tree planting to minimize soil erosion and improve soil fertility.

Lack of land ownership security seems to be one of the factors leading into environment and natural resource degradation because people tend to exploit land / environmental resources for short-term financial benefits. Thus, land reforms should be implemented to ensure that the poor people obtain land rights and gain land ownership security.

Promote investment on labour intensive environmental infrastructure development activities such as terracing, contour making, construction of storm water drainage systems, roads. This will help to protect the environment and at the same time create employment for the local communities.

The agricultural production in the basin is largely dependent on rainfall and is carried out without taking any protection measures to minimize soil erosion. This leads into increased sediments loads transfer into the river. The local communities in the basin are also faced by lack of capital and limited agricultural technology to cope with increasing population growth and increasing demand for food supply. It is therefore recommended that intervention should be made to promote irrigation and soil conservation programmes.

Support to the Water Supply and Sanitation Programme

The following activities will support the implementation of the Potable Water and Sanitation Programme presented in Section 10.4:

Lack of good sanitation facilities and hygiene is one of the potential problems that contribute to pollution of surface and ground water resources in the basin. To alleviate this problem there is a need to develop environmental sanitation and hygiene programmes. These programmes should be geared at promoting private sector investment in sanitation infrastructure (e.g. construction of Ventilated Improved Pit (VIP) latrines, water borne toilets, etc).

Promote involvement of private sector in the development water resources (ground and surface). This will alleviate the current problem of increasing demand and lack of accessibility to good quality water by the majority of the population in the basin.

7.4.3 Proposed investments in support of Environmental Management in the Kagera River basin

The following table summarizes the estimated costs to support the environmental management aspects of water and related resources in the Kagera River basin:

Table 7.1 – Environmental Management in the Kagera River Basin - Summary of Potential Investments

Environmental Resources	US$ (million)
Kagera River Basin Environment Management Information System	
Establishment of Environmental Management Information System	5
Protected Areas - Inventory Study	1.5
Environmental Beneficial Uses - Valuation Study	1.5
Water Resource Development and Environmental Monitoring Programme	12
Harmonization of Environmental Quality Standards	1.5
Total:	**21.5**

8. Fisheries and Aquaculture

8.1 Importance of Fisheries and Aquaculture

Fresh water fisheries are one of the important sectors that support the livelihood of local communities and economies of most African countries. For example, it is estimated that inland fisheries provide annual export earnings of about USD 3,000 million in Africa and provide health support of 200 million people in terms of protein and income to the over 10 million people who engage in production, processing and trade (UNEP, 1999). Other estimates indicates inland fisheries contribute about 60% of fish consumed in Tanzania and that about 60% of the total protein intake in Malawi comes from fresh water fisheries (UNEP, 1999). Lake Victoria has been found to generate an annual GDP of about USD 3 to 4 billion and provides more than 25,000 people with an annual income of between USD 90 to 270 per capita.

Thus, there is no doubt that the fisheries sector plays an important role in poverty alleviation among the local communities of a number of African countries. However, those benefits continue to be at risk due to over-exploitation and poor fishing practise (FAO, 2004), while at the same time no significant effort has been undertaken to promote aquaculture fisheries. To-date the fisheries industry in Africa is characterized by poor fishing habits, such as use of poisoning agents and dynamite. This not only results into negative long term cumulative impacts due to destruction of natural habitat for growing fish stocks and other larval forms of aquatic life on which the same fisheries is dependent upon.

The fresh water fisheries could be improved if strategic investments were put in place to safeguard the contribution of this important sector in poverty alleviation and economic development in general. These investments should include improved management of natural fish stocks, development of aquaculture production and enhancement of fish trade at the domestic, regional and international markets levels (UNEP, 1999).

In the Kagera River basin the capture fisheries could be one of the important economic activities, in addition to timber trade, agriculture, livestock keeping and brick production. However, there are no comprehensive data on capture fisheries in the basin. Nevertheless, some information does exist from some basin countries such as Rwanda and Burundi.

8.2 Status of Capture Fisheries and Aquaculture in the Kagera River basin

8.2.1 Capture Fisheries

(a) Productivity

The available information shows significant capture fisheries are carried out in small lakes in Rwanda (PAIGELAC / MINAGRI, 2006) and in the Burundi (FAO, 1998) portions of the Kagera River basin. In Rwanda the important lakes include the Akagera National Park (NP), Nasho, Gisaka and Bugesera Complexes.

The Akagera NP Complex is comprised of Lake Ihema, Kivumbo, Hago, Mihindi, Rwanyakizinga and Rwakibara Lake, which together occupy about 184.2 km². The Nasho Complex is formed by Lake Nasho, Cyambwe and Mpanga, with a total area of about 44.9 km². The Gisaka Complex, which is comprised of Lake Mugesera, Sake and Bilira occupy a total area of about 58.7 km². Finally, the Bugesera Complex is formed by more numerous small lakes. These include Lake Cyohoha South, Rweru, Gaharwa, Kilimbi, Mirayi, Rumira, Kidogo and Gashanga, which in total occupy about 58.4 km².

Other important lakes where capture fisheries are carries out include Lake Muhazi, Burera and Ruhondo, with a total area of about 114.2 km². Thus, in total the Rwanda side of the Kagera River basin has total fishable lake areas of about 424.4 km².

According to 1992 estimates the capture fisheries could produce about 1,200 metric tonnes of fish per annum and employ about 2,170 people (PAIGELAC-MINAGRI, 1993). Another estimate carried out in 2006 shows the freshwater lakes can produce about 2,500 metric tons of fish per year and create employment of about 4,298 people[139]. However, other studies (Mughanda, 1989) shows the fish production potential, especially for *Cichlids* (3 species of *Tilapia*) introduced in 1950 have the average production potential of about 1,500 and 900 metric tons per annum in Lake Rweru and Cyohoha, respectively.

Table 8.1 shows the status and production potential of capture fisheries in the Kagera River basin lakes.

Table 8.1 – Status and Production of Capture Fisheries in the Kagera River basin Lakes[140]

LAKES	SURFACE AREA (KM^2)	PRODUCTION TONS / YEAR		NO. OF PEOPLE EMPLOYED	
		1992	2006	1992	2006
1. Akagera Lakes	148.2	231.8	NA	90	NA
2. Nasho Lakes	44.9	152.0	94.0	192	
3. Gisaka Lakes	58.7	282.0	2080	560	
4. Bugesera Lakes	58.4	388.9	76.8	438	
5. Lake Muhazi	34.1	75.0	151.2	646	
6. Lake Burera	54.0	27.0	75.4	94	
7. Lake Ruhondo	26.1	47.0	2.2	150	
TOTAL	**424.4**	**1203.7**	**2479.6**	**2170**	**4298**

[139] Plan Directeur Pêches et Aquaculture, 1993

[140] Source: Plan Directeur Pêches et Aquaculture, 1993 ; Rapport annuel 2006 et Rapport mois d'Août 2007, PAIGELAC-MINAGRI

In Burundi, capture fisheries activities are conducted in Lake Rweru, Cyohoha, Kanzigiri, Gacamirinda and Rwihinda with a total area of about 19,390 Ha, of which about 15,545 ha are in Burundi side. According to 1984 estimates for Lake Rweru and Cyohoha the recorded production was 350 - 400 and 50 metric tonnes of fish per year, respectively. However, the potential production for these lakes was estimated at 400 metric tonnes per year for Rweru and 200 metric tonnes per year for Cyohoha – potentially employing about 200 and 50 people, respectively.

The other lakes such as Kanzigiri, Gacamirinda and Rwihinda have a total production potential of about 100 metric tonnes of fish per year and capable of employing 30 people. This makes the total production potential for all the basin lakes in Burundi to be estimated at 700 metric tonnes per year, with ability to employ about 280 people. The status, recorded and potential fish production for the Burundi side of the Kagera Basin is shown in Table 8.2.

There is no information on capture fisheries activities in the Tanzania and Uganda portion of the basin. However, unlike Uganda the Tanzania side contains some lakes which provide some potential on capture fisheries, such as Lake Rushwa, Rwakanjaju and Ngoma. Thus, there is a need to carry out a study to establish the fish production potential of these lakes.

Table 8.2 – Status and Production of Capture Fisheries in the Kagera River basin - Burundi[141]

LAKES	TOTAL AREA (KM^2)	AREA IN BURUNDI (KM^2)	RECORDED PRODUCTION TONS/YEAR	ESTIMATED POTENTIAL TONS/YEAR	NO. OF PEOPLE EMPLOYED
1. Rweru	10,200	8,000	350-400	400	200
2. Cyohoha	7,850	6,125	50	200	50
3. Kanzigiri	750	750			
4. Gacamirinda	250	250			
5. Rwihinda	340	340			
TOTAL	**19,390**	**15,465**		**700**	**280**

(b) Current Status

The current status of capture fisheries in the Kagera River basin shows that the fish stocks in the majority of lakes in Rwanda side have been over-exploited. The Akagera NP Complex seems to provide a great potential for capture fisheries but fishing activities in this area have as the lakes are protected within the National Park.

Capture fisheries production in the Kagera River basin is faced with a number of problems, including uncontrolled fishing methods and lack of proper fishing gear whereby immature fish stock are capture leading into complete extinction. Sometimes the local people use poisoning and dynamite fishing, which leads into complete destruction of the lake ecosystem and extinction of fish and other related organisms from the lake.

Continued dependence on one type of species also leads into their extinction and loss of biodiversity. For example, some studies carried out in Lake Ihema (Mughanda, 1989) shows species preference was mainly on *Clarias gariepinus, Haplochromus Group,* and other *Tilapia* species such as *Marcusemus victoriae, Alestes Sp., Synodontis Spp, Gnathonemus longibarbus,* and *Schilbe mystus.*

Capture fisheries problems are also compounded by lack of extension services to educate the local community on sustainable fishing methods and lack of infrastructure for fish preservation

[141] Source: FAO (1986)

and processing. So far there is no monitoring of fishing activities being carried in the Kagera River basin, as can be reflected by the absence and/or inadequate information on fisheries activities in the area. The introduction of some alien species also leads into extinction of indigenous types. For example, the introduced species like *Protopterus aethiopicus* in 1984 became a predator to indigenous *Cichlides* and *Clariides*. Other threatened species include *Tilapia leucosticta*, *Tilapia variabilis* and *Tilapia esculenta* – which were introduced into Lake Ihema in 1972 (Mughanda, 1989).

8.2.2 Aquaculture Fisheries

The fisheries industry can play an important role in ensuring food security, economic development and poverty alleviation among the local people in the Kagera River basin. However, these benefits are being jeopardized by a number of factors such as increasing over-exploitation of natural fish stocks, pollution of the basin waters from industrial effluents, domestic sewage and agrochemicals.

The introduction of aquaculture could be one of the strategies to alleviate the problem and ensure sustainable fish production and environmental protection. Aquaculture technology could also provide an alternative to capture fishing in the existing lakes and rivers, hence preserving their biodiversity. It could also help the local people engage into other productive activities as they will serve time usually being waste in capture fishing activities.

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 ccould be established.

Currently, aquaculture is being initiated in Rwanda through support from the PAIGELAC, ADB and MINAGRI Projects. The current status shows the involvement of some Cooperatives and Associations in aquaculture production. So far no production of fish has been recorded, but to-date there are about 37 Cooperatives and Associations which have constructed 260 fish ponds with a total area of about 17.3 ha and employing 2,572 people (PAIGELAC, 2006). Table 8.3 shows the locations and number of aquaculture stations in Rwanda.

Table 8.3 – Distribution of Aquaculture Stations in Rwanda[142]

LOCATION	NUMBER OF COOPERATIVES/ ASSOCIATIONS	NUMBER OF FISH PONDS	AREA COVERED (Ha)	NUMBER OF PEOPLE EMPLOYED
Eastern Province	13	39	1.8	900
North Province	6	90	4.3	437
South Province	15	73	3.4	1000
KIGALI	3	58	8.4	235
TOTAL	**37**	**260**	**17.9**	**2572**

[142] Source: Annual report, PAIGELAC-MINAGRI, 2006

8.3 Conclusion and Recommendations

8.3.1 Fisheries potential, policies and guidelines

Fisheries and aquaculture provide great economic potential and could play an important role in poverty alleviation for local communities in the Kagera River basin. However, the industry presently faces poor management practices due to lack of proper fishing and fisheries technologies, as most the fishermen depend on fish poisoning and dynamite. This practice is not only environmentally hazardous but leads to total destruction of natural habitats on which the same fish depends. In addition to lack of fisheries technologies, aquaculture has not yet been introduced as an alternative to capture fisheries production in the basin.

It is recommended that the basin countries develop strategies to ensure that stakeholders, policy makers and the local communities understand the importance of the fisheries industry in the basin to development and poverty alleviation. The strategies should focus on introducing and developing aquaculture as a means of sustainable development of the fish industry. The introduction of aquaculture can be used as one of the strategies to reduce dependence of local communities on capture fisheries which seem to be unsustainable. Through aquaculture, some local communities could be self-sufficient in food protein and income generation as they could be able to sell excess to external markets. However, access to external markets will also depend on improved roads and other communication infrastructure, which should also be considered in the basin development scenarios.

However, there must also be established and put in place appropriate guidelines to ensure sustainability of aquaculture as a part of the ecological process. That means it is important to recognize the dependence of aquaculture on natural ecosystems. Therefore, development of aquaculture must be accompanied by feasibility studies which incorporate environmental considerations.

8.3.2 Aquaculture development programme

A possible investment programme which could be introduced into the upper parts of the Kagera River Basin, whereby there are numerous small lakes / wetlands but fish scarcity is currently high due to over-exploitation of the natural fish stock in most of the existing lakes. For example, in Rwanda there is a potential to increase fish production through aquaculture from the current estimates of 2,500 to 17,000 t/yr by the year 2012 and 23,000 t/yr in 2020. This objective can be achieved through promotion of aquaculture fisheries. The governments should encourage the financial institutions to provide loans to the private investors. Tanzania and Uganda are already practising aquaculture in other parts of their territories. For example, according to FAO report in 2000 Tanzania and Uganda produced about 10,500 and 7,000 metric tonnes of fish from aquaculture activities. This shows how aquaculture if implemented could contribute to economic development and alleviate poverty among the local communities in the basin.

A programme of developing 1,000 ha of aquaculture ponds and associated facilities over a period of 10 years is proposed. The estimated cost for such a programme would be USD 50 million[143] over the 10 year period, or about USD 5 million/year. The benefits of such a programme could be:

- Increased availability of food protein for the local communities.
- Increased income by selling fish.
- Creation of employment.

[143] Based on discussions with Mr Gregore D.M., Rwadad MINAGRI, estimated cost of developing 1 ha of aquaculture pond and associated facilities is USD 50,000.

- Protection of aquatic environment of the existing lakes – which could lead into increase in fish stock in the basin lakes.
- Time saving by local people, which is usually lost in capture fisheries by local people

8.3.3 Fisheries management in association with multi-purpose dams

The reservoirs created by the proposed hydropower dams in the Kagera River basin (Rusumo Falls and Kakono) offer the possibility to develop fisheries production. The fisheries management associated with these dames could include boating facilities (docks, etc.) ice production, service centres, refrigeration, pisciculture, fish processing (e.g. smoking) facilities, etc. which are estimated to cost approximately USD1 million per dam.

8.3.4 Proposed investments in support of Fisheries and Aquaculture

The following table summarizes the estimated costs to support the fisheries and aquaculture management in the Kagera River basin:

Table 8.4 – Fisheries and Aquaculture in the Kagera River Basin - Summary of Potential Investments

Fisheries and Aquaculture	US$ (million)
Aquaculture development programme	50.0
Multipurpose dam, fisheries management	2.0
Total:	**52.0**

8.4 Recommendations for Further Study

Conduct an integrated study which will set up a strategic management plan of water bodies for the development of fisheries and aquaculture within the basin. The plan will include institutional and regulatory arrangements and technical aspects (introduction of improved and harmless species, appropriated techniques and equipment for fishing, conservation, transportation and transformation and market), etc.

9. Energy and Hydropower

9.1 Energy, development and poverty reduction

The links between energy, development and poverty reduction are well known (Lamech and Sullivan, 2002). Households require energy first to satisfy basic consumption needs, and then as their income increases, to obtain welfare-enhancing amenities and energy for economic growth and development:

Basic consumption needs: A minimum amount of energy enables cooking of food to meet nutritional requirements, illumination for homes and heating in cold climates.

Welfare enhancing amenities: Additional energy enables commercial cooking, community and educational and institutional lighting, appliances such as fans for comfort and refrigerators for food preservation, potable water and sanitation systems, access to information, entertainment and communications, and access to health care.

Women and energy: Women are adversely affected by inadequate energy supplies as they affect health and education, transport and water supply (women are often responsible for collecting potable water), labour in crop tending, harvesting and processing, cooking and child care, collecting biomass fuels and labouring in agricultural activities, as well as potential income generation activities in the informal sector that depend on modern energy services.

Energy and economic growth and development: Factories, farms, shops, trading, transportation and construction are the engines of economic growth. All such enterprises benefit from readily available energy supplies.

9.2 Status and projected demand for energy in the Kagera Basin

9.2.1 Introduction

In the Nile Equatorial Lakes region as a whole, and the Kagera River basin in particular, the present lack of a reliable supply of electricity adversely affects the quality of life and severely constrains economic development throughout the region. Only a very small proportion of the population – between 2 and 7% in the Kagera basin - has access to electric power. In urban centres, power supply is unreliable and, in some areas available for fewer than six hours per day. While larger facilities such as hospitals, hotels and government buildings have access to back-up diesel generating units, the general population has to go without refrigeration, effective lighting and ventilation for long periods of the day. In rural areas, the absence of electric power supply has resulted in reliance on expensive fossil fuels for generators and wood or charcoal for most domestic purposes, thus contributing to deforestation and adding to the workload of women and children.

The analysis draws primarily from the Social Sector Strategic/Sectoral, Social and Environmental Assessment of Power Development Options in the Nile Equatorial Lakes Region (SSEA) prepared by SNC-Lavalin International in February 2007. The SSEA was conducted over a three-year period (2003-2006) in two stages within the framework of the NBI/NELSAP. The analysis takes a regional approach including all of Burundi, Kenya, Rwanda, Tanzania and Uganda, and the eastern part of the DRC.

Key elements of the process included:

- A period of forecast analysis of about 15 years to 2020.
- A participatory approach in soliciting stakeholder inputs in key steps in the SSEA study.
- Use of existing data as well as information provided by the East African Community Power Master Plan and national master plans.
- Consideration of the legal and regulatory framework of each of the countries as well as relevant international agreements and conventions.
- Assessment of possible impacts of climatic changes.
- Ranking of power development options according to cost, environmental, social and risk factors.
- Preparation of example portfolios of investments to satisfy alternative development strategies and load growth scenarios.
- Preparation of a NELSAP Indicative Power Development Strategy to guide future investment planning.

Although the SSEA study was a regional study encompassing the entire Equatorial Lakes region, and the scope of this monograph is the Kagera River basin, we believe the approach and conclusions are directly useful and relevant:

- Kagera basin data and information about energy production and use are certainly available they have not been compiled and collated at the basine scale. Such acquisition and collation would take quite some effort to obtain and we furthermore believe this is outside the scope of this Consultancy, and unnecessary to assess the energy and hydropower needs and potential of the basin.
- We further believe that because the fact that energy production and use goes beyond basin and country borders it is in fact less important and relevant to aquire such data at the Kagera basin level and for the purposes of this monograph, the regional data and information available under the SSEA is adequated.
- Furthermore we are fortunate that the SSEA is a very recently completed study carried out with extensive consultations over a period of several years and subject to extensive review and revision.

Key conclusions from the SSEA assessment that are directly relevant to the Kagera basin are as follows:

- 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!
- The amount of electric energy demand by current customers exceeds the amount that can be provided reliably by electric power producers.
- Electric power demand forecasts were linked to historical trends, which implies a continuation of, and gradual improvement on the current socioeconomic conditions in the region.

Four load growth scenarios were derived. Three are based on a continuation of the status quo with variations on the assumptions from a *base, low* and *high* rates of growth. A fourth scenario estimates the need for the region to improve significantly enabling a *transformation* of the present economic situation.

Present levels of availability and use of electricity in the region are very low. Current production capacity in the region totals about 1800 MW. Current consumption is overall about 95 kWh/capita/year.

At the end of the forecast period (2020) there can be some improvement depending upon the load growth scenario that is achieved (ref. Figure 9.1).

- *Base* forecast scenario: 103 kWh/capita/year, an increase of less than 10% over current levels of about 95 kWh/capita/year. Total production capacity would be need to be increased by 1500 MW.
- *Medium* forecast scenario: 141 kWh/capita/year, an increase of 53% over current levels but not even half of the current average for all of Africa (even excluding the wealthier countries) of 320 kWh/capita/year. Total production capacity would need to be increased by 2700 MW.
- *High* forecast scenario: 181 kWh/capita/year, 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). Total production capacity would need to be increased by about 4000 MW.

Transformation scenario: 318 kWh/capita/year, an increase to over three times the current level in the region but just equal to the current average for all of Africa excluding the wealthier countries. This is still only about one third of the level reached by the developing countries of the world, even when the wealthier of them are excluded from the comparison. Total production capacity would need to be increased by about 8600 MW.

The regional summary follows:

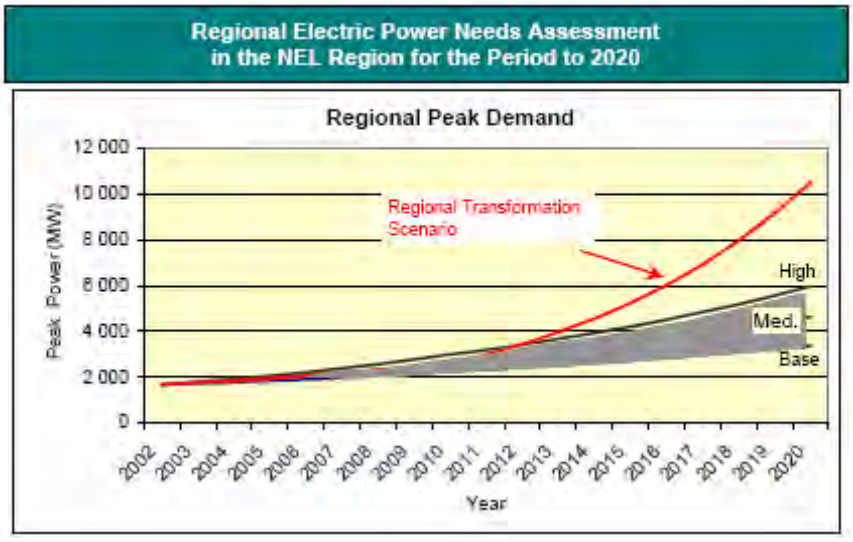

Figure 9.1 – Regional Electrical Power Needs Assessment in the Nile Equatorial Lakes Region (2002 – 2020)

The SSEA provides a comprehensive foundation for planning the development of the power sectors of the region through a proposed *development strategy* and a *NELSAP indicative power development plan* to the year 2020. The assessment and proposals are based on a review of the current environmental and social context, the existing legal and regulatory framework, and assessment of the power needs for the region, an identification of the power development options available in the region and a comparison of these options in terms of environmental, socio-economic and risk considerations. The SSEA includes a preferred project portfolio of options defined as the *NELSAP Indicative Power Development Plan.*

The SSEA report provides a regional assessment going beyond the scope of the Kagera basin and including the full equatorial lakes region. This is considered to be appropriate and the Kagera region hydropower options are presented in this context.

The present status of electrical energy demand in the four Kagera river basin countries are presented with recommendations and conclusions for their development as follows.

9.2.2 Present status

Presently a very small proportion of the population has access to electrical power supply. The present status and installed capacity for the Kagera basin countries is summarized following

Burundi:

Only 2.5% of the population of Burundi has access to electrical supply. The installed capacity in Burundi totals 37 MW of which Kagera River basin hydropower production is about 20 MW summarized as follows:

Table 9.1 – Existing Generation Capacity in Burundi

Burundi				Kagera Basin hydropower		
Name	**Type**	**Capacity (MW)**	**Firm Generation (GWh)**	**Capacity (MW)**	**Firm Generation (GWh)**	**Comments**
Rwegura	Hydro	18	35.7	18	35.7	
Mugere	Hydro	8	19			
Ruvyronza	Hydro	1.3	10.5	1.3	10.5	
Gikonge	Hydro	0.9	2.1			
Nyemanga	Hydro	1.4	12.2			Isolated load
Kayenzi	Hydro	0.8	1.3	0.8	1.3	Isolated load
Mini-hydro	Hydro	1.4	3.1			Isolated load
Bujumbura	Diesel	5.5	--			Backup
	Totals:	**37.3**	**83.9**	**20.1**	**47.5**	

Rwanda:

Only 2.4% of the population of Rwanda has access to electrical supply. The installed capacity in Rwanda totals 41 MW of which about 24 MW is from Kagera River basin hydropower generation summarized as follows:

Table 9.2 – Existing Generation Capacity in Rwanda

Rwanda				Kagera Basin hydropower		
Name	**Type**	**Capacity (MW)**	**Firm Generation (GWh)**	**Capacity (MW)**	**Firm Generation (GWh)**	**Comments**
Mukungwa	Hydro	12.5	48	12.5	48	
Ntaruka	Hydro	11.2	22	11.2	22	
Gihara	Hydro	1.8	9.8			
Gisenyi	Hydro	1.2	8.4			
Gatsata	Diesel	2	15			Recently refurbished
Kigali	Diesel	12.2	65			
		40.9	**168.2**	**23.7**	**70**	

Tanzania:

Only 7% of the population has electricity in Tanzania. The Tanzanian system comprises both hydro and thermal generation units of 555 MW and 230 MW respectively for a total generation capacity of 785 MW. There is presently no hydropower generation within the Tanzanian portion of the Kagera river basin.

Table 9.3 – Existing Generation Capacity in Tanzania

Tanzania				Kagera Basin hydropower		
Name	**Type**	**Capacity (MW)**	**Firm Generation (GWh)**	**Capacity (MW)**	**Firm Generation (GWh)**	**Comments**
Mtera	Hydro	80	420			
Kidatu	Hydro	204	1100			
Hale	Hydro	17	300			3 plants
Kihansi	Hydro	180	540			
Pangani Falls	Hydro	66	580			
Nyumba Ya Mungu	Hydro	8	70			
Ubongo	Thermal	40	280			
Ubongo II	Thermal	80	561			
Diesels II	Thermal	0	0			unused
Tegeta	Thermal	100	657			
Other	Thermal	10	26			total of 4
		785	**4534**	**0**	**0**	

Uganda:

In Uganda, only about 3% of the population has electricity. Electricity is supplied mainly from two hydroelectric plants, namely the Nalubale and Kiira generation stations at Owen Falls. The total installed capacity amounts to 327 MW summarized as follows. There is presently no active hydropower generation within the Ugandan portion of the Kagera basin:

Table 9.4 – Existing Generation Capacity in Uganda

Uganda				Kagera Basin hydropower		
Name	**Type**	**Capacity (MW)**	**Firm Generation (GWh)**	**Capacity (MW)**	**Firm Generation (GWh)**	**Comments**
Owen Falls 1-10	Hydro	180	403			Nalubale
Owen Falls 11-13	Hydro	120	535			Kiira
Other	Hydro	17	0	1	0	Mabiza station in Kagera basin: out of use
Kakira	Thermal	10	60			
Aggreko	Thermal	100	650			
		427	**1648**	**1**	**0**	

9.2.3 Projected demand

Potential electricity demand in the region, merely from the electrification of rural areas is enormous. It is estimated that full electrification could increase the load in the region by a factor of 2.3 times the current load. However, the cost of such electrification would be very high and is considered to be uneconomical unless justified to fulfil social objectives.

Rural electrification programmes are in place for Uganda and Tanzania, but there are currently no clear targets for rural electrification in Rwanda and Burundi, although Rwanda is about to mandate a study of rural electrification. The SSEA study puts forward a load forecasting programme based on what they suggest is a *reasonable* approach between:

- a programme where there is no rural electrification, and
- a programme where there is full electrification.

The SSEA discusses electricity demand in three scenarios where the rate increased by between two time to eight time the current level over the study period.

Burundi:

Burundi experienced severe political and civil strife in the 1990s. Historical demand over the 1981 – 2001 period is shown in Figure 9.2 showing steady growth of about 8% in energy demand from 1981 to 1994, followed by a severe drop in 1995-96, with a return to average 8% growth since.

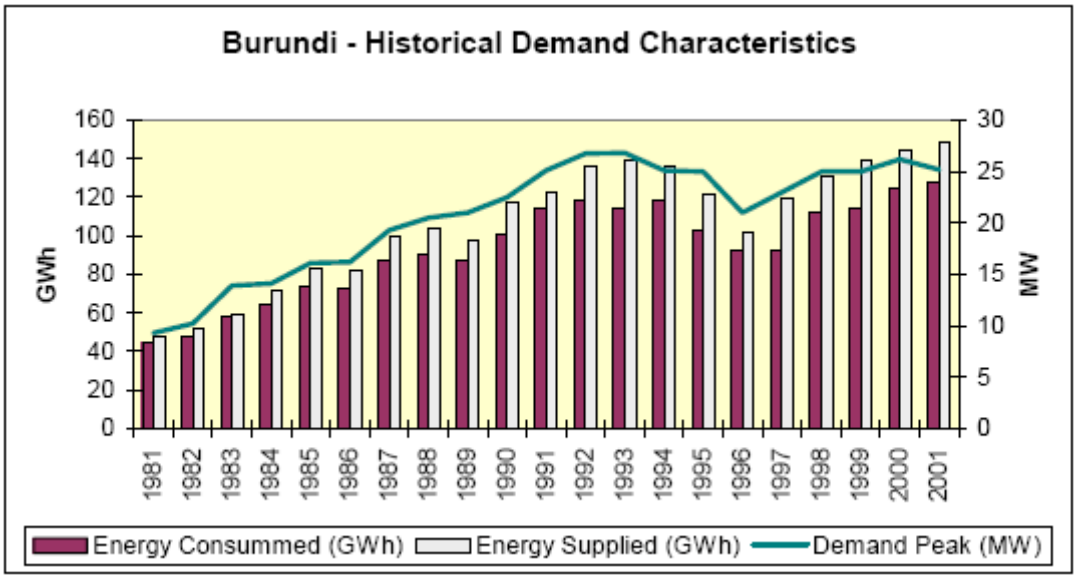

Figure 9.2 – Burundi – historical demand characteristics

Power demand to 2020 has been estimated to increase from the current 2.5% to a *low* of 6%, a *base* case of 15%, and a *high* of 24% in 2020. These projected demands are summarized as follows.

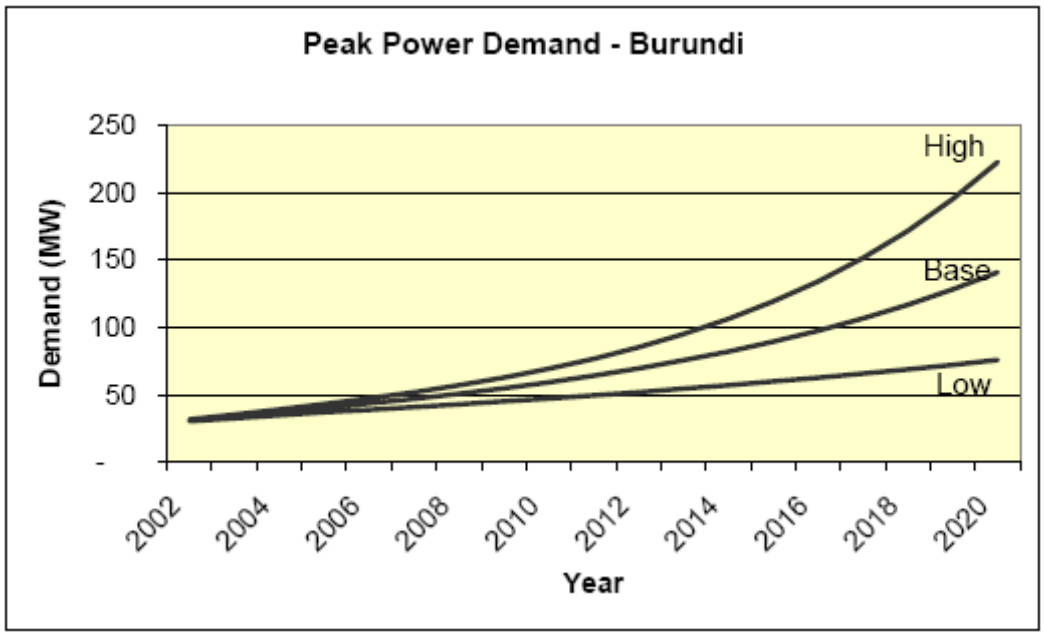

Figure 9.3 – Burundi – Peak power demand forecast (2002 – 2020)

Rwanda:

Like Burundi, Rwanda also suffered civil strife in the 1990s. Historical demand is illustrated in Figure 9.4. In the period 1981-1992 growth progressed at about 8%. From 1995 onwards electrical demand averaged 10% annually.

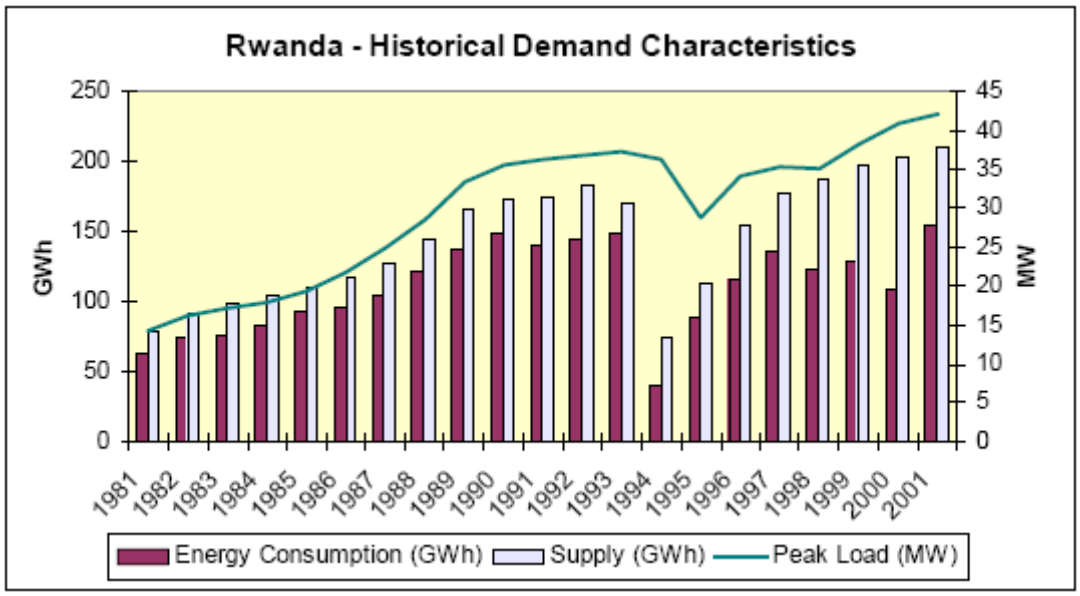

Figure 9.4 – Rwanda – Historical demand characteristics

Low, base and high load forecasts from the present 2.4% to 5%, 13% and 20% in 2020 respectively were made with the following projections:

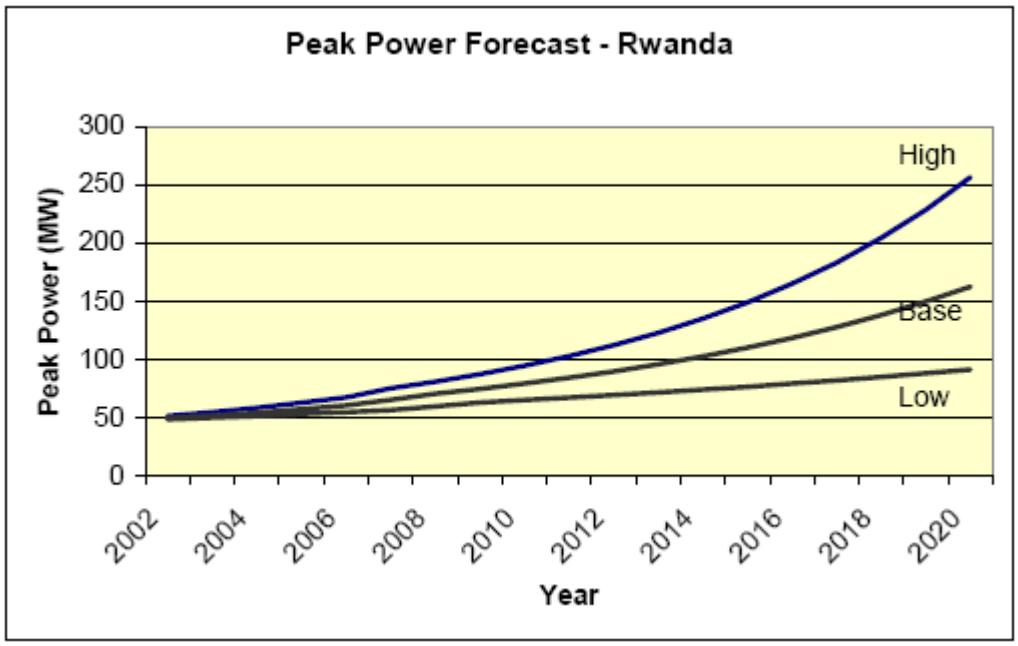

Figure 9.5 – Rwanda – Peak power forecast (2002 – 2020)

Tanzania:

Load forecasts were made for low, base and high growth rates with the following projections to 2020.

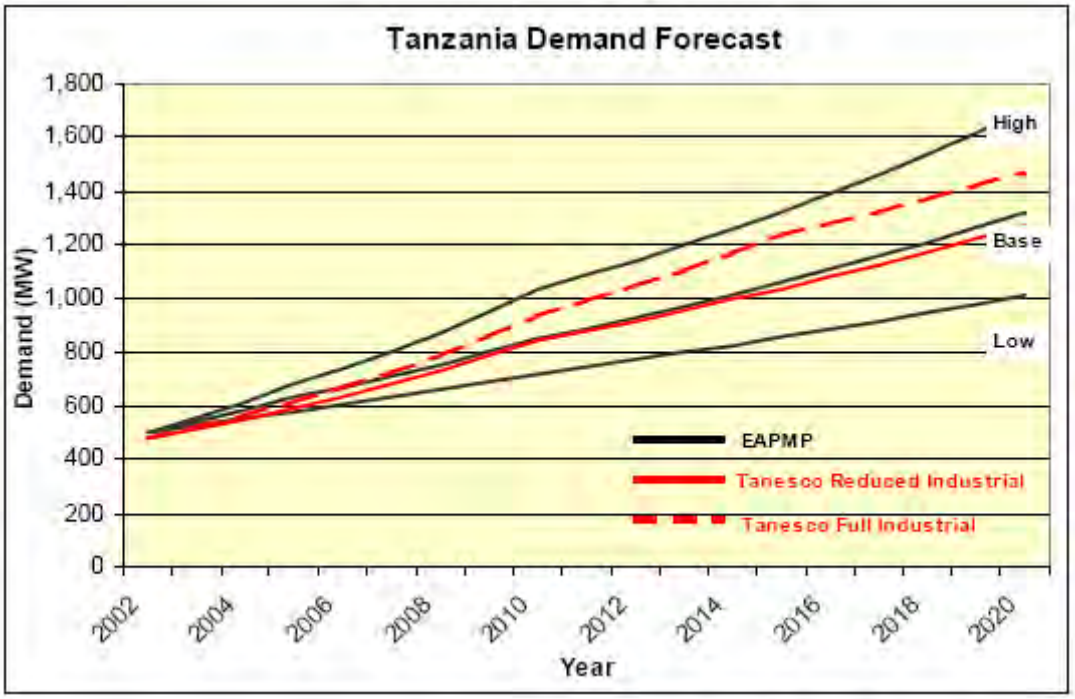

Figure 9.6 – Tanzania – Peak power demand forecast (2002 – 2020)

Uganda:

The people of Uganda have an extremely low electricity access rate of less than 3% on average. This is due to the continuous economic decline through the 70s and 80s and the Uganda Electricity Board's difficulties in managing and expanding the system in the early 90s. During the 90s the improved economy saw the electricity demand increase by over 8%/year.

Low, base and high forecasts were developed based on assumptions enumerated in the SSEA report summarized as follows:

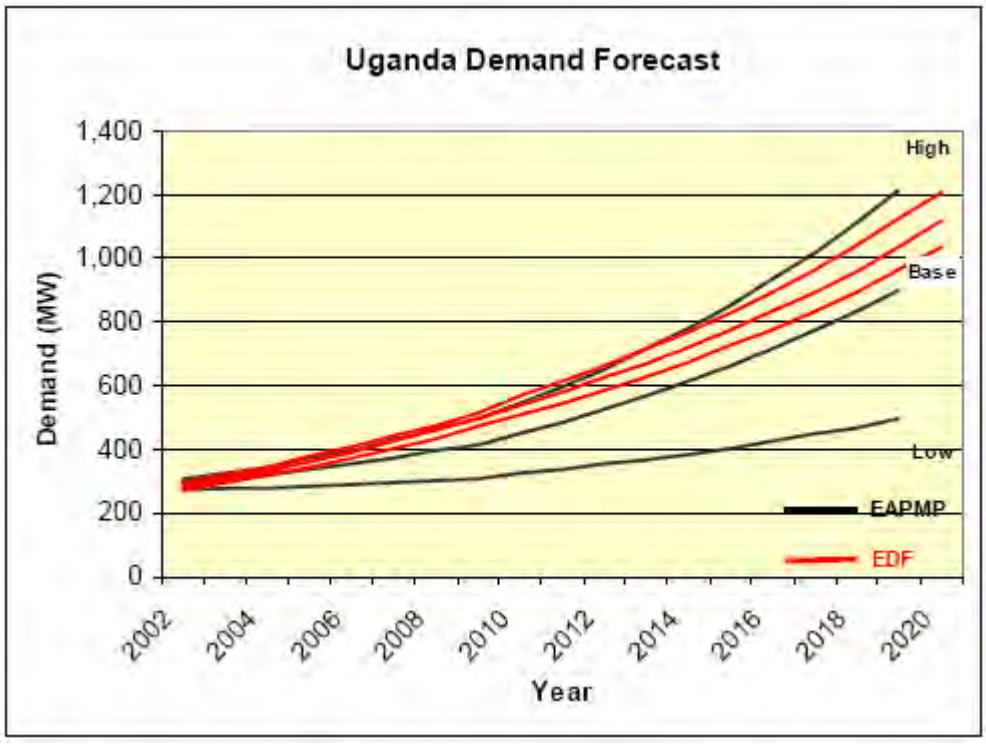

Figure 9.7 – Uganda – Peak power demand forecast (2002 – 2020)

An analysis of existing supply and demand within the equatorial lakes region indicates an already existing power shortage in the region.

Table 9.5 – Existing capacity and demand in the Kagera basin countries

Country	Capacity Available in 2002 (MW)	Estimated Demand in 2002 (MW)	Estimated year of deficit
Burundi	37.3	30	2004
Rwanda	28.3	30	2004
Tanzania	785	500	by 2005-2007
Uganda	327	280	by 2005

9.3 Scenarios for energy development in the Equatorial Lakes Region

In identifying options for developing new electric power generation options, the SSEA first prepared a long list of options without regard for feasibility of their development. This resulted in identification of 9011 MW of hydro capacity and 2395 MW of thermal and geothermal capacity. The subsequent screening according to criteria suggested by the stakeholders and approved by the Project Steering Committee reduced the amount to 1899 MW of hydro capacity and 2095 MW of thermal and geothermal capacity, plus another 30 MW of wind energy conversion.

The power options retained are presented in the following table.

Table 9.6 – Power Development Options Retained for Comparative Analysis – Nile Equatorial Lakes Region

Table 1:
Power Development Options Retained for Comparative Analysis

Options Passing the Screening

Hydro

- Bujagali (250 MW)
- Kabu 16 (20 MW)
- Kakono (53 MW)
- Karuma (200 MW)
- Masigira (118 MW)
- Mpanga (144 MW)
- Mutonga (60 MW)
- Ruhudji (358 MW)
- Rumakali (222 MW)
- Rusumo Falls (61.5 MW)
- Ruzizi III (82 MW)
- Songwe (330 MW)
- Upper Kihansi (no capacity, only energy)

Renewable

- Kivu methane engines 30 MW x 4 units (120 MW)[3]
- Generic wind (nominal capacity depends upon sites, 2 X 30 MW assumed)

Geothermal

- Longonot (70 MW)
- Menengai (140 MW)
- Olkaria extension (35 MW)
- Suswa (70 MW)
- Generic (assumed at 140 MW)

Thermal

- Combined cycle gas x 3 units (generic, capacity depends upon amount of gas to be imported)
- Gas turbine 60 MW gas – generic x 4 units (generic, capacity depends upon amount of gas to be imported)
- Mchuchuma – coal (400 MW)
- Mombasa – LNG (generic, capacity depends upon amount of gas to be imported)
- Mombasa – coal (generic, capacity depends upon amount of gas to be imported)

The locations of these options are shown on the following Figure:

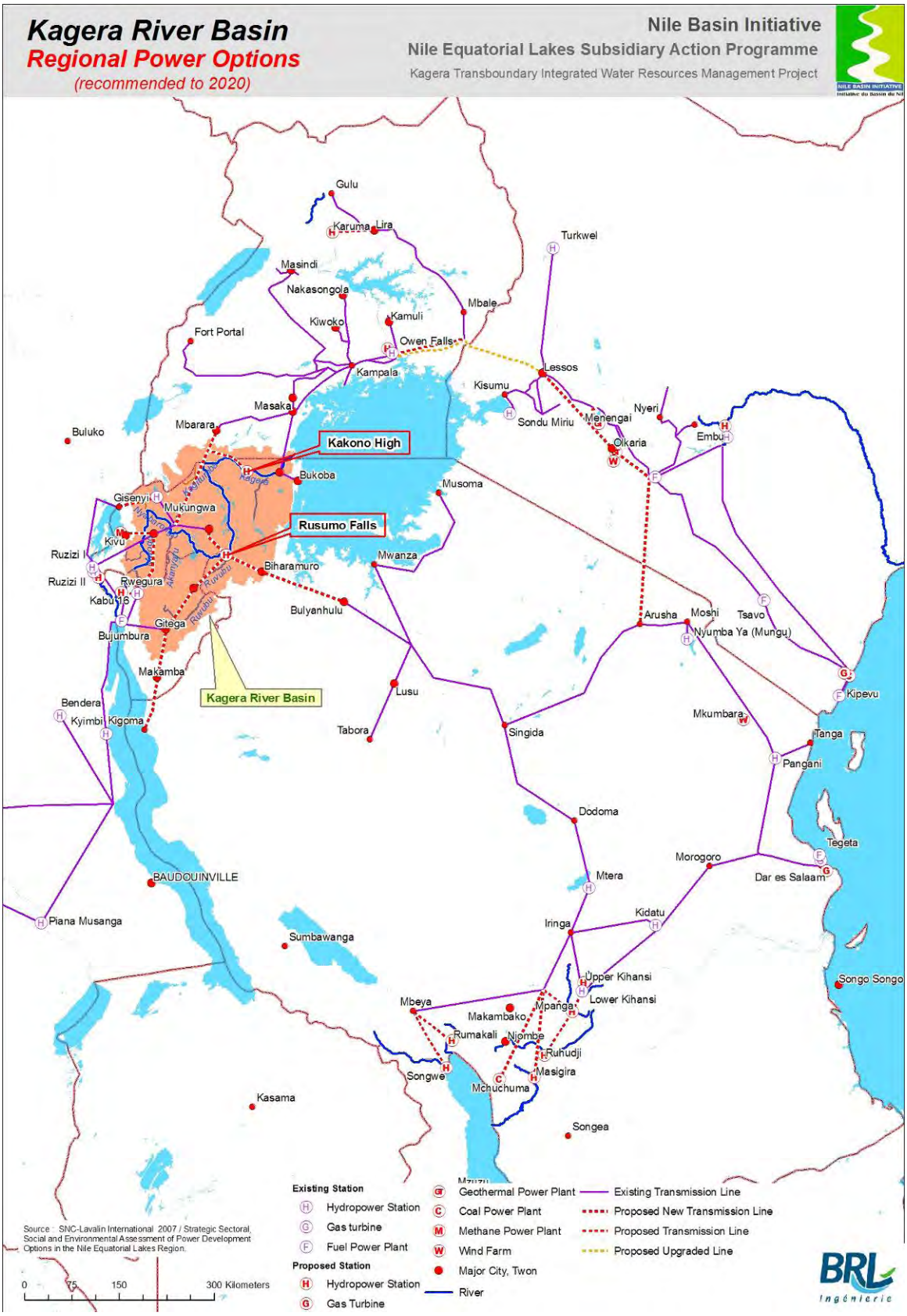

Figure 9.8 – SSEA Retained power options

Within the Kagera basin, two hydropower generation options are on the SSEA retained list:

Kakono Hydroelectric Development Project: This is a 53 MW run-of-river project. The project is located in Tanzania on the Kagera River near the border with Uganda. A portion of the benefits of this project would be the provision of irrigation water to Tanzania and possibly Uganda.

Rusumo Falls: This is a 61.5 MW project with a major reservoir. It is located on the Kagera River at the border between Rwanda and Tanzania. The main impacts would be flooding of 400 km², including 125 km² of existing lake, 250 km² of existing wetlands and 15km² of valley slopes. Approximately 3,000 persons may be affected and some displaced.

The status and potential of these and other hydropower options are discussed in further detail in the next section.

9.4 Kagera basin hydropower development opportunities

9.4.1 Large hydropower projects

In this section we summarize the main new large hydropower installations possible in the Kagera basin. These are:

Rusumo Falls Hydropower Project (61.5 MW)

The 61.5 MW Rusumo Falls hydroelectric project would be built on the Kagera River at the border between Rwanda and Tanzania. The Rusumo Falls is situated on the Kagera River 2 km downstream from the confluence of the Kagera and Ruvubu Rivers, marking the head of the Kagera River as a distinct hydrological feature and the master stream of the basin. The river forms the border between Rwanda on the left bank and Tanzania on the right bank.

The project will comprise a conventional gravity dam in the main channel with a full supply level of 1325m – approximately 5 m about normal river levels. The raised river levels from the fore bay would flood upstream in the Ruvubu River, and would marginally affect levels in Lake Rweru, some 70 km upstream on the Nyabarongo River. The dam would be 12 m high, and include spillway gates. Power facilitates would include intake above the dam, a 460 m power tunnel and three unit powerhouse with an installed capacity of 61.5 MW under a head of 35m. The project would increase downstream flows in the dry period, and potentially improve the viability of the Kakono Hydropower and Kyaka Irrigation projects in Tanzania.

Total costs have been estimated (2004) at about USD 114 million, including capital, indirect and environmental mitigation works. Cost of firm energy produced is estimated at 4.14 UScents/kWh.

Numerous studies have been completed on this project since the initial Norconsult/Electrowatt (1976) prefeasibility study. A further feasibility study has recently been commissioned by the NELSAP to commence in October 2007 which will include optimization and full assessment and recommendations of the multi-purpose opportunities.

Main Environmental Issues: Upstream flooding from the dam is estimated in the order of 400 km², which would include 125 km² of existing lake, 250 km² of existing wetlands and 15 km² of valley slopes. The reduction in downstream flood flows and levels could affect wetlands downstream, including in the Akagera National Park. The increased surface area of the reservoir (as compared to the lake) would result in an increase in evaporation; however, the current rate of evapotranspiration in the wetlands is estimated to be similar to the evaporation rate. Thus the net impact on loss of water is expected to be minimal. Greenhouse gas will be emitted following flooding of the reservoir, although the total quantity would be less than what would be theoretically expected from a new 400 km² reservoir because 125 km² are already a lake and another 250 km² is constituted of wetlands already emitting some GHG. The construction of the dam will have a positive impact on the water quality of the Kagera River by trapping an estimated 15 to 20% of the quantity of nutrients flowing into the system.

A run of river option would reduce the extent of the reservoir area but also the power generation capacity. Whichever design option is selected, care is needed to take account of the sedimentation issue.

Main Socioeconomic Issues: Approximately 3,000 persons may be affected and some displaced based on a rough estimate by SNC-Lavalin using the latest census data upstream of the dam. Increase in water areas upstream could increase health risks due to bilharzia and malaria.

Rusumo Falls is strategically placed in the region to: a) strengthen, electrically, the backbone transmission system required for the benefits of regional power planning to be enjoyed by all parties and b) meet the new loads from the mines in the Kagera District that are being implemented. However, Rusumo Falls has a relatively high risk. Environmental impact studies are required to better assess its environmental issues, especially with regards to potential downstream effects and the impacts of the creation of a reservoir that include some 250 km² of wetlands. In particular, its project design could be re-evaluated so as to minimize reservoir impacts on natural habitats; operation rules could be determined so as not to alter riverine habitats in the Akagera National Park; a mitigation plan should be developed to control risks of increase of malaria and bilharzia. A resettlement and rehabilitation plan is also required. Finally, a power sharing agreement between Burundi, Rwanda and Tanzania will also have to be negotiated, possibly within the framework of the Kagera River basin Integrated Water Resources Management Project.

Kakono Dam Hydropower Project (53 MW)

The 53 MW Kakono hydroelectric project would be located in Tanzania, on the Kagera River near the Uganda border, approximately 90 km from the mouth of the Kagera River and about the same distance from the city of Bukoba and Lake Victoria. Kakono is the furthest downstream potential hydropower site on the Kagera River offering multi-purpose development opportunities. The Kagera River Valley below the site contains 50,000 ha or more of alluvial soils which are suitable for development of irrigated agriculture. The reservoir created by the dam could command much of the irrigable area, and the remainder could be served by pumped supplies using energy from the hydropower plant.

The project would comprise a 35 m high concrete gravity dam and spillway, and earthfill dam with a full supply level of 1182 m. The dam would great a small reservoir with live storage equal to 30 h of plant output. Power facilitates would include intake in the dam, and a two unit powerhouse at the toe of the dam with an installed capacity of 53 MW under a head of 26m. The project was identified for both power and downstream irrigation (about 70,000 ha). The reservoir would extend 40 km; however it would only be about 15 km² in area. Firm energy and flow would be increased if the Rusumo dam is in place. Potential multi-purpose downstream benefits from increased dry season flows at the Kyaka irrigation project in Tanzania have been included in the evaluation (ref. Section 6.3.3).

Total costs have been estimated (2004) at about USD 86 million, including capital, indirect and environmental mitigation works. Cost of firm energy produced is estimated at 7.76 UScents/kWh.

***Main Environmental Issues*:** The project would flood part of the Minziro Forest Reserve. The plant could provide daily peaking, with consequent downstream flow and level variations over 75% of the year.

Main Socioeconomic Issues: The reservoir would be located in a medium population density area and could involve significant resettlement. Several potential irrigation areas near Kyaka exist, and these have been discussed Section 6.3.3 of this monograph.

Kishanda Valley Hydropower Project (180 to 207 MW)

The Kagera River drops more than 100 metres between 120 and 90 km upstream of the river mouth. Several power development options to exploit the hydroelectric potential of this stretch of the river were studied by Norconsult/Electrowatt (1976) as part of a study that included Rusumo Falls. This report is referred to as a *prefeasibility* study.

The Kishanda Project is a diversion scheme, which would divert the water of the Kagera River downstream of Lake Rushwa. The water would pass successively through an arm of Lake Rushwa, then into a reservoir along the valley of the Kishanda River created by a dam built at Murongo. This reservoir would extend 60 km up the Kishanda River. Flow would be used at a powerhouse located close to Bugara and returned to the Kagera River.

The Kishanda project, as would the Kakono scheme farther downstream, would provide improved regulated flows for possible additional irrigation in the Kyaka area. There is a potential for 160 km² of irrigation at Kyaka, and further opportunities farther downstream. These are outlined in the 1976 report by Norconsult/Electrowatt, and in the 1982 report for the KBO[144]. The 1976 report refers to pre-feasibility level studies of the Kyaka irrigation project as part of the same study.

The Norconsult/Electrowatt 1976 study proposed an installed capacity of 180 MW and corresponding annual energy of 1,087 GWh. The later KBO study refers to an installed capacity of 207 MW and firm energy of 500 GWh.

The project would have a high environmental/social risk, and thus has been screened out by the SSEA. The primary reason is the diversion of significant flows out of the Kagera River over an extended distance, and flooding from the reservoir in the Kishanda River. The Akagera National Park in Rwanda and the presence of extensive wetlands of importance to the regional biodiversity in Tanzania and Rwanda would also be of international concern.

In may be noted that the studies are now almost 30 years old and they have not been updated.

[144] Kagera Basin Organization. 1982. Development of the Kagera Basin, Final Report, Volume 3 – Energy. United Nations.

Nyaborongo Hydropower Project (28 MW)

The Nyaborongo hydropower project would provide power to the Kigali area. The project was studied in 1999 by SOGREAH, who issued both feasibility[145] and environmental[146] studies. The project would involve diversion from the Nyaborongo River from a dam/intake to the powerhouse over some 8 km. The projected cost of the project is high, with the firm energy cost estimated as 15 cents/kWh. As this exceeds the selection criteria established by the SSEA, this project has been screened out.

It should be noted that the 1999 study was not a complete feasibility study, as it only included limited field investigations.

Other hydropower projects

Uganda: A number of hydropower projects are under discussion. Two sites: *Kikagati* and *Nshungyezi* on the Kagera River near the Uganda/Tanzania border were identified as having potential for hydropower development. A detailed study to determine the hydropower potential is yet to be carried out. Two permits have been recently issued for power development: 1) to China Shan Sheng Industry (U) International Ltd (for *Kikagata* site on Kagera River), and 2) to the Kisiizi Hospital Power Limited (*Kisiizi* River draining into Kagera River).

Tanzania: In addition to the Kakono Kagera River mainstream hydropower project, the NBCBN (2005) has identified 2 small/mini-hydropower sites in the Tanzania portion of the Kagera River basin (Kasongenye and Kaonjuba) totalling 1.2 MW capacity (ref. discussion in following section).

9.4.2 *Small, mini* and *micro* hydropower potential

Small hydro is the development of hydroelectric power on a scale serving a small community or industrial plant. The definition of *small* hydro varies but a generating capacity of up to 10 MW is generally accepted as the upper limit. *Small* hydro can be further subdivided into *mini* hydro, usually defined as less than 1 MW, and *micro* hydro which is less than 100 kW. *Micro* hydro is usually the application of hydroelectric power for small communities, single families or small enterprise.[147]

Small hydro plants may or may not be connected to conventional electrical distribution networks. Alternatively, small hydro projects may be built in isolated areas that would be uneconomic to serve from a network, or in areas where there is no national electrical distribution network. Since small hydro projects usually have minimal reservoirs and civil construction work, and they are seen as having a relatively low environmental impact compared to large hydro. As well, since small hydro projects usually have minimal environmental and licensing procedures, and since the equipment is usually in serial production, standardized and simplified, and since the civil works construction is also small, small hydro projects may be developed very rapidly.

Small and mini hydro power schemes constitute an interesting option for rural electrification in the region, particularly for relatively remote villages. They would also permit rural electrification in relatively small increments and with limited capital expenditures. Interconnections with the national grid can also be carried out at the time of installation if possible, or in future as warranted.

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145 SOGREAH Consultants. Novembre 1999. Faisabilité détaillée de l'aménagement hydroélectrique de Nyabarongo, Dossier final d'avant-projet détaillé, Rapport principal, République Rwandaise, Ministère de l'Énergie, de l'Eau et des Ressources Naturelles, Projet de Réhabilitation du secteur de l'énergie, 40 0196 R8

146 SOGREAH Consultants. Novembre 1999. Faisabilité détaillée de l'aménagement hydroélectrique de Nyabarongo, Rapport final d'environnement, (étude d'impact socio-économique complémentaire), République Rwandaise, Ministère de l'Énergie, de l'Eau et des Ressources Naturelles

147 For definitions of *small, mini* and *micro* hydro used in this report, ref: http://en.wikipedia.org/wiki/Small_hydro accessed 16 December 2007.

SGI Ingénierie SA (2005) studied the feasibility of small and mini hydro power installations in Rwanda. From a long list of over 100 sites, the SGI study identified 26 which they deemed as feasible for future study and financing, 16 of which are in the Kagera basin. The sites range in hydropower potential from 60 to 5,400 kW capacities, totalling 25.4 MW. The 16 sites within the Kagera basin have a total capacity of 22.8 MW. At an estimated capital cost of USD2,000/kW installed capacity, the total investment in Rwanda is estimated at USD 45.6 million.

The NBCBC report (2005) estimates minihydropower potential in Burundi at about 3 MW. However, if we make an extrapolation of Rwandan estimates on the basis of basin area, we may expect as much as 9 MW from about 6 sites of small and mini hydropower potential in Burundi[148]. At an estimated capital cost of USD2,000/kW installed capacity, the total investment in Burundi is estimated at USD 18 million.

The NBCBN (2005) has identified 2 small/mini hydropower sites in the Tanzania portion of the Kagera River basin (Kasongenye and Kaonjuba) totalling 1.2 MW capacity.

About 3 MW small and mini hydropower potential have been estimated for Uganda[149].

Questions regarding available technical capacity for the design and installation of small and mini hydro power schemes, as well as the long term maintenance, sustainability and cost-recovery, need to be addressed before proceeding with such schemes.

9.4.3 Overall hydropower potential of the Kagera River basin

The overall hydropower potential of the Kagera River basin is about 490 MW summarized as follows:

Table 9.7 – Hydropower potential of the Kagera River basin

Type/Location	Potential (MW)	Feasible (MW)
Existing hydropower development	**43.8**	**43.8**
Possible new hydropower development:	**443.5**	**215.5**
Large-scale hydropower projects:	***407.5***	***179.5***
Rusumo Falls	61.5	61.5
Kakono, Tanzania	53.0	53.0
Kikagati, Uganda	10.0	10.0
Maziba, Kiruruma R., Uganda	1.0	1.0
Nshungyenzi, Uganda	54.0	54.0
Kishanda Valley, Tanzania	200.0	no
Nyabarongo, Rwanda	28.0	no
Small/mini hydropower projects:	***36.0***	***36.0***
Burundi (extrapolated from SGI, 2005)	9.0	9.0
Rwanda (SGI, 2005)	22.8	22.8
Tanzania (NBCBC, 2005)	1.2	1.2
Uganda (personal communcations)	3.0	3.0
Total:	**487.3**	**259.3**

[148] Because of landform and topography, we would expect the potential for small and mini hydropower potential to be limited in the Ugandan and Tanzanian portions of the Kagera basin, and have therefore not attempted an estimate. Nevertheless, we would welcome input from the respective authorities and stakeholders towards determining realistic estimates of small and mini hydro power potential.

[149] Personal communication, Mr. Henry Bidasala-Igaga, Ag. Asst. Commissioner Elect. Power, Ministry of Energy and Mineral Development, Kampala.

9.5 Conclusions and Recommendations

A summary of the main conclusions and recommendations of this chapter are as follows:

- 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.
- The hydropower potential of the Kagera River basin is about 490 MW of which only about 44 MW, or less than 10% has been developed to date.
- Given present day economic, social and environmental constraints, only about 216 MW, of the remaining potential is considered feasible, including about 36 MW of small and mini hydropower projects, mostly in Rwanda.
- The Rusumo Falls (61.5 MW) and Kakono (53 MW) Projects have been identified as necessary and sound investments under the SSEA (2007) and are recommended to proceed soon. The total capital costs associated with these projects is estimated at about USD200 million (USD114 million and USD86 million respectively).
- Small and mini hydropower development appears to offer a solution to remote communities in the Kagera River basin with a total capacity of about 36 MW appearing to be feasible . At an estimated capital cost of USD 2,000/installed kW capacity, the total capital cost of this investment is estimated at USD 72 million.
- **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, such as that put forward in the SSEA (2007), will be required to provide electricity necessary for transformational development in the region in the long-term.

As noted above and in the SSEA study, electricity development is most efficiently carried out using a regional, and in the case of the Equatorial Lakes region, a transboundary approach. To put the Kagera hydropower investments totalling about USD 272 million into perspective, the SSEA study has determined overall regional investment requirements as follows:

- The total capital investment required over the period 2005 to 2020 *medium* load growth scenario is about USD 5.8 billion.
- The *high load* growth scenario would require over 50% more investment, or about USD 9 billion.
- The *transformation* scenario would require over three times more USD 16 billion.

Although potential hydropower investments in the Kagera River basin are relatively small in relation to the overall regional requirements noted above and to other investments identified in this monograph (ref. Agriculture, Potable Water and Sanitation), they correspond to the full investments required to develop the limited hydropower potential of the basin.

10. Potable Water and Sanitation

10.1 Potable water and sanitation – and the links to development and poverty reduction

By the end of the last century, an estimated 3 billion people lacked access to basic sanitation and some 5 million die each year from diarrhoeal diseases caused by water contamination worldwide. The association between poverty, ill health and poor water supplies and sanitation is strong, based on the evidence that more and better quality water, in combination with reduction in exposure to disease pathogens through better sanitation and improved hygiene behaviour, improves the health of individuals and contributes to the productivity of communities (WaterAid, 1999).

At the Millennium Summit in September 2000 a gathering of world leaders adopted the UN Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets, with a deadline of 2015, which have become known as the Millennium Development Goals (MDGs). The MDGs are the world's time-bound and quantified targets for addressing extreme poverty in its many dimensions, including amongst other lack of potable water and sanitation. One of the MDG targets is to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation.

Sustainable improved water supply and sanitation has a direct link to poverty alleviation, as it leads to:

- Improved maternal and infant health, and reduced infant mortality[150]
- Improvement in the school enrolment, specifically for girls
- A reduction in time spent for water collection, specifically for women
- An increased productivity because of better health

In most of the Kagera River basin, availability of water is less an issue than access to clean and safe water. The Congo-Nile Divide as well as the hills and mountain foothills (Hydro-geographic Zones I and II) are generally well endowed with springs. Few regions in Tanzania are as well watered as the Tanzanian part of the West Lake Region (Zone IV), where rainfall is adequate for the production of most tropical crops. Rivers, streams, ponds and springs are plentiful in most parts of the region. Lake Victoria dominates the region to the east creating a shoreline of some 250 km. In Zones I and II, and part of Zone IV, the availability of water resources is enough to supply a quickly growing population. However, in Zone III, and part of IV it is not. Zone III covers half of Rwanda and a small part of Burundi and Tanzania. A picture on the estimated deficit (water resources - water need < 0) is given in Figure 1-6 of the SGI (2005) report on Rwanda, indicating that half of Rwanda has a deficit by 2020.

In contrast with this description of the availability of water is the access to potable water. Potable water is derived from protected springs, boreholes and shallow wells with hand pumps, and treated surface water. On average[151], the safe water coverage is 48%, meaning that more than half of the population uses unsafe water (see also Table 10.2).

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150 The problems of inadequate sanitation, unsafe drinking water, and poor hygiene are typically problems for the poor population that cannot afford safe water and sanitation services. These problems result in diarrheal diseases, parasitic infestations, and skin diseases. Improving access to safe water for the poor could lead to substantive improvements in the mortality rate of children under five years and the infant IMR.

151 Based on coverage by province / district for those that are within the Kagera basin. This estimate does not take into account differences in population figures per province / district.

Water supply and sanitation coverage is used in this chapter to describe the percentage of the population per administrative unit (province, or district) that has access to potable water and sanitation services. Water supply coverage is defined differently by each of the four countries. In Uganda, the percentage water coverage is calculated by dividing the estimated total number of users by the projected district rural population[152]. In Rwanda, officially the following criteria are applied: use of 20 litres per person per day, water quality according to national standards, maximum walking distance to the source of 500 m, and regular water supply[153]. The background to the 1999 coverage figures for Burundi as supplied in the sector policy of the Ministry of Energy and Mines (Ndikumana, 2007) is not documented. Similarly, the definition of water supply coverage for the figures in the Tanzanian part of the country has not been given.

Sanitation involves more than the access to latrines and toilets, but also includes numerous other aspects, including domestic hygienic behaviour and adequate solid waste disposal, to name a few. Household latrine coverage has been taken as one of the more easily measurable aspects of sanitation. However, not every latrine is considered adequate to increase the sanitary situation. Again, latrine coverage seems to be defined differently in the four countries of the basin. Although latrine coverage figures of 80 – 100% have been listed for the region (Tanzania Household Census 2005; PGNRE, 2005), the real adequate coverage is much less.

In Table 10.1, the present (or most up-to-date) coverage figures are given for water ands sanitation in the four countries of the basin, as compared to the MDG goals for these countries.

Table 10.1 - Current and planned overall water and sanitation coverage in the four countries of the Kagera basin

Potable water supply coverage

		Present			MDG/government goal for 2015		
Country	Reference Year	Rural	Urban	Overall	Rural	Urban	Overall
Rwanda	2005	55	69	57	85	85	85
Burundi	1999	43	76	47			84.5*
Uganda	2006	61	67	66	77	95	80
Tanzania	2002	42	85	52	64	90	64

* IMF, 2005

Adequate latrine coverage

		Present			MDG/government goal for 2015		
Country	Reference Year	Rural	Urban	Overall	Rural	Urban	Overall
Rwanda	2005	10	10	10	65	65	65
Burundi	2004			36			
Uganda	2006	58	71	60	80	100	83
Tanzania	2002	90	90	90	95	95	95

Source (apart from Burundi): Getting Africa on Track to Meet the MDGs on Water & Sanitation - A status report on 16 countries
Source water supply Burundi: Ndikumana, 2007. Burundi DSS Baseline report; IMF, 2005
Source sanitation Burundi: Ndikumana, 2007. Burundi DSS Baseline report

The Table shows that countrywide, Uganda has the better water supply coverage, and Tanzania scores highest in terms of latrine coverage. Furthermore, it shows that Burundi scores worst in terms of both water and sanitation supply coverage. Finally, coverage figures are far from the MDG targets, specifically for Rwanda and Burundi.

To improve the current water supply and sanitation situation in the Kagera basin, the following activities are required:

- Improve and extend the current water supply in an equitable manner,
- Encourage the community involvement in water supply and sanitation,
- Increase hygiene awareness and access to improved sanitary facilities, and
- Strengthen water management capacities.

[152] Rural water supply in Uganda assumes: 200 people for any size of protected spring, 200 people for a shallow well, 300 people for a borehole, and 150 people per tap for piped schemes.

[153] In practice, the estimated water consumption is 8-10.5 litres per person, the average walking distance in 9 out of the 12 provinces exceeds 500 m, many water sources are bacteriologically polluted.

10.2 Status of water supply and sanitation in the Kagera basin

10.2.1 Overall water supply in the Kagera basin

From the Millennium Development website (http://millenniumindicators.un.org/unsd/mdg/) it follows that water supply is improving overall in the countries of the Kagera basin since 1994, though the urban water supply coverage is going down in Burundi. An overview of the water supply status by administrative unit is given in Figure 10.1.

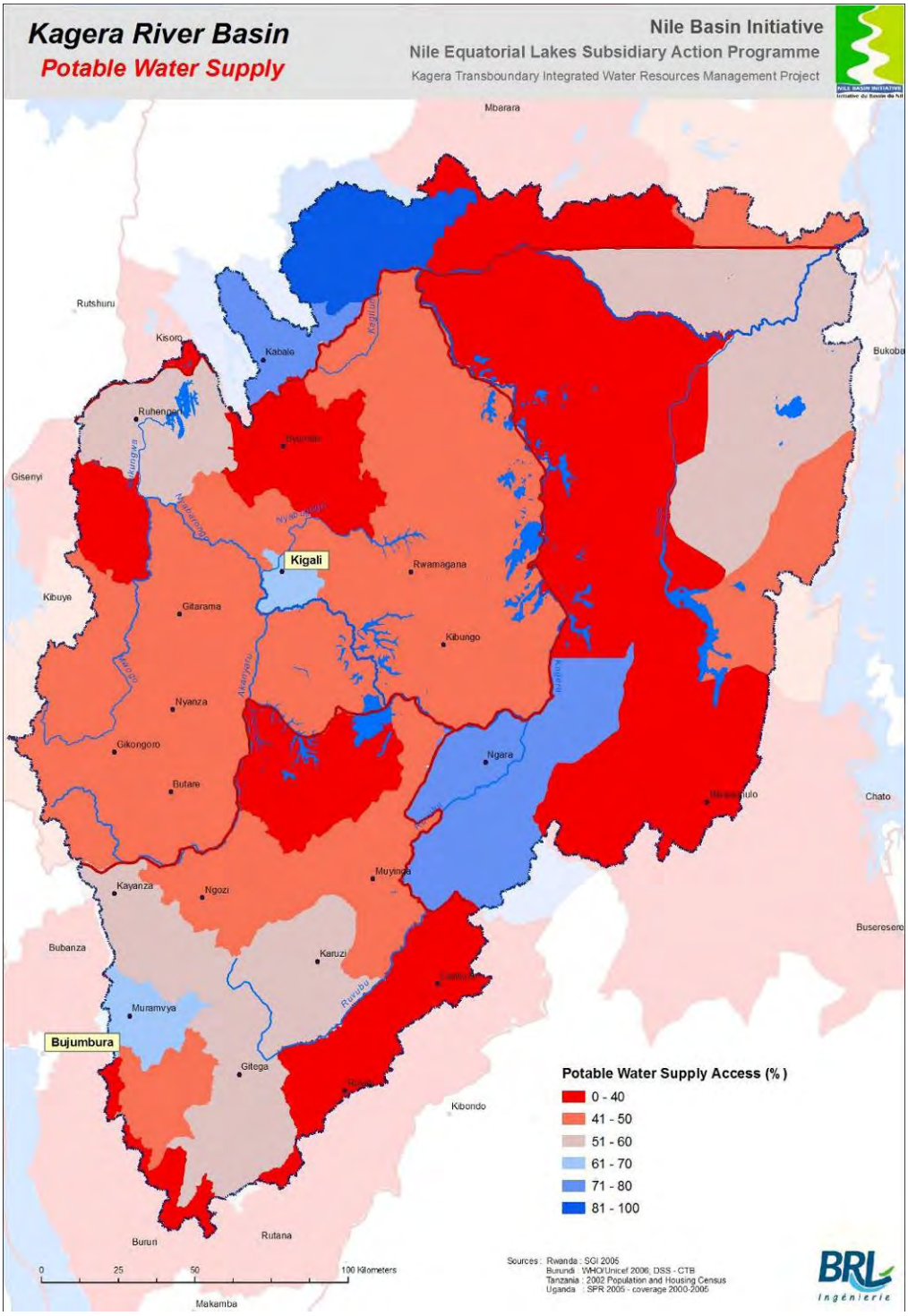


Figure 10.1 – Kagera River Basin – Water Supply Coverage

Rwanda

In 2005, 57 percent of Rwanda's 8.2 million people had access to safe water supply and 10 percent had access to hygienic sanitation (85 percent had access to basic sanitation) (WSP, 2006). In the Rwandese provinces of the Kagera basin, coverage varies between 30 and 49%.

This means that 43% of the population in Rwanda uses unsafe water sources. To make things worse, the water supply potential, i.e. the distribution of water resources, is not uniform over the basin, and there are parts of the country with insufficient resources to develop potable water supply for the population. The situation in Kigali town is most critical. In 1993, the deficit commenced, and worsened progressively after the genocide in 1994, when the city's population increased from 250,000 to the present 800,000 (SGI, 2005).

It is estimated that 30% of the existing water supplies in Rwanda is non-functional (PGNRE, Composante D, 2005).

Burundi

In Burundi, 35% of all improved water sources are not functioning (Ndikumana, 2007).

Uganda

The non-functionality of water sources in the Ugandan part of the basin varies between the districts from 11 - 32% (water and sanitation sector performance report 2006).

Tanzania

In the Kagera Region in Tanzania, the water supply coverage is gradually reducing, as a result of breaking down of existing water supplies, and the insufficient construction of new water sources to cover a fast growing population.

According to the website of the Republic of Tanzania, proportionately more people live in rural areas in the Kagera region than in any other region of Tanzania. In the year 2002 there were 2,906 water schemes at various levels of operation, throughout the region. Hand pumps were the most popular form of water delivery technology, followed by rainwater harvesting. Hand pumps accounted for 1,242 schemes which are 44% of all schemes. In terms of water source, springs and shallow wells together account for 64% of all schemes. Shallow wells at 1,078 are the most popular source of water for rural water supply schemes. Springs and rain water are not far behind underground water from shallow wells. The fact that no rural water schemes drew water from the Lake Victoria or rivers shows that there were plentiful other sources of water as better alternatives. It is a tribute to the well watered nature of the region. However, this picture does not correspond to the safe water coverage of 2005, as listed in the Water Sector Development Programme Implementation Manual (Ministry of Water, United Republic of Tanzania, 2006). This document shows that percentage potable water coverage has reduced from 44 to 40% in Karagwe District, from 60 to 53% in Bukoba Rural District, and from 45% to 36% in Birahamulo District. Overall coverage is thus taken to be around 50%.

Table 10.2 gives a picture of the water supply coverage by administrative unit in the Kagera basin.

Table 10.2 - Current potable water coverage per administrative unit in the four countries of the Kagera basin

Country	Admin. Unit	Name	Safe water supply coverage [%]	Main type of source	Source of info
Burundi	Province	Bururi	37	protected springs	DSS Baseline Burundi: source CTB, 2006
	Province	Bujumbura rural	30		
	Province	Mwaro	50		
	Province	Muramvya	66		
	Province	Gitega	56		
	Province	Rutana	34		
	Province	Bubanza	32		
	Province	Kayanza	59		
	Province	Ngozi	45		
	Province	Ruyigi	32		
	Province	Karuzi	54		
	Province	Cankuzo	36		
	Province	Muyinga	41		
	Province	Kirundo	33		
Rwanda	Province	Kigali Ville	66		SGI 2005 (based on piped water connections)
	Province	Kigali Ngari	48		SGI 2005
	Province	Butare	48		
	Province	Ruhengeri	59		
	Province	Byumba	30		
	Province	Umutara	50	shallow wells	
	Province	Gikongoro	47		
	Province	Gisenyi	36		
	Province	Cyangugu	49		
	Province	Kibuye	46		
	Province	Gitarama	45		
	Province	Kibungo	47	shallow wells	
Tanzania	District	Bukoba	53	protected springs	WSDP 2006 - coverage 2005
	District	Karagwe	40	gravity flow schemes	WSDP 2006 - coverage 2005
	District	Muleba	50	no data	WSDP 2006 - coverage 2000
	District	Biharmulo	36	shallow wells	WSDP 2006 - coverage 2005
	District	Ngara	79	no data	WSDP 2006 - coverage 2000
Uganda	District	Rakai	49	shallow wells	Sector Performance Report (SPR) 2005
	District	Kabale	78	protected springs	
	District	Kisoro	39	protected springs	
	District	Ntungamo	83	springs	
	District	Mbarara	39	protected springs	
	Kagera Basin Average		**48**		

10.2.2 Overall latrine coverage in the Kagera basin

The sanitation coverage as regards percentage of population having (adequate) latrines or toilets is given in Figure 10.2. The latrine coverage distribution clearly demonstrates the differences per country, but this may also be linked to the different definition of adequate latrines. In Rwanda, around 80% of the population has a latrine, but less than 10% of those latrines are considered hygienic and are contributing to official latrine coverage (PGNRE, Composante D, 2005)[154]. In Tanzania, the national census reported over 80% coverage in the region, but adequate sanitation coverage as reported by LVEMP (2004) varied per district by between as little as 7 % to 56%[155]

[154] For example, appropriate latrines in Rwanda are defined (in PGNRE Composante D, SGI, 2005) as: affordable, ecological, separate for boys and girls, hygienic, simple to clean, possibility to reuse the waste, preceded by participatory training, etc. This means that only well-constructed ordinary latrines, VIP latrines and ECOSAN toilets are counted.

[155] While many of the latrines are not 'improved', and so may not amount to basic sanitation, they do isolate the faeces from the humans. A strict MDG definition may place coverage closer to 50 percent. (WSP, 2006).

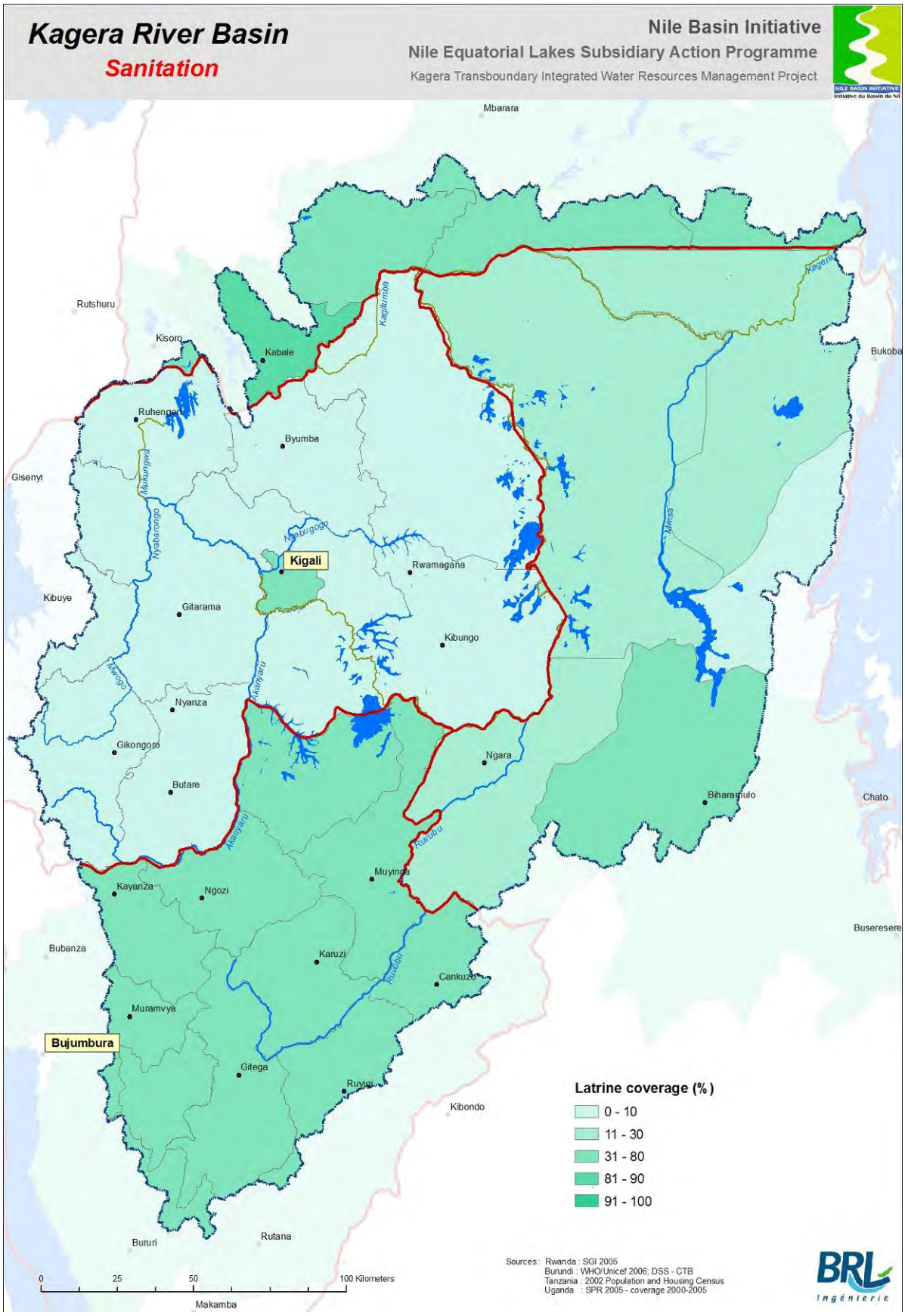


Figure 10.2 - Kagera River Basin – Sanitation Coverage

From the millennium development website it follows the sanitation situation is slowly improving in the countries of the basin, but in Burundi it is worsening as a result of the strong rural decline as compared to urban.

Table 10.3 gives a picture of the adequate household latrine coverage by administrative unit in the Kagera basin.

Table 10.3 - Current household latrine coverage per administrative unit in the four countries of the Kagera basin

Country	Admin. Unit	Name	Latrine coverage [%]	Source of info	Comments on latrine coverage
Burundi	Province	Bururi	35	WHO/Unicef 2006; 2004coverage estimates improved sanitation_Burundi	countrywide estimate based on assumption that 50% of traditional latrines is improved
	Province	Bujumbura rural			
	Province	Mwaro			
	Province	Muramvya			
	Province	Gitega			
	Province	Rutana			
	Province	Bubanza			
	Province	Kayanza			
	Province	Ngozi			
	Province	Ruyigi			
	Province	Karuzi			
	Province	Cankuzo			
	Province	Muyinga			
	Province	Kirundo			
Rwanda	Province	Kigali Ville			
	Province	Kigali Ngari	6	SGI 2005	Based on estimate that 1/8 of all latrines is hygienic
	Province	Butare	8		
	Province	Ruhengeri	5		
	Province	Byumba	6		
	Province	Umutara	5		
	Province	Gikongoro	6		
	Province	Gisenyi	5		
	Province	Cyangugu	6		
	Province	Kibuye	6		
	Province	Gitarama	7		
	Province	Kibungo	6		
Tanzania	District	Bukoba	14	LVEMP (Annex 4), 2004	After HESAWA Project had ended
	District	Karagwe	15		
	District	Muleba	7		
	District	Biharmulo	56		
	District	Ngara	11		
Uganda	District	Rakai	66	SPR 2005 - coverage 2004	All covered latrines
	District	Kabale	87	SPR 2005 - coverage 2004	
	District	Kisoro	64	SPR 2005 - coverage 2004	
	District	Ntungamo	77	SPR 2005 - coverage 2004	
	District	Mbarara	74	SPR 2005 - coverage 2004	
	Kagera Basin Average				

There is no urban Ugandan and Tanzanian population in the Kagera basin. A discussion on urban sanitation aspects is therefore focused on Rwanda and to a larger extent Burundi.

Sewage systems do not exist in the Burundian part of the Kagera basin. In the main settlements, the toilet wastewater pollution is treated with septic tanks. Domestic grey water does not undergo any treatment and is discharged to the overtopping from septic tanks. In most cases, they are directly connected to the urban drainage network or in the water courses. There is no solid waste management system (Ndikumana, 2007).

On its web site, the WHO/AFRO lists the *urban* sanitation coverage in Rwanda in 2000 as 12%, and 8% in the *rural* areas. Apart from some pilot neighbourhoods, Kigali does not have a sewage system (SGI, 2005). Septic tanks and wet latrines are used by 92,000 from the 133,000 people living in urban Kigali, providing a so-called *adequate* sanitation coverage of 69%. There is no solid waste management system.

Referring to the WHO/AFRO website, overall rural latrine coverage in Uganda is 72%, which is similar to the coverage figures in the Ugandan part of the basin.

10.3 Development of water supply and sanitation – requirements, opportunities, scenarios

The industrial sector is so far little developed in the Kagera basin, with main industrial developments taking place in Rwanda. Even though important investments in the industry are expected in Rwanda, leading to an envisaged five-fold increase in water consumption between 2005 and 2020, the industrial water consumption by 2020 will remain modest as compared to the domestic water needs (6.1 Mm^3/year, as compared to 170 Mm^3/year) (PGNRE, Composante D, 2005).

In 2005, 57 percent of Rwanda's 8.2 million people had access to safe water supply and 10 percent had access to hygienic sanitation (WSP et al, 2006). The national targets which are more ambitious than the MDG targets aim to achieve 100 percent coverage by 2020. To achieve this, nationwide an additional 4.9 million people would need to have access to water supply, and 6.5 million to improved sanitation. An estimated minimum investment of USD 250 million is needed by 2015 to reach these goals, on rehabilitation and construction of new infrastructure, as well as for sector management and capacity building (WSP et al, 2006).

If the committed resources from the Government of Tanzania (GoT) and donors materialise on time, and are spent efficiently, Tanzania should be able to achieve the MDG targets. The donor community and GoT have recently come to an agreement on a four-year *Sector Wide Approach* and have pledged sufficient resources to reach the interim targets outlined in Tanzania's National Strategy for Growth and Poverty Reduction. An estimated minimum investment of USD 219 million is needed by 2015 to reach these goals, on rehabilitation and construction of new infrastructure, as well as for institutional strengthening and capacity building (WSP et al, 2006).

Overall, Uganda seems to be on track for water supply, particularly if the 80 percent functionality rate in rural areas is improved. However, it has to be mentioned that over the last two years, the water supply coverage has stagnated as a result of a high population pressure, increasing unit costs for potable water sources and a too stringent government of Uganda sector ceiling. In addition, there is a bias for financing urban water supplies when the demand is greater for rural areas where 80 percent of the poor live. Only 40 percent of the Medium Term Expenditure Framework Allocation went to rural areas in 2005/06. Due to very low coverage in the 1990s, Uganda's MDG targets are low relative to current progress. The Poverty Eradication Action Plan (PEAP/PRSP) more relevant targets call for 80 percent and 83 percent coverage in water supply and sanitation by 2015. As of 2006, about 61 percent have access to water, and 58 percent have access to sanitation; roughly 14.5 million people will need improved WSS facilities by 2015 to achieve the PEAP targets. An estimated minimum investment of USD 147 million is needed by 2015 to reach these goals, on rehabilitation and construction of new infrastructure (WSP et al, 2006).

Based on a study of actual availability of sources and potential for construction of new potable water sources in Rwanda, it follows that by 2020 there is countrywide potentially just enough water to supply the whole population. However, the distribution of potable water resources is not even, which is expected to cause a potable water deficit in Kigali and the eastern half of the country. The situation in Kigali town is most critical. In 1993, the deficit commenced, and worsened progressively after the genocide in 1994, when the city's population increased from 250,000 to the present 800,000. The deficit between water demand and available water resources in the year 2020 is estimated to amount to 37Mm^3/year (PGNRE, Composante D, 2005). No such study has been carried out for Burundi, but in view of the similarity in hydro-geographical socio-economical zones a similar deficit as described for eastern Rwanda may be expected in the eastern part of Burundi. Part of the Ugandan part of the Kagera Basin is

situated in the so-called cattle corridor, an area with comparatively less rainfall and low surface and groundwater development potential. In the mentioned water-stressed areas in the three countries, alternative (low cost) technologies should be studied, including rainwater harvesting technologies and household filtration.

10.4 Conclusions and recommendations

Improving access to and use of water and sanitation facilities in the basin will strongly improve the health of the population. This will increase the potential productivity, which is the main way out of the prevailing poverty.

10.4.1 Strengths and weaknesses

Strengths and weaknesses of the water and sanitation sector in the Kagera River basin may be summarized as follows:

Strengths	Weaknesses
The Governments of Rwanda, Uganda and Tanzania's policies and institutional frameworks are in place, following best practices to achieve the MDGs.	Basin-wide weak sector collaboration and resource mobilisation through a government-led coordination mechanism, to assist the ministry and donors in identifying gaps in the sector strategy and investment plan
Tanzania and Uganda have a sound enabling environment in terms of reformed institutions, policies, and strategies as well as a coherent WSS programme have been created. The government's commitment to change is demonstrated in the increasing decentralisation of implementation.	Low safe water and sanitation coverage
High percentage of improved springs in Burundi and Rwanda	Functionality of improved water sources is declining
	Low community participation / willingness to pay for maintenance
	No treatment of industrial and urban waste
	Little erosion control measures
	Sanitation and Hygiene guidelines at the district level, a national strategy and MDG Roadmap for sanitation are absent.
	Low capacity at the district level to manage and monitor WSS services.

10.4.2 Rehabilitation of non-functional improved water sources

To minimise the actual and future potable water deficits in the most cost-efficient manner, first of all the non-functioning water supplies in the basin need to be rehabilitated, initially focused on the areas with lowest water supply coverage.

An inventory carried out in Burundi in 1999 revealed that in 1989, the water supply coverage was 45%, whereas ten years later, with a doubling of the amount of protected springs and public taps, the coverage had actually reduced to 43%. This is, although population growth also plays a role, largely the result of a great percentage of non-functioning improved water sources. A successful rehabilitation of all non-functioning sources in Burundi would increase the coverage from 43 to 70% (Ndikumana, 2007). This would involve rehabilitation works for some 11,000 protected springs and public taps in the whole of Burundi. In Rwanda, the situation is taken to be the same, with a similar population size and density, protected springs as main technology, average safe water coverage of 46% and a non-functionality rate of 30%. A total of some 15,000 springs could thus be rehabilitated in Rwanda's and Burundi's part of the basin[156].

In Uganda, the situation is somehow better, with an average non-functionality rate in the districts in the Kagera basin of 15%, and average potable water coverage of 59%. Successful rehabilitation of the 15% non-functional sources would increase the coverage to 69%. Assuming 200 users per spring, and half of the districts' area situated in Kagera basin, this would involve the rehabilitation of some 500 springs. No information could be obtained on the non-functionality rate in the Kagera region in Tanzania, but coverage rates go down, indicating a possible functionality problem[157]. With an estimated 1,700,000 people in the Tanzanian part of Kagera basin, potable water coverage of 50% and assuming an 'intermediate' non-functionality rate of 20%, some 1,000 sources would need to be rehabilitated in the Tanzanian part of the basin.

All in all, some 16,500 springs would need to be rehabilitated in the basin.

Community sensitisation would need to be carried out to create a sense of ownership, and ensure that people pay for, and carry out regular maintenance of their water sources. Tap stand attendants would need to be trained, and spare part outlets should be set up in all Provinces.

Table 10.4 - Information on functionality rates of potable water sources in Uganda and Tanzania as situated in the Kagera basin

Uganda's districts in the Kagera Basin		Projected rural population	population served (includes non-functioning sources)	access to functional source	population served with functional source	population not served	non-functioning	population possibly served by rehabilitation
District	Rakai	481,318	245,788	33%	158,835	322,483	35%	86,953
District	Kabale	459,494	430,584	81%	372,190	87,304	14%	58,394
District	Kisoro	219,893	91,850	38%	83,559	136,334	9%	8,291
District	Ntungamo	402,708	368,470	85%	342,302	60,406	7%	26,168
District	Mbarara	322,882	173,730	49%	158,212	164,670	9%	15,518
	Total	1,886,295	1,310,422		1,115,098		15%	195,324
			69%		59%			

Source: Uganda's Sector Performance Report 2006 (Annex A3.2)

Kagera Basin assumed half of the Ugandan districts' area	943,148	655,211		557,549			97,662

Kagera, Tanzania	1,700,000	1,062,500	50%	850,000	850,000	20%	212,500
		63%		50%			

[156] Assuming that the 22,000 non-functional springs and tap stands are spread evenly over the two countries, and 53% of Burundi lies in the Kagera Basin, as well as 85% of Rwanda

[157] Another option is water supply implementations that cannot keep pace with the increasing population through population growth and/or influx of refugees.

10.4.3 Construction of new improved water sources

A next step would be to develop the groundwater resources in the areas where cheaper spring water supply is not feasible (notably in hydro-geographic zones III and IV). The initial focus should be on the urban centres. Assuming that rehabilitation of existing sources has led to an average increase in the basin-wide coverage to 65% based on the existing population in the basin, it means new sources will be constructed to arrive at the 2015 MDG targets. This additional coverage will need to be ensured through shallow wells and boreholes, as it can be assumed that the spring potential will have been largely exhausted. Two of the five districts in Uganda, namely Rakai and Kisoro have a low water resource potential, making potable water coverage improvements difficult and expensive. Assuming that the water resources potential is sufficient to reach MDG potable water coverage, it follows that some 10,500 boreholes or shallow wells will need to be drilled (see Table 10.5).

Table 10.5 - Information on functionality rates of potable water sources in Uganda and Tanzania as situated in the Kagera basin

Projection July 2007	Kagera River basin Population (million)	Mean annual growth rate (%)	65% water supply coverage 2007	Population in 2015	Target 10 coverage per country, 2015 [%]	Target 10 population covered per country, 2015 [%]	Additional coverage required to reach target	New boreholes (300 people per borehole)
Burundi	4.6	2.75	2,990,000	5,504,036	85%	4,678,431	825,605	2,752
Rwanda	7.5	2.75	4,875,000	8,973,973	84.5%	7,583,007	1,390,966	4,637
Tanzania	1.7	2.5	1,105,000	2,006,821	64%	1,284,365	722,455	2,408
Uganda	0.9	2.5	585,000	1,062,434	80%	849,948	212,487	708
Basin	**14.7**	**2.7**						10,505

10.4.4 Sanitation awareness campaigns

The national policies in the Kagera basin are to promote the building of latrines by the population. Therefore, no subsidies are provided for household sanitation. However, extensive sanitation awareness campaigns will need to be held to convey the message that sanitation saves lives.

10.4.5 Recommended programmes and financial requirements

The potential programmes proposed to reach MDG goal 7, target 10 in the Kagera River basin are summarised in Table 10.6 below. These figures are highly preliminary, and are intended to give only a *ball-park* figure of required needs for both the rural and the urban setting. As indicated in Section 10.4.3, the estimated rehabilitation and construction needs in the Kagera Basin are based on the assumptions that coverage is similar over the basin, and that target 10 is reachable in each part of the basin.

It is envisaged that a water and sanitation programme for the Kagera basin will consist of four components:

The first component is the ***rehabilitation of the non-functional water sources***, mostly protected springs with distribution networks in places. A unit cost of USD 8,000 has been envisaged. The lump sum incorporates a baseline survey of the repairs required on each non-functional source as well as programme overheads.

The second component is the ***construction of new sources***. It is assumed that the potential for protected springs has been exhausted after rehabilitation of the non-functional sources, and that the same number of new sources - boreholes and shallow wells with hand pumps – is required. A unit cost of between USD 18,000 and USD 18,500 has been used, which includes the costs of borehole site investigations, and drilling of dry boreholes. In water-stressed areas, alternative technologies will be studied and introduced. Kigali City water supply extensions have not been included in the budget for water and sanitation.

Sanitation and hygiene awareness campaigns, including also the construction of some model *Ecosan*[158] latrines have been budgeted as 25% of the cost of all source rehabilitation and construction works. This relatively high percentage is purposely used, as the sanitation situation in a large part of the basin is rampantly poor.

Finally, between 10% and 15% of the total costs of the water and sanitation programme has been reserved for ***capacity building and institutional strengthening***[159]. In the whole of the basin, decentralisation is a key policy, but the capacity at the provincial / district level is still weak. The component is intended to increase both i) the institutional and technical capacity at provincial / district level, and ii) the level of advocacy, promotion, and public awareness of the need for potable water and adequate sanitation as a means to get out of poverty.

It should be noted that the relative financial importance of the individual budget components will vary by region in the Kagera Basin.

The final costs are of the same range as those envisaged by WSP et al. (2006) to reach the MDG goals in the water and sanitation sector for Rwanda, Uganda and Tanzania[160].

[158] A latrine constructed such that urine and faeces are collected separately. In this way, the faeces can be composted whereas the urine can be used for fertiliser irrigation. The latrine can thus be used 'indefinitely', as it doesn't fill up.

[159] This percentage is based on the anticipated need for capacity building and institutional strengthening in Government of Tanzania's Local Government Reform Programme in 2006 (WSP, 2006).

[160] The final costing for the basin is based on the needs per country assuming that Burundi has the same requirements as Rwanda, and that the costs per country can be reduced proportional to the area of the basin in each of the four countries.

Table 10.6 - Water supply development programmes in the Kagera basin

Water and Sanitation	US$ (million)
Rehabilitation of non-functional water sources	
Rehabilitation of 16,500 sources, including community awareness	130.0
Construction of new improved water sources	
Construction of 16,500 new boreholes, including community awareness	300.0
Sanitation and hygiene awareness campaigns	
Valued at 25% of costs of rehabilitation and construction	110.0
Institutional strengthening, capacity building and sector management	
Valued at 12% of all costs	75.0
Total:	**615.0**

10.4.6 Recommendations for further studies

The implementation of a large-scale water supply and sanitation project of this magnitude would be more efficiently implemented if it was preceded by a basinwide baseline survey on locations and functionality status of existing potable water sources. This baseline survey would provide coverage figures at the lowest level, and give a detailed picture of the works to be done on non-functional sources, meanwhile providing an insight in the reasons for non-functionality and means to address the causes for non-functionality in the new water supply and sanitation project.

The cost estimates have been based on the commonly applied technologies, including spring protection, digging of shallow wells, and the drilling of shallow boreholes. It is however recommended to study the (large-scale) introduction of alternative low cost technologies in the Kagera River basin, including notably household water filtration devices and rainwater harvesting.

11. Transport and Navigation

11.1 Transport, development and poverty reduction[161]

Regional transportation projects are by and large assessed in terms of reducing costs, improving efficiency and promoting economic growth. The contribution of transport operations to poverty alleviation is seen, in general, as indirect and stemming from broadly based economic development. Yet, most direct poverty-targeted interventions (schools, health clinics, nutrition programs, social services, access to markets, etc.) depend on transport as a complementary input for their effective delivery.

11.1.1 Transport has an indirect and a direct role to poverty reduction

Indirect approaches involve increasing the efficiency of resource allocation, especially the performance of markets, the flexibility of adjustments, and the fostering of economic growth. Direct approaches are concerned with enhancing human capital formation, especially education and health, and improving access to economic and social opportunities, including labour and product markets, schools, and clinics.

Typically, indirect approaches operate at the level of improving overall mobility, while direct approaches operate at the level of improving basic access for the poor.

Transport is an intermediate service: it is a means to an end. Transport alone cannot reduce poverty, but it serves a pervasive and crucial complementary role. Transport reduces absolute poverty mainly by increasing economic efficiency: by lowering costs and prices and enhancing opportunities.

11.1.2 Transport needs of the very poor should be recognized

High-cost transport means geographical, social, and economic isolation which is especially a handicap to the poor. In poor rural areas, lack of adequate, reliable transport penalizes households pursuing cash crop farming, non-farm employment opportunities, and access to social services. In urban areas, poor neighbourhoods often suffer from the lack of affordable access to public transit or physical and regulatory barriers to entry by informal transport services.

Transport access is complementary to the availability of other basic “merit” services such as health care and education. The effectiveness of direct service assistance strategies depends significantly on the accessibility of the poor to those services.

[161] ref. Gannon, 1997

Nevertheless, efficiency-oriented transport development may benefit the rich more than the poor, and in some cases, may hurt the poor, so that high cautiousness regarding the poverty reduction should be taken concerning transport projects:

- measurement of benefits and costs based on monetary willingness-to-pay, as registered through the market system, tends to favour higher-income groups;
- exclusive focus on the efficiency criterion tends to neglect the needs of the poor;
- orientation toward efficiency leads to a higher dependence on motorized transport which tends to displace infrastructure for non-motorized transport, to the disadvantage of the poor;
- rights-of-way are often imposed on poor communities for high mobility projects that may not benefit the poor of these communities directly.

In this "transport" thematic chapter, the following plan will be adopted.

- A general overview of the transport in the basin: What are the main characteristics of the transport sector? How is it integrated in a regional context? What is the status of the inland navigation in the Kagera River basin?
- The navigation development opportunities: What could facilitate any navigation development on the lower Kagera River?
- Conclusions and recommendations.

11.2 Status of transport in the Kagera River basin: a regional context

The East African Community (EAC) has a strong mandate to facilitate regional trade and transport matters. It has made the construction and maintenance of roads a high priority. To this end, it has made significant progress in coordinating external support for the development of the *East African Road Network.*

The landlocked countries in East Africa have two distinct advantages vis-à-vis other regions in Africa:

- excellent existing transit transport cooperation with their transit neighbours; and
- a variety of corridor and route choices (ref. Figure 11.1).

Burundi, Rwanda and Uganda presently use both (i) the Northern and (ii) the Central Corridors; with each Corridor offering road and intermodal transport options.

Though each individual country's trade has been mostly geared towards imports and exports outside the region, intra-regional trade has been growing significantly, especially between Uganda and Kenya, over the last few years. However, the main trade flows (more than 80%) are still in and out of the region. The regional transport industry is therefore centred on the ports of Mombasa and Dar es Salaam:

Mombasa is Kenya's only international seaport and handles cargo not only for Kenya but also for Uganda, Sudan, Rwanda, Burundi, Democratic Republic of Congo (DRC) and Northern Tanzania. The road Mombasa-Kampala-Kigali is paved.

Dar-es-Salaam is the principal port of Tanzania and is a major sea outlet for Zambia, Rwanda, Burundi, Malawi, DRC and Uganda. The Dar es Salaam - Kigali road has gravel sections that are difficult to pass during the rains but should be completely paved by 2008.

Despite its weaker transport infrastructure in comparison with the Northern Corridor, the Central Corridor is quite competitive and likely to become more so once the pavement is completed. Its competitiveness rests on (a) direct access to the sea (with no need to transit other countries) for six developing countries (Burundi, Democratic Republic of the Congo, Malawi, Rwanda, Uganda and Zambia); (b) shorter distances to the sea for Burundi, the Democratic Republic of the Congo and Rwanda (see table below); (c) lower transit tariffs; (d) shorter transit times; and (e) streamlined customs and administrative procedures.

Table 11.1 - Distances between seaports and Kagera riparian countries' capitals (km)[162]

Distances between (km)	Kampala	Kigali	Bujumbura
Dar es Salaam	1 588	1 530	1 400
Mombasa	1 300	1 800	2 100

The freight market is split between rail and road transport. Road is the dominant mode, with rail representing only 20% for transit containers, on the two corridors (rail on Mombasa corridor is 13%, 32% for Dar es Salaam) [PMASEA, 2005]. The following paragraphs and Figure 11.1 describe these two corridors.

11.2.1 Northern corridor

The port of Mombasa is linked to the hinterland by rail. The 1,300 km main Mombasa–Nairobi – Malaba–Kampala line was once operated by a single operator, the East African Railways Corporation (EARC). During the 1960s, railway transport was the principal means of transport for Kenya, Uganda, the Democratic Republic of the Congo, Burundi and Rwanda. Both the collapse of the EARC in the 1980s and the split of the railways into separate national companies triggered a downward spiral for the railways, characterized by inadequate inter-railway coordination, underinvestment and poor service. In their efforts to revive railway transport services along the Northern Corridor, in 2006 the Governments of Kenya and Uganda granted a concession to a single operator, the Rift Valley Railways (RVR), to manage the Mombasa–Kampala railway network for a period of 25 years. RVR is committed to acquiring substantial investments of about USD 300 million in order to meet specified performance targets.

Road transport has grown substantially from its subsidiary position as the provider of feeder services in the 1960s to become the main carrier of freight and passengers along the Northern Corridor. Available figures for transit trade indicate that by the late 1990s, the freight market was equally split between rail and road transport. However, by 2003, the share of road transport had jumped to 74%. The dramatic growth of road transport is not attributed to the changing structure of trade in East Africa, but rather to the underperformance of railway transport. Indeed, trade in the sub-region, characterized by low-value, high-bulk export commodities, should augur well for railway transportation.

The rapid expansion of road transport has increased the demand for road construction and maintenance. All countries along the Northern Corridor are committed to improving transit roads, even if the roads in Rwanda and Uganda are in good to fair condition. Governments are also addressing the issue of vehicle overloading with renewed vigour. In this regard, more weighbridges are being installed along the Corridor, as well as modalities to ensure their effective use. Another important development relates to the construction of bypass roads, which will enable transit traffic to avoid going through the centre of major cities. In this connection, work is underway in Nairobi and Kampala.

[162] Sources: MBULI, 2007.

11.2.2 Central Corridor

The Tanzania Railway Corporation (TRC) provides railway services for the Central Corridor. The 2,600 km main line links the port of Dar es Salaam with the inland lake ports of Kigoma and Mwanza, which in turn serve Burundi, the Democratic Republic of the Congo, Rwanda and Uganda. However, the railway is in poor condition and its carrying capacity has decreased to about 45 per cent, because of lack of motive power and wagon availability. The Tanzanian press reported in 2006 that the TRC had been leased to an Indian firm, Rites Consortium. However, the report proved to be premature. As of March 2007, all necessary processes for the lease had not yet been fully finalized.

The road from Dar es Salaam to Isaka and onwards to the border with Burundi and Rwanda is being paved as part of the United Republic of Tanzania's integrated road programme. When completed in 2007-2008, it will be 270 km shorter than the alternative road from Mombasa to Kigali. The road also offers Burundi and Rwanda the convenience of a single border crossing.

11.2.3 Pipelines

Kenya has built a pipeline from a refinery in Mombasa to the main centres of economic activity in Nairobi, Eldoret and Kisumu. The pipeline currently meets 60% of the local demand for petroleum products. An extension of the pipeline to Kampala, Uganda is under discussion with potential investors from the private sector. Transportation of petroleum products by pipeline is not only cost-effective, but also improves road safety by taking fuel transporters off the road network.

Another pipeline exists in the Southern Corridor but there is no link with the Kagera River basin (the 1,065 mile Tazama pipeline, jointly owned by Zambia and the United Republic of Tanzania).

Figure 11.1 - East African transport network: Northern, Central and Southern corridors[163]

[163] Sources: HOYLE, 2000.

11.2.4 Inland water transport

Inland water transport, in the Kagera River basin, is possible along the lower part of the Kagera River and through to Lake Victoria (Commission Economique pour l'Afrique, 1986). However, from the previous description of the regional road network, one may conclude that with the recent and planned evolution of comprehensive regional road and railroad networks it would be difficult for inland water transport on the Kagera River to compete. It explains why navigation on the Kagera River is presently and likely for the future, only feasible as a localized, informal and non-commercial activity.

Navigation activities in the Lake Victoria basin on the Tanzania side are largely confined to the lake itself. The major ports are located in the towns of Mwanza, Musoma, Bukoba and Ukerewe Island. In the Lake Victoria a total of 43 large vessels of weight 50 gross tonnages and above are registered with the Directorate of Maritime Safety and Security of Sumatra. However, there are about 12,208 vessels of weight below 50 gross tonnages plying in Lake Victoria on Tanzania side which are generally classified as small vessels. (Tanzania draft DSS baseline assessment, 2007).

In the Kagera River basin, there is currently only informal navigation by small boats on the rivers and lakes giving remote areas access to markets and other services and for local fisheries. This informal navigation also contributes to a minor extent to the external trade of Rwanda, Uganda and Tanzania through their common frontiers.

The development of the navigation was one of the priorities of the former KBO and is currently still planned by, for instance, the Rwandan Ministry of Infrastructure (MININFRA) program [Ministère des Infrastructures, 2004]. The next section therefore analyses the opportunities to develop navigation in the Kagera River basin.

11.3 Kagera River basin navigation development opportunities

11.3.1 Trade opportunities

The feasibility of navigation on the Kagera River was studied in the "Preliminary study concerning the navigability of the Kagera River", in 1986, under the KBO initiative. It only deals with the lower Kagera River basin, situated downstream of Rusumo Falls, because this portion of the Kagera River is by far the most suitable for trade navigation opportunities. Because of competition from the road network, the study concludes that the volume of river traffic would be very limited and only appropriate for remote areas:

Inside the lower Kagera River basin:

- from Rwanda & Tanzania to Uganda: cattle, food crops, cash crop, mineral, and
- from Uganda to Rwanda & Tanzania: manufactured products;
- From the lower Kagera River basin to Rusumo Falls: minor utility; and
- From the lower Kagera River basin to Tanzania, via the Lake Victoria: sugar, cattle, coffee and food crops.

11.3.2 Navigation opportunities are linked to the Kagera River basin development

Future market

Currently, no marketable commodity is dependent on or expecting service from formal organised navigation transported on the Kagera River. However, some planned projects could enhance the transport of exportable products in the lower Kagera River basin:

- Plains irrigation development opportunities, in the Tanzanian portion of lower Kagera River basin (see Section 6) could use navigation transport on the Kagera River to move inputs and outputs;
- The Rusumo Falls and Kakono hydroelectric projects might attract investment opportunities and population migration and thus increase the trade demand of these two zones situated on the lower Kagera River. To enable navigation through the Kakono dam appropriate locks would need to be included;
- Mining activities (see also Section 13.1) situated to the lower Kagera River basin, could utilize cheap and appropriate means – such as river navigation - to export their production;
- The rail development project from Rusumo to Kigali and the rail development opportunities from Rusumo or Kigali to Bujumbura could be linked to these navigation facilities, from Rusumo Falls to Lake Victoria.

Low flow control

Navigation on the lower Kagera River is presently possible all year round with small boats, thanks to the existing natural flow regulation of the numerous lakes. However, sedimentation and the presence of rapids and rocky shores in some portions of the river do not allow for passage of large boats. This is particularly the case in the zone immediately between the Kagera River and the Lake Victoria, so that, without specific works, large Lake Victoria vessels would not access to the Kagera River network.

The Rusumo Falls and Kakono hydroelectric projects would also play an important role in low flow regulation, which would be expected to be beneficial to Kagera River navigation.

11.4 Conclusion and recommendation

Navigation is not a development priority in the Kagera River basin

The 1986 *Preliminary study concerning the navigability of the Kagera River* carried out under the KBO concluded that the navigation transport on the Kagera River basin would probably not be able to compete with the road or the rail transport. However, since then, no efforts and progress have been made concerning these navigation opportunities. This does not mean that the navigation is not feasible, but no comprehensive feasibility study has been elaborated while at the same time transport means have been developed or are being developed.

The following table shows that the road network in the Kagera riparian countries (even if Tanzania is missing) is well developed. Thanks to important programmes implemented with international financing, Rwanda and Burundi have a good quality road network. Uganda is also well placed and has a good main roads network. The Northern and Central Corridors have been under rehabilitation in 2007 (especially the Central Corridor in Tanzania) and are now in good state.

Table 11.2 – Paved roads in some African countries close to the Kagera river basin[164]

Country	length of paved roads (km)	length (km) of paved roads per 1000 km²
Burundi	1 220	44
Rwanda	1 000	38
Kenya	8 600	15
Uganda	2 600	11
Cameroun	3 500	7
Gabon	900	3.5
Congo	500	1.5
RDC	2 000	0.8
RCA	450	0.7

The regional rail network is also in progress and the feasibility study for the Kigali-Rusumo-Isaka railroad has been launched recently. A possible railroad between Rusumo Falls or Kigali and Bujumbura is also projected by the two countries. These traffic lines would definitely complete the rail Central Corridor.

Inland navigation is also in progress in some of the Kagera riparian countries. It does however not concern the limited Kagera River basin but Lake Victoria and Lake Kivu.

Feasibility Study on Navigation in the Lower Kagera River

Although indications from previous studies indicate that the potential for navigation as a commercially viable means of transport in the Lower Kagera River basin are not encouraging, this conclusion is made without the benefit of an objective feasibility study. Such a study is estimate to cost USD 500,000, and is proposed to be carried out in 2010 as part of the investment development scenarios for the basin.

[164] Sources: « Initiative des Grands Lacs, Secteur Transports », Commission Économique pour l'Afrique. Centre de Développement sous-régional pour l'Afrique de l'Est, Kigali 2002.

12. Tourism

12.1 Links between tourism and poverty alleviation: "Pro-poor tourism"

Tourism is an industry that currently affects the livelihoods of many of the world's poor, both positively and negatively. Impacts vary between poor people, destinations, and types of tourism. Tourism is already a significant or growing activity in many poor countries including the Kagera River basin.

Tourism is not very different from other economic productive sectors, but it has four potential advantages for pro-poor growth (Bennett et. al. 1999):

- It has higher potential for linkage with other local enterprises because customers come to the destination;
- It is relatively labour intensive and employs a high proportion of women;
- It has potential in poor countries and areas with few other competitive exports such as the Kagera River basin;
- Tourism products can be built on the natural resources and cultures which are assets that some of the poor have.

There are six compelling reasons for focusing efforts on developing pro-poor tourism (Bennett et. al. 1999):

- Tourism is a massive and growing industry, already affecting millions of the poor. So a marginal improvement could generate substantial benefits;
- Tourism has advantages over other economic sectors in relation to poverty elimination;
- Even if the poorest will not be direct beneficiaries of tourism, it is important to reduce the costs they face. Benefits from tourism can be expanded for the 'fairly poor,' such as tea-sellers, casual and unskilled workers, artisans, and others;
- As a poverty intervention, tourism probably does not compare with more direct tools, such as investment in health, education and agriculture. But as a strategy for promoting broad-based economic growth (also essential for achieving poverty elimination), pro-poor tourism has good potential;
- Progress in placing environmental issues on the tourism agenda shows that concerted action can make a difference, even in such a diverse industry as tourism;
- *Pro-poor tourism* is tourism that generates net benefits for the poor (benefits greater than costs). Strategies for pro-poor tourism focus specifically on unlocking opportunities for the poor within tourism, rather than expanding the overall size of the sector.

Issues of overall approach include treating tourism like any other economic sector; collaborating with other donors where possible, recognising that pro-poor tourism is different from what has gone before, drawing on lessons from other sectors; recognising that the poor are not homogeneous and will not benefit uniformly; and, learning by doing.

12.2 Tourism in the Kagera River Basin

12.2.1 Tourism and Integrated Water Resources Management

Tourism in the Kagera River basin is largely linked to exploiting the attractions that are linked to the natural environment (flora and fauna) present in the region. Their effective management requires consideration of the alternative uses by the people in the basin. As such the development and management of tourism beneficial uses requires an integrated (i.e. IWRM) approach. For example, tourism's benefits to the region would need to be weighed against alternative uses such as irrigation and hydropower development in the consideration of optimising opportunities for poverty alleviation for the benefit of the peoples of the Kagera.

Despite a good potential for tourism in the Kagera River basin, with some exceptions, it has been to-date negatively affected by inadequate tourism organisation, poor publicity about the region, security and the hospitality of the peoples, lack of infrastructure and the relative remoteness of Kagera Region from the main tourist circuits. A summary of the obvious and existing tourist opportunities in each of the Kagera basin countries follows:

12.2.2 Burundi

Burundi is a country that has been called the Switzerland of Africa. This is because Burundi has a variety of climates, a mild weather, and wonderful fauna and flora. However, because of the socio-economic and political crises that have hit Burundi during the past several decades, such attractions did not attract sufficient tourists as expected. Because Burundi is coming back to a more stable situation, the expectation is that tourism can play a major role in the economic growth of the country, provided that the government commitment to develop this sector and the right resources are directed to this sector.

The small size of Burundi is a positive factor in tourism because the tourist circuit can join the entire portion of the Kagera basin and Bujumbura Capital of Burundi, renowned for its beautiful Lake Tanganyika sunny beaches, which is already benefiting from increasing tourist visitors, and which has already a hotel infrastructure including good hotel services.

Interesting tourist attractions in Burundi include beautiful landscapes, wonderful flora and fauna and lakes, and ***Ruvubu National Park***.

Beautiful landscape viewing organised in terms of travelling by road from Bujumbura to Muramvya and Gitega in the Kagera Basin with visit to traditional craft workshops in Gitega to admire or buy leather items, ceramic products, ivory and wood carvings.

Wonderful flora and fauna that include the savannah and steppes, and ombrophilous mountain forest and a delightful blooming country. The fauna is rich and comprises different type of animals: antelopes, hares, buffalos, and cynocephalus. Cohoha, Rweru and Rwihinda, the Birds Lake are fantastic. Kirundo is an attractive region because of its nice lakes Cohoha and Rweru, and especially the lake Rwihinda which is now called, as a surname, the "Birds Lake." In fact, there are many birds which are coming over there form different parts of the world, just for a season. The trip in the North leads also to Gitega, the second city in Burundi where the world famous drummers' dancers use to entertain visitors. Gitega is a centre of different important cultural and scientific Institutes: the National Museum, and the School of Arts. On the way back to Bujumbura, the tourist is advised to have a break at Muranvya where are the historical residential royal domain.

Trips are organised to visit the southernmost source of the Nile. This source is situated in Rutovu in Bururi Province. A restaurant is operational on the road to the sources of the Nile at Resha, with facilities for swimming and camping. The trip continues to Bururi province after having crossed a big forest with monkeys, giving a good opportunity to visit the southern Nile Source, which was “discovered” in 1934 by the German explorer Burckhard Waldecker, where a symbolic pyramid had been built by the authorities.

12.2.3 Rwanda

Rwanda is most famous for its ***Volcanoes National Park*** in the North with its world-renowned mountain gorillas. The national tourist agency ORTPN organises trekking during which experienced guides lead tourists through the dense forests to watch the gorillas. This dense forest is also inhabited by the golden monkeys which are rare primates to watch.

Nyungwe National Park (partly inside the Kagera River basin) covers 1,030 km² and is rich in biodiversity including 13 types of primates like chimpanzees, more than 275 species of birds, more than 250 tree and shrub species, 100 varieties of orchids and large mammals including leopards, golden cats, bush pigs, black-fronted duikers, chimpanzees, black and white colobus monkeys, mangabeys and blue monkeys. Nyungwe National park is suited for hikers and trekkers in want of exploration of natural forests.

Akagera National Park is another attractive tourist area known for its large animals including lions, leopards, elephants, antelopes, giraffes and buffaloes. The lake Ihema which is part of the Akagera has crocodiles and hippopotamus to watch. There are beautiful lakes to visit within Akagera National Park

Burera and Buhondo Lakes are also important attractions. These lakes are situated in the Northern Province. Brera district authorities have plans to build tourist facilities including tourist hotels near the lakes.

Besides the national parks, a museum has been developed in Butare to house one of the best ethnographic collections in East Africa.

12.2.4 Tanzania

In Tanzanian part of the Kagera River basin, tourism is insufficiently developed although a lot of potential tourism opportunities do also exist there. One unique tourist activity which is on-going is hunting in the game reserves. For instance, from 1996 to 2001, the total hunting revenue in the whole Kagera Region amounted to more than USD 150,000. This includes the hunting fees paid for hunting in the Burigi Game Reserve in Karagwe and Biharamulo District.

Lack of electricity and reliable roads between Mwanza and the district headquarters of Karagwe, Muleba, Biharamulo and Ngara have been a disincentive for the development of tourism although tourism attractions are available in all the districts of Kagera region. The absence of a reliable aero port in Bukoba town has added to the problems of tourism development in Kagera region, in general and in Kagera River basin in particular. Moreover, the existing accommodation facilities need to have customer-cantered services, which is not the case yet.

In Ngara district, earmarked tourist attractions to be developed are listed as follows:

Rusumo Falls: There is a very beautiful terrific panoramic view of the valleys from the summit of the escarpments and surrounding hills which converge to form the magnificent water falls from the height of about 50 meters and measuring 70 to 80 meters wide. Nature lovers may be interested to visit the place if appropriate accommodation is provided in Rusumo or in Ngara small town .Possible tourist activities include taking steep down paths to the falls, climbing the steep mountain near the falls, seeing the place where the Ruvubu River and the Nyamarongo River meet to form the Kagera River, having a traditional canoe ride on the Kagera River. Building a lodge at Rusumo Falls and taking measures to preserve the environment at Rusumo falls should boost tourism in Rusumo Falls. Rusumo Falls, being the Border of Rwanda and Tanzania could attract tourists coming from Rwanda, Burundi, DRC and Tanzania.

Kanazi Chiefdom Palace: Kanazi chiefdom Palace was built in 1940 by Chief. There tourist interested in culture will learn how the culture of Burundi and Ngara is historically common.

Kimisi Game Reserve: Kimisi Game reserve has a great potential to attract tourists with interest in wild life. Kimisi Game reserve is adjacent to the famous Burigi Game Reserve. It covers an area of 1026.3 km² within Ngara and Karagwe districts. It has a beautiful mountainous landscape with extended plains and many plateaus, valleys and papyrus wetlands along the Kagera River and Lake Ngoma. This adds a lot to the attractive scenery of the area. Abundant wildlife that roam around the scattered woodlands includes Impala, dick-dick,antelopes, gazelles, baboons, monkeys, giraffes, buffaloes, bushbucks, waterbucks, elephants and many others. With a good guide, some patience and bit of luck, a tourist may see the hippos, crocodiles, and sitatungas in their natural water habitats and wet plains.

The Shyunga Hill: The Shyunga hill is the highest point in Kagera region at an altitude of 1843 m.a.s.l. Its summit offers a beautiful panoramic view, on some days one can see clearly the smoky volcanic mountains of Nyiragongo along the Rwanda and DRC's border. Traditionally the first Bugufi chiefdom residence and state house was established here before it was transferred later to other centrally located villages of Nyamiaga/ Mukabingo and Kanazi.

A site seeing to the ancient "Chigufi" caves where the name Bugufi originated may be arranged from here. The chiefdom treasures and identification symbols were safeguarded and stored. The Shiyunga Hill offers a valuable opportunity for colourists

Murgwanza Escarpments: Murgwanza escarpments offer a beautiful opportunity for sightseeing. Standing at an altitude of 1800 m amsl it offers a splendid view of the surrounding landscape, you can see many places of Rwanda and Burundi, beautiful hills with fascinating terrains when you visit this cliffy summit.

The Kabulanzwili Hill: The mountain crops out like a large anthill above the surrounding landscape adjacent to the Ruvubu River with an altitude of 1810 meters. Traditionally renowned as a "flat topped bald headed hill", it never grows grass above it all the year around (Kabula means Without, Nzwili means Hairs). Local leaders used this hill as a tower to communicate with the community on various messages that required implementation in the chiefdom while performing special drumbeats and other musical instruments to alert particular attention. It is an ideal place to enjoy a picnics getting, gulps of fresh air and sightseeing the beautiful valleys and the catchment forests of the river line below. Adjacent to this hill, a small river island harbours natural habitat for nesting to crocodiles.

The Bushubi Chiefdom Palace at Keza: Keza was the hub of the Bushubi heifer from time immemorial. Only a few partial lime-painted walls of the ruins remain standing, however one can still get an idea of what they once looked like. Burial sites for some of the chiefs can also be visited. Of particular interest are the two large caves within Mllole sub village of Keza where he

chiefdom treasures, identification marks were kept, and acted as hiding places during tribal wars.

The Buseke Deep Valley: is a long deep natural valley bisecting the Bushubi area in two topographical higher west and the lower parts to the east. Because of its flat bottoms in larger portions with many rocky outcrops and caves, the valley used to harbour large numbers of game. Ancient chiefs and colonial rulers used the areas for picnic, meetings, rituals and hunting grounds. This is another site for tourists fond of nature.

Other sites of interest to visit in Ngara District include caves, rock footprints, transborders'chief administration tracks from Biharamulo to Burundi, minor water falls and sacred water.

The weakness of the tourist sector in Ngara in the pats was caused mainly by lack of road and hotel infrastructure and as well as lack of electric power and communication infrastructure in the past. This was the case for all other districts of Kagera Region including Karagwe District which is entirely in the Kagera River basin

These issues are being addressed as a priority in regional development. Tarmac road projects are being implemented in Biharamulo, Ngara and Karagwe districts. Telephone communication is already established since Vodacom, Celtel and TTCL , Telephone providers are already present in Kagera Region. Other services like banking are also available.

There is a need to involve the private sector to improve further tourism infrastructure, especially accommodation and support services including travel agencies network, and tour guiding. This of course should go along with tourism marketing and improvement of tourist site management

There is a good potential for tourism in Biharamulo District especially in Burigi National Reserve. Biharamulo District has game reserves in which different types of wildlife can be found. In additional to game reserve the district has the ***Burigi National Reserve Project*** of about 1,300 square km² (a small area of this reserve is in Karagwe district) in which wildlife hunting is done by tourists. Local harvesting is however not accepted. Participatory wildlife management should be introduced to minimize the problem of poaching and enable nearby communities benefit from wildlife.

Water falls in the reserve that has potential for hydroelectric power production and irrigation potential may also be used as sites for ecotourism.

Beside bird watching in Minziro Forest in Missenyi District, game hunting in the game reserves of Biharamulo, Ngara and Karagwe, another type of tourism attraction is the thermal water sources at Ruhwa, Mugara and Mutagata in Karagwe District.

For tourists interested in culture heritage, alternative attractions include traditional dance, traditional architecture and crafts like basketry, pottery, iron smith work, canoes and boat building.

12.2.5 Uganda

Uganda is endowed with valuable natural resources that give it a strong base for generating substantial income. The physical beauty of Uganda, a country which is sometime called “The Pearl of Africa “has golden savannas, semi-desert, thirst lands, equatorial rain forests, and farmlands as well as rain mountains. The major attractions in Uganda that include the following:

- Kibale Forest National Park,
- Lake Mburo National Park,
- Queen Elisabeth National park.

The Kibale Forest National Park is a resave that is inhabited by a wonderfully diverse community of animals, which includes red colobus, red-tailed guenon (white-nosed monkey), grey-cheeked mangabey, blue monkey, L'Hoest's monkey, and black and white colobus. Along with these are olive baboon, bush baby, the nocturnal potto and chimpanzee. These animals have been the subjects of long-term research projects, so they are now tame and easy to observe. A trail grid has been cut in the forest to facilitate walking. Kibale is located just east of the Rwenzori, near the town of Fort Portal.

Lake Mburo National Park is situated at 230 km south west of Kampala. It is characterized by a varying landscape, a beautiful flora and fauna. It has lakes, 68 different species of animals, and 313 different species of birds.

Queen Elizabeth National Park which is situated in the west of Uganda was gazetted as a wildlife reserve in 1952 when Queen Elizabeth II visited the area. The park is rich in biodiversity. The park's northern section is particularly scenic and attracts tourists loving nature. It is an interesting park to view lions and leopards, grazing topi, kob and buffalo.

12.3 Strengths and Weaknesess of the Tourism Sector

Strengths	Weaknesses
Numerous tourist attractions based on the natural environment have been identified and in some cases already developed to some extent in Kagera River basin, and more of these can be in future Serious efforts for conservation of the natural habitat of rare fauna and flora exist in the countries of Kagera River basin. These efforts are reflected by the various policies and laws in dealing with the protection and conservation of natural resources. There are initiatives for identification of tourist attractions , advertising for tourists, and some tourism development in the Basin	Inadequate investment in tourism infrastructure including accommodation facilities in the Basin. Infrastructure to support the tourism industry is insufficient in Kagera River basin and this insufficiency is critical in Burundi and Rwanda In addition to insufficient infrastructure, the skills required for a developed touristy industry are lacking There is little promotion of existing tourist attractions on local and external markets Investment funds in tourism are scarce

12.4 Conclusions

As summarized in Section 12.1, *pro-poor tourism* development offers opportunities to alleviate poverty in the Kagera basin. Developing these opportunities will involve partnerships with governments and the private sector. Because of the clear links to poverty alleviation, donors can also be encouraged to support such activities.

Partnerships with businesses are most likely to be in the tourism destinations. Useful approaches in developing pro-poor tourism are to:

- Facilitate partnerships between small business and the wider tourism industry;
- Support micro finance aimed at promising small businesses which are without sufficient collateral or track record to attract commercial finance and are beyond the scope of development banks;
- Assist in the enhancement of linkages between tourism and other sectors; and
- Promote improved visitor awareness.

At the international level a number of private sector tourism bodies have embraced the environmental agenda but not focused on any social agenda in relation to poverty elimination.

There is potential for partnerships to be established with one or more such associations to promote the social agenda in tourism.

As for donor involvement, there are compelling reasons for focussing efforts on pro-poor tourism:

- Tourism is a massive and growing industry, already affecting millions of the poor. So a marginal improvement could generate substantial benefits;
- Tourism has advantages over other economic sectors in relation to poverty elimination;
- Even if the poorest will not be direct beneficiaries of tourism, it is important to reduce the costs they face. Benefits can be expanded for the 'fairly poor,' such as tea-sellers, casual and unskilled workers, artisans, and others;
- As a poverty intervention, tourism probably does not compare with more direct tools, such as investment in health, education and agriculture. But as a strategy for promoting broad-based growth (also essential for achieving poverty elimination), pro-poor tourism has good potential;
- Progress in placing environmental issues on the tourism agenda shows that concerted action can make a difference, even in such a diverse industry as tourism;
- Limited evidence suggests a range of strategies can be used to develop pro-poor tourism, but little is being done in practice. So much remains to be done.

Three underlying issues influence all of the above and also need to be addressed. These are:

- Participation of the poor in decision-making;
- Government commitment and capacity; and
- Business interest in pro-poor tourism.

12.5 Recommendation: A Pro-Poor Tourism Development Programme

It is recommended that a comprehensive, basin-wide *Kagera River Basin Pro-Poor Tourism Development Programme* be developed and implemented within the context of the responsible river basin organization finally established. It is proposed that as part of the Kagera River basin development scenario, a feasibility study be carried out by qualified experts for this program. The initially estimated cost for such a programme is USD 1 million.

The feasibility study should consider the wider context of the evolving economic and political cooperative relationships betteen the members of the EAC, especially Kenya and Tanzania which already have a well-developed tourism industry/

13. Mining and Industry

This section is included in a discussion of water and natural resources management insofar as these activities support social and economic development and can also have impacts (positive and negative) on water resources management. Mining and industrial activities of require water adequate quality but also have by-products and wastes that can have a negative impact on other uses within the basin.

We start first by a discussion of mining and its relationship to poverty in general, and an overview of the existing and proposed mining activities within the basin.

We continue with an overview of industrial activities in the region, and conclude with a brief summary of the strengths and weaknesses of these sectors.

13.1 Mining in the Kagera River Basin

Kagera Basin has a great potential for mining development. Mining industries exist in the basin, but are at a different development levels.

13.1.1 Mining and poverty

Potential positive impacts on the poor

Mining can contribute to poverty reduction in a variety of ways (Weber-Fahr, et. al, 2002). Most linkages work directly by generating income and creating opportunities for growth for lateral or downstream businesses. There are also indirect linkages through investments, which, in turn, enable better social services and catalyze improvements in physical infrastructure:

- Fiscal impact and foreign exchange income. Commercial-scale mining can be an important source of foreign exchange and fiscal receipts for governments. When managed well, the net foreign exchange and taxes generated by mining can be used by governments as an engine for overall economic growth and as a funding source for social sector and poverty reduction programs.
- Income generation. Small-scale mining provides a livelihood for approximately 13 million workers and their families worldwide. Large-scale mining provides direct employment and for every job created directly by large mines, between 2 and 25 jobs are created with suppliers, vendors, and contractors to the mine and to miners and their families, typically provided in the context of small and micro-enterprise activity.
- Local economic development. Large mining operations often invest substantially in local economic development through training, social services, and public goods such as clean water, transport, energy, and other infrastructure. They can also be a catalyst for improvements in local government capacity as they work with local governments and communities to avoid the creation of a culture of dependency on the mine.
- Improved land-use planning. Geo-science and mapping data collected for mining purposes can contribute to improved land-use planning. This can benefit the poor by helping identify and address issues related to competing land uses, which in turn helps to avert negative impacts on agricultural production and food security.

Potential negative impacts on the poor

Mining, and the cessation of mining where it has become economically untenable, can also be a cause of poverty. It can become a drain on a government's budget and can, directly or indirectly, adversely affect the living conditions of the poor and other vulnerable groups. Areas of concern that require monitoring include:

- Governance, corruption, and macroeconomics. If poorly managed, a large and profitable mining sector can have negative consequences on governance and macroeconomic development. The often substantial fiscal incomes derived from mining can create a cycle of corruption and inefficient governance in mineral-dependent economies.
- Environment. Food security can be threatened or compromised by mining-related factors such as loss of agricultural land; water pollution; water supply (which can be affected when the demands of mining operations divert excessive amounts of water from the local supply); tailings management of mineral and stone waste; noise; dust; and land disturbance often associated with mining activities. Each of these therefore presents a potential threat to the health and livelihood of the poor and vulnerable groups who have little mobility or means of alleviating negative impacts.
- Health and human development. Small-scale and large-scale miners are often migrant workers who live without their families and within disrupted social contexts. This situation can encourage a high prevalence of HIV/AIDS and other communicable diseases in and around mining communities.
- Socio-cultural issues. Mining projects frequently are located in remote areas where indigenous communities are members of a distinct cultural group, often a minority within a community of minorities. Here mining activities can have a negative impact on the livelihood of indigenous people, especially with regard to issues concerning land tenure, often causing socio-cultural conflicts within and among communities. At the same time, the lure of new opportunities can create in-migration that may cause new tensions in the community between existing residents and newcomers.
- Negative impacts on non-mining sectors. Large mining operations can inadvertently have an adverse effect on the ability of the local non-mining population to achieve and sustain economic self-sufficiency.

13.1.2 Mining in Burundi

Burundi is a producer of columbium (niobium) and tantalum ore, gold, tin ore and tungsten ore, most of which, in 2005 was designed for export. The country produces also limestone, peat, and sand and gravel for domestic consumption. Additionally, Burundi has resources of cobalt, copper, feldspar, nickel, phosphates rock, platinum group metals (PGM), quartzite, rare earth elements, uranium, and vanadium. In 2005, manufacturing accounted for 8% of Burundi's gross domestic product, construction 5%, and mining and energy, only 1%.. An open mine of pit in Musongati is expected to produce 45,000 metric tonnes of nickel per year, 7,500 tonnes of cobalt per year and 2,500 tonnes of copper per year. Production of gold increased from425 kg in 2001 to 3,228 kg in 2004 to 33,905 kg in 2005. Gold accounted for 90% of recorded production of minerals in 2005. Gold mines are concentrated in Muyinga province which border Tanzania in north-eastern Burundi.

Artisan miners exploit tin and tungsten. In 2005, production of tungsten amounted to 94 metric tonnes, and tin 4 tonnes. Tin and tungsten accounted for 3% of the reported mineral production. A deposit of peat has bean found in Akanyaru river valley near Buyongwe. Peat is produced for domestic consumption.

There are no known deposits of coal, natural gas or petroleum. Burundi could benefit from the production of mineral depending on the behaviour of the mineral world market and its political stability. The people of Burundi could see an improvement of their livelihood, although increased minerals; production will result in notable environmental degradation and a high volume of water use.

13.1.3 Mining in Rwanda

Rwanda produces and exports the following minerals: gold ores, columbite concentrates, tantalite concentrates, tin, and tungsten. Rwanda produces also, cement sapphire and a small quantity of natural gas. Rwanda was also known as a producer of beryllium, kaolin and peat. Rwanda also re-exports concentrates of columbites, tantalite and tin from the Congo Kinshasa.

In 2004, the value of production in the mining and quarrying sector rose by 55%. From 1999 to 2004, mineral exports accounted for nearly 45% of the increase in Rwanda total exports.

Artisanal miners produced small quantities of gold in Nyungwe forest, but mining in Nyungwe Forest has now been prohibited.

Rwanda exports cassiterite produced in Gatumba and Gisenyi factories. Cassiterite accounted for 16% of total exports in 2004, compared with 7% in 2003, and 3% in 2002. Beside the production of gold and tin, Rwanda produces cement and natural gas. The trend of the production of minerals in Rwanda is shown in the table below.

Table 13.1 - Rwanda Mineral production

Mineral types	2000	2001	2002	2003	2004
Cement	70,716	912,004	100,568	104,613	104,205
Columbium and tantalite					
Gross weight ore concentrates (kg)	561,000	41,000	96,000	128,000	200,000
Nb content (kg)	176,000	76,000	30,000	40,000	63,000
Ta content (kg)	121,000	53,000	20,000	26,000	40,000
Gold, mine output Au content	10	10	10	2	
Natural gas gross (thousand m^3)	1,373	828	103	314	320
Tin					
Mine output Sn content	276	169	197	192	300
Refined	0	0	25	70	71
Tungsten, mine output W content	108	142	153	78	120

13.1.4 Mining in Tanzania

Tanzania is endowed with various mineral deposits including gold, diamond, base metals, gemstones and industrial minerals. In 2005 exports of minerals represented nearly USD 700 million .The growth rate of mining increased from 9.6% in 1996 to 15.7% in 2005. Tanzania has eight large gold mines and is thus the 3rd largest worldwide after Ghana and South Africa in gold production. The Barrack Company which exploits the eight mines in Tanzania is the world biggest goldmine company.

The portion of Tanzania which is part of the Kagera Basin has important deposits of minerals. Small miners with insufficient equipment exploit gold mines. Important mines of nickel have been discovered Kabanga in Ngara and gold in Biharamulo districts. The Tulawaka gold mine in Ngara District is one of the largest gold mines in Tanzania, together with the Resolute Golden mine in Nzega, the Bulyankulu goldmine in Kahama, the Placer Dome gold mine in Tarime, and the Buhemba Goldmine in Musoma.

Kabanga locality in Ngara District has one of the world's most attractive underdeveloped nickel sulphite deposits, with inferred resources of 36.3 millions tonnes grading 2,8% nickel. A feasibility study was started in February 2007 and exploration has already cost more than USD195 million. In 2005, Barrick 's subsidiary Kabanga Nickel Company Ltd signed with Falonbridge a contract to delineate Kabanga deposits and explore Kagera belt. Production of Nickel is expected to start in 2008. It is known that the north-western Tanzania has nickel, cobalt, copper, tin and tungsten-bearing rock, and the chance is that more minerals will be discovered in Kagera region. It is also known that the western Tanzania that includes Ngara and Biharamulo region has gold bearing rock. Gold is already exploited in Biharamulo. In Karagwe district, tin has already been discovered, but exploitation has not started yet. This potential mining development, if implemented, will result in employment, increased wealth for the rural people of the Kagera Basin. Mining investment normally goes along with the provisions of social services including water supply, education, and health.

Mining requires the use of large volume of water, and result in huge environmental pollution and degradation. The development of more mining in Kagera basin should not be implemented without parallel measures of environmental conservation. Already canyons and quarries can be observed in Kabanga mining site before effective mining production has started.

13.1.5 Mining in Uganda

Uganda has made a great effort to survey and discover minerals. Although it is known where minerals are found, there are areas with potential mineral production that have not been yet explored. The Uganda government is looking for investors to develop the mining sector. The value of mineral exports has increased from USD 53.4 million in 1990 to USD 120.0 million in 2000. The table below shows the trend of mineral production from 1995 to 2002.

Table 13.2 - Uganda Mineral Production Performance (1995-2002)

Mineral	1995	1996	1997	1998	1999	2000	2001	2002
Gold(grams)	1,507	3,000	6,400	8,150	4,730	55,980	14,200	25,650
Tin ore(tons)	4,29	0.38	1.31	1.1				
Wolfram(tons)	17.31		11.76	7.83	0.32	0.12	26.69	24.82
Tantalite/columbite (tons)	1.82				256.3	2.27	11.09	6.46
Iron ore(tons)	7	200	2,432	785		2,400	1,236	
Vermiculite(tons)							220	664
Cobalt(tons)					76.74	410.75	511.99	
Limestone(tons)	209,512	159,479	919,353	140,235	121,521	253,032	229,032	140,022
Gypsum(tons)	5,467	2,281		143.35	256.6		5.12	

The Uganda government with the support of the French Government and the United Nations Development Programme appraised the mineral occurrences and this resulted in the discovery of mineral targets including the following:

- Kasese cobalt
- Tira gold mine near Busia
- Bjordal wolfram mine at Nyamuliro, Kabale
- Wampewo tantalite mine at Wakiso
- Kisita gold mine near Kyakidu,
- Namekhara vermiculite mine in Bukusu in Mbale.

However, current mineral production is still too low to satisfy the local demand. While limestone mined for the production of cement and lime is largely consumed locally, aggregate, gravel and small quantities of gold, tin and tungsten concentrates are currently produced largely for export. There are many high mineral potential areas in Uganda which remained inadequately explored.

The list of discovered minerals include beryllium, bismuth, chromium, copper, cobalt, gold, iron ore, lead, lithium, niobium-tantalum, tin, clay, diatomite, feldspar, limestone, marble, salt, and vermiculite. Potential mineral not yet explored include platinum group metals, diamond, nickel and rare earth elements

13.1.6 Conclusions

The development of mining in Kagera Basin is dependent on the development of the world mineral market prices. Favourable mineral world prices will boost mining production. In Rwanda and Burundi social stability is a positive factor to attract heavy investments in the mining sector. In all the countries of the basin acquiring investment capital is a requisite for mining development. Availability of adequate road network, communication facilities reliable electricity, skilled labour and banking services are important conditions for a sustainable mining sector that can maximize the benefits to the community.

13.2 Industries

13.2.1 Industries in Burundi

The types of Burundi industrial products include beverage production, coffee and tea processing, cigarette production, sugar refining, pharmaceuticals, light food processing, textiles, chemicals (insecticides), public works construction, consumer goods, assembly of imported components, light consumer goods such as blankets, shoes, soap.

The contribution of industrial sector in the economy of Burundi represents 20% of GDP in 2006. The manufacturing sector in Burundi was only less than 1% in 2001. The contribution of the manufactured goods to total exports declined from 2.65% in 1993, and 0.71% in 1996 to 0.23% in 2001.

Major industries in the portion of the basin part of Burundi has coffee and tea industries

13.2.2 Industries in Rwanda

Rwanda industry includes cement, agricultural products, small-scale beverages, soap, furniture, shoes, plastic goods, textiles, and cigarettes. As in Uganda and Burundi, there are many small workshops operated by one of several operators and using simple tools and equipment.

Industrial sector in Rwanda contributed 8.6% of GDP in 2001 from 10.6% in 1999. This sector employs barely 2% of the labour force. The industrial production in Rwanda grew by 7% in 2001. Sugar, tea and coffee is situated in Kagera basin part of Rwanda.

Rwanda has also an important factory that produces pyrethrum products.

13.2.3 Industries in Tanzania

Industries in Tanzania include primarily agricultural processing (sugar, beer, cigarettes, fish, and sisal twine), textiles, clothing, tires, batteries, pharmaceuticals, bricks and tiles, electrical goods, petroleum refining, metals, motor vehicles, footwear, cement, wood products, fertilizers, pulp and paper.

Tanzania has agricultural processing industries producing sugar, beer, cigarettes and sisal twine. There are also factories that manufacture textiles products, clothing, tires batteries and pharmaceuticals. Goods manufactured in Tanzania include electrical goods, refined petroleum products, metals, motor vehicles, footwear, cement, wood products, fertilizer, pulp and paper.

In Kagera River basin appertaining to Tanzania, the following industries have been established:

- Kagera Tea Company Ltd
- Katoke Tea Estate
- Kagera State Oil Mill Manufacturing
- Kagera State Trading Co.
- Mali Juice Factory
- Kagera Sugar Ltd
- SBC Ltd
- Karagwe Marketing Cooperatives
- Karilo Cooperative
- Kagera Tea Company Ltd
- Amri Hamza Ltd
- IKA Investment
- Tanganyika Instant Coffee Co Ltd
- Biharamulo Cotton Company

There are a few agro-processing industries which provide market for rural products and employment in Missenyi District. There is a major sugar factory in Missenyi District. In 1995, the district commissioned an identification study on small and medium scale agro-processing industries in the fruits and vegetables sector. Some potential fields of investment (passion fruits, fruit cakes, cassava and banana four, dried fruits, banana juice/chips) have been identified which can improve the income and employment situation of rural households. Missenyi District Authorities are looking for investors in food processing.

In 2000, the industries in Kagera employed 1576 workers in all the districts of Kagera Region. Generally, industrialization is in its infancy in Kagera region. Late industrialization was due to lack of infrastructure, lack of electricity and good roads. Development of infrastructure in Kagera Region is progressing well. There are also several small scale industries including metal works, wood works, milling, saw mills, garages and tailoring marts.

13.2.4 Industries in Uganda

Uganda industries include beverages, tobacco, textiles and apparel, leather and leather products, wood products, metallic products, clay products, cement and chemicals.

The manufacturing sector in Uganda is small, contributing only 18% to GDP. The sector is characterized by small scale processors of agricultural commodities (food processing), and production of basic consumer goods.

13.2.5 Industries in the Kagera River Basin - conclusions

Besides the classical benefits that result from any industry (employment, income, salaries, knowledge and skills, social services), the bye-products and the wastes of the main product can provide additional beneficial uses sometimes requiring an additional cost that is not necessarily prohibitive.

The main industries in the Kagera Basin are agro-processing industries, including coffee, sugar and tea. All these industries produce wastes and by-products that can procure additional beneficial uses to the community. Diversification of agriculture would also have similar effects.

13.3 Strengths and weaknesses in mining and industries

Strengths	Weaknesses
Tanzania is making progress in nickel mining survey at Kabanga in Ngara district, while there are plans for mineral exploitation in the other countries of Kagera River basin Small miners are exploiting cassiterite and gold in the Kagera River basin There is a high awareness of the need for regional cooperation in trading within the riparian countries and this is demonstrated by the existing water basin programmes Investment in transportation and communications infrastructure such as highways construction, tele-communications, power, and financial services such as banking are taking place in the Basin, and these investments are a positive factor contributing to the boosting of industries, mining and trade.	Small miners use simple tools and equipment to mine gold, cassiterite and gems in the Kagera River basin There is no adequate local investment funds to inject in the mining sector The outputs of the mining sector are aimed at export not at local consumption There is insufficient use of sugar and coffee bye-products into alternative uses for the direct benefits of the community (production of biogas) Cooperation in increasing international trade between the countries of Kagera River basin could be improved for the mutual benefit of the countries' economies. Heavy imports of manufactured products that have no short term impact to the community. Insufficient diversification of export products that could boost income.

13.4 Recommendations for futher study and action

It is recommended to carry out a study for the development of shared infrastructure designed to support the development of industries, mining, and trade in Kagera River basin.

14. Strategic Framework for Integrated Water Resources Management and Development of the Kagera River basin

14.1 IWRM principles and approach

Transboundary water and related resources management is today being carried out through application of Integrated Water Resources Management (IWRM) principles. IWRM as defined by the Global Water Partnership (2007) is *"a process which promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital eco-systems".* As the name suggests it is an *integrated* approach:

- IWRM considers not only the *bio-physical* interdependencies within ecosystems, such as the Kagera River basin, but also the related *economic* and *social* interactions and demands;
- IWRM is *participatory*, with an emphasis on *stakeholder involvement*, including *women*, in water development and management; and
- IWRM considers *water as an economic good* which cannot continue to be freely available to all competing users and uses.

IWRM explicitly challenges conventional water development and management approaches. It starts with the recognition that traditional top-down, supply led, technically based and sectoral approaches to water management are imposing unsustainably high economic, social and ecological costs on human societies and on the natural environment. Business as usual is neither environmentally sustainable, nor is it sustainable in financial and social terms. As a process of change which seeks to shift water development and management systems from their currently unsustainable forms, IWRM has no fixed beginnings and will probably never end. The global economy and society are dynamic and the natural environment is also subject to change, IWRM systems will, therefore, need to be responsive to change and be capable of adapting to new economic, social and environmental conditions and to changing human values.

IWRM is not an end in itself but a means of achieving three key strategic objectives.

- *efficie*ncy to make water resources go as far as possible;
- *equity*, in the allocation of water across different social and economic groups; and
- *environmental sustainability*, to protect the water resources base and associated eco-systems.

14.2 IWRM and "benefits-sharing"

Underlying the IWRM approach is the understanding that water resources management can be considered as the very foundation of any modern economy. For examples, we only need to look the harnessing of the Nile River for agriculture and hydropower as the basis for the modern state of Egypt, or the role of water resources development in opening of the American West. There is no question that water is the foundation for all sustainable human activities.

The benefits of an integrated approach to water resources management therefore should be to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital eco-systems. That is, an IWRM approach is intended to maximise and optimise mutual benefits from these resources.

Also, contrary to those who believe that the next wars will be fought over water, it has been demonstrated through countless international experiences, that water is actually a driver for cooperation and regional integration (Wolf, 1997). A good regional example is that of the Southern African Development Community (SADC). The SADC arrangement is based on a regional treaty known as the *SADC Founding Protocol* which is supported by a range of other treaties, one of which is the *SADC Protocol on Shared Watercourses.* This established the enabling environment in which water resources management can be developed to the point that a range of complex water development activities and transfers can be implemented over time. It appears probably that the future economic viability of the four most water-scarce States in the SADC Region is closes associated with this process (Phillips et. al, 2006).

Perhaps the Eastern African Community and its Lake Victoria Basin Commission can provide a similar *enabling environment* for IWRM in support of human and economic development in the Kagera River basin countries?

Benefit-sharing, is being increasingly put forward as a basis for cooperation in transboundary water resources management (Phillips et. al. 2006, Sadoff and Grey 2002). As a relatively new concept as compared with cooperation based on more simplistic *water allocation* agreements, it needs to be significantly developed. However, due to the consistency of *benefit-sharing* approach with modern understanding of IWRM and international water law, it has been proposed as the basis for discussions on water resources management and development in the Kagera River basin.

14.3 Institutional requirements

Promoting cooperation on transboundary water management is to a large extent process-related. These processes typically require institutions, typically *river basin organizations* (RBOs), supported by appropriate legal frameworks (e.g. treaties and protocols between the respective governments) enabling multi-sectoral water use management and the building of trust amongst the riparian states.

Promoting cooperation is a long-term and resource-intensive process, but considered essential and cost-effective in enabling IWRM and benefit-sharing in a transboundary context. To be effective, such institutional frameworks and arrangements must also be supported continually by top-level commitments within the riparians. In the economic context of the Nile basin and specifically the Kagera basin, continued external public funding to support cooperation is justified (Jägerskog et. al. 2007).

Possible legal and institutional frameworks for the Kagera basin are the subject of the parallel *Cooperative Framework* consultancy. We have provided a summary review and recommendations in Section 5 of this monograph.

14.4 IWRM Strategic Framework for the Kagera River Basin

It is desirable that stakeholders, represented by decision-makers within the Kagera River basin, have a shared strategic vision for water resources management and development. In spite of the fact that the details on the legal and institutional arrangements are presently being worked out through the *Cooperative Framework* consultancy and other ongoing discussions in the Kagera River, Lake Victoria and Nile River basins, it is not premature to put forward strategic principles that are already commonly understood as expressed by existing commitments and institutions. These are for example:

- The UN Millennium Development Goals – especially those related to water and resources management;
- The principles of international water law;
- The vision and mission statements of the East African Community;
- The statements of cooperation of the Lake Victoria Basin Commission;
- The vision of the Nile Basin Initiative; and
- The objectives of the Kagera Transboundary Integrated Water Resources Management and Development Project.

On the basis of these and the principles of IWRM, *strategic directions* for IWRM for the Kagera River basin are proposed for discussion.

14.4.1 Millennium Development Goals

The United Nations Millennium Declaration of 2000 adopted as a resolution eight Millennium Development Goals (MDGs) – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015. These goals form a blueprint agreed to by all the world's countries and all the world's leading development institutions.

Although improved water resources management and development are implicated in all eight MDGs, goals that are particularly relevant to the management and development of water and related resources are:

MDG 1: Eradicate extreme poverty and hunger

- Reduce by half the proportion of people living on less than a dollar a day.
- Reduce by half the proportion of people who suffer from hunger.

MDG 7: Ensure environmental sustainability

- Reduce by half the proportion of people without sustainable access to safe drinking water.

A direct contribution offered by IWRM to this goal is to facilitate, in a structured way, the achievement of a balance between economic and social objectives and activities, and environmental sustainability.

IWRM therefore provides a framework within which to consider tradeoffs between different development objectives, benefits, sectors and regions and, where possible, to identify *win-win* investments. By aligning and integrating interests and activities that are traditionally seen as unrelated or that, despite obvious interrelationships, are simply not coordinated, IWRM can foster more efficient and sustainable use of water and related resources to achieve the MDGs (GWP, 2007).

14.4.2 International water law

The primary role of international water law is to determine each State's "entitlement" to the *benefits* of the use of an international watercourse and to establish certain requirements for States' behaviour while developing the resource (Wouters et. al. 2005). The *1997 UN Convention on the Law of the Non-navigational Use of International Watercourses* is generally considered to be the most recent and authoritative legislative instrument relating to international water law. Underlying this convention are the following three key principles:

Equitable and reasonable use: Customary international law provides that each state has the right to an *equitable and reasonable use* of a transboundary watercourse located in its territory. This right, however, is limited by an obligation not to act so as to prevent other states from enjoying their *equitable* use. International water law provides guidance on how the principle of equitable and reasonable utilisation is to be implemented – i.e. that *all relevant factors* must be identified and considered together and a conclusion reached on the *basis of the whole*.

Avoidance of significant harm: States are under an obligation to take all appropriate measures to ensure that activities conducted under their jurisdiction do not cause significant harm to or within the territory of other states.

Prior-notification of works which may affect co-riparians: States must provide prior notification and exchange information with respect to a planned measure that might significantly harm other watercourse states.

14.4.3 East African Community

The *Treaty for the Establishment of the East African Community* (EAC) was signed at Arusha on 30th November 1999 by representatives of the governments of Kenya, Tanzania and Uganda. In June 2007, Burundi and Rwanda also joined, thus expanding the EAC membership to five countries, consistent with the countries sharing the Lake Victoria basin.

Vision: The vision of EAC is to have a prosperous, competitive, secure and politically united East Africa.

Mission: The mission of EAC is to widen and deepen economic, political, social and cultural integration in order to improve the quality of life of the people of East Africa through increased competitiveness, value added production, trade and investment.

14.4.4 Lake Victoria Basin Commission

In November 2003, the *Protocol for Sustainable Development of Lake Victoria Basin* was concluded and signed by the governments of Kenya, Tanzania and Uganda under the provisions of the EAC Treaty. The Protocol provides for, among others, the establishment of an EAC institutional framework to manage the Lake Basin namely: Lake Victoria Basin Commission (LVBC), which is to be an Apex institution of the Community responsible for all the initiatives in the Lake Victoria Basin.

Article 3 of the Protocol states that:

"The Partner States have agreed to cooperate in the areas as they relate to the conservation and sustainable utilisation of the resources of the Basin including the following:

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

Provisions of the Protocol enable states that become party to the EAC Treaty to become *de facto* party to the Protocol. On this basis it is understood that Burundi and Rwanda, through their recent membership in the EAC, are also therefore members of the Lake Victoria Basin Commission.

We view this evolution of the EAC and the LVBC positively as it is consistent with IWRM principles of integration of the management and development of the physical ecosystem (the Kagera River basin) in synergy with the regional political and economic governance mechanisms.

14.4.5 Nile Basin Initiative

The Nile Basin Initiative (NBI) is a partnership initiated and led by the riparian states of the Nile River, including the Kagera River basin countries, through the Council of Ministers of Water Affairs of the Nile Basin states (Nile Council of Ministers, or Nile-COM).

The NBI seeks to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security. Cooperative water resources management is complex in any international river basin. In the Nile Basin, which is characterized by water scarcity, poverty, a long history of dispute and insecurity, and rapidly growing populations and demand for water, it is particularly difficult.

The NBI started with a participatory process of dialogue among the riparians that resulted in their agreeing on a shared vision — to *"…achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources."*

14.4.6 The Kagera Transboundary IWRM and Development Project

The Nile Equatorial Lakes Subsidiary Action Programme (NELSAP) of the NBI has established the Kagera Transboundary IWRM and Development Project with the following objective:

"To develop tools and permanent cooperation mechanisms for the join, sustainable management of the water resources in the Kagera River Basin in order to prepare for sustainable development-oriented investments to improve the living conditions of the people and to protect the environment."

14.5 Conclusion: Proposed "Strategic Directions for IWRM for the Kagera River Basin"

The declarations and commitments summarized above elicit many consistent aspects. On the basis of these, we are proposing the following *"Strategic Directions for IWRM for the Kagera River Basin"* for consideration by its stakeholders:

- 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 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 optimise benefits from the joint resource and to minimise 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 basin from harmful effects of development.
- Dealing with climate variability: To prevent, mitigate or minimise 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.

15. Scenarios for Kagera River Basin Development

15.1 Introduction – analytical framework

The *strategic framework* for the integrated management and development of the water and related resources of the Kagera River basin proposed in Section 14 has been based on *integrated management and development of the water and related resources in a manner that alleviates poverty while sustaining the environment*. However, regional human and economic development within the context of natural resources management is a much more complex subject.

There are many factors related to water and resources management that are within the capacity of water managers stakeholders to influence - and decisions about these can be based on an assessment of the *strengths and weaknesses* of the relevant water and resources sectors. However, there are also many *external factors* which influence development, some positively and other negatively, and we categorize these here as *opportunities and threats.*

This section of the monograph seeks to identify and discuss these various factors and inter-relationships on the basis of an analysis of these *strengths, weaknesses, opportunities and threats* (SWOT), finally focussing on those that are relevant to Kagera River basin water resources management and development. This SWOT analysis factors were discussed during regional/district consultations in October 2007, in each of the Kagera basin countries. This framework, summarized in Figure 15.1, describes:

- The *cross-cutting factors* underlying development in the Kagera basin presented in Sections 2 to 5 of this monograph;
- *Opportunities and Threats*: external conditions that are helpful and/or harmful to achieving the development objectives:
- The main *human driving forces* underlying development;
- Other *external factors*, beyond the control of decision-makers and leaders within the basin;
- The *enabling governance environment* for integrated water resources management;
- *Strengths and Weaknesses*: attributes of the water and resources sectors that can help and/or limit achieving the development objectives:
- The main water and resource use constraints and issues of relevance to the Kagera basin;
- The main opportunities for management and development of the *beneficial uses* discussed in Sections 6 through 13 of this monograph;
- Key *development indicators* enabling us to monitor the progress towards achieving sustainable development in support of poverty reduction; and
- Possible *Kagera River Basin Development Scenarios* pointing the direction for future investment.

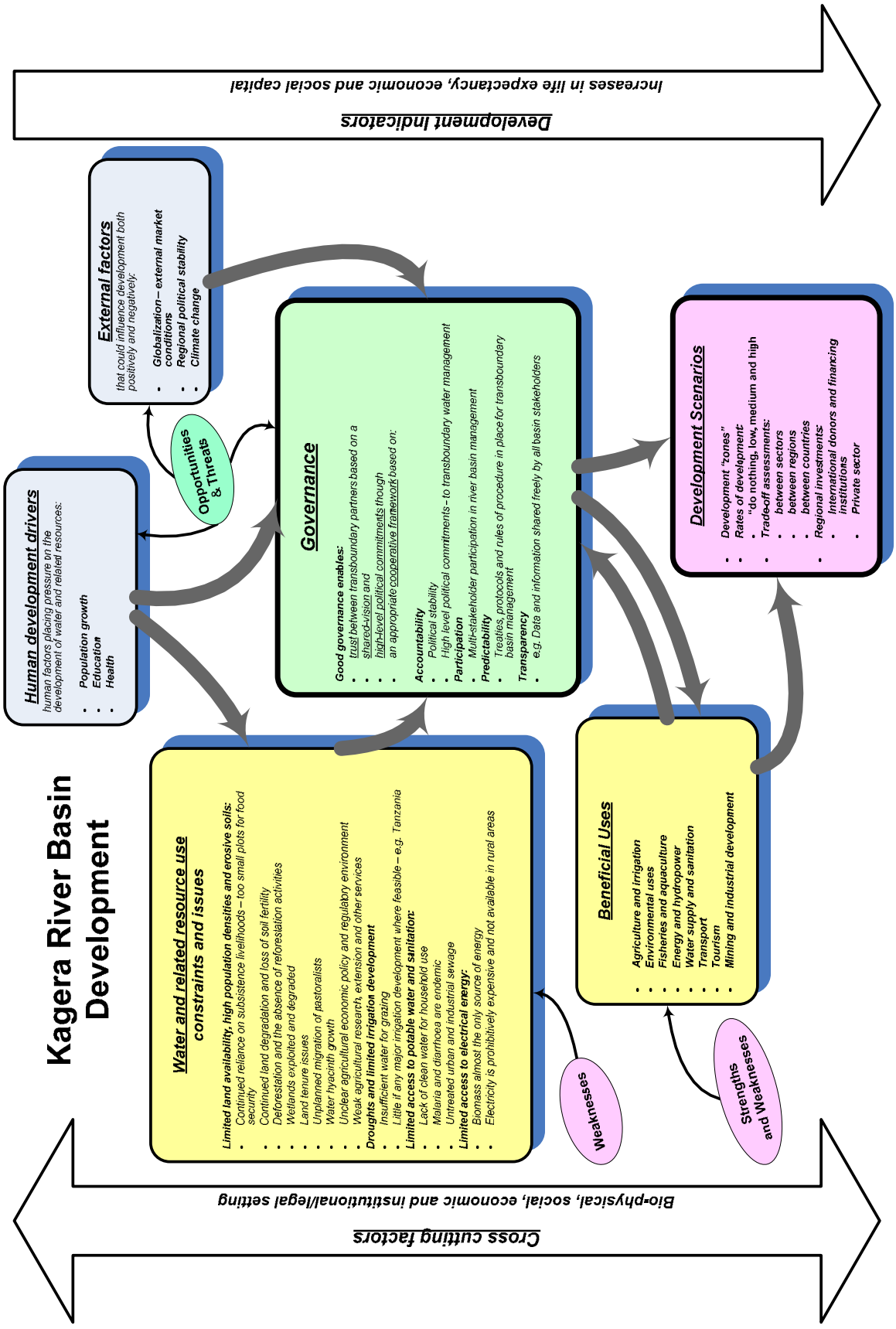


Figure 15.1 – Kagera River Basin Development Analytical Framework

In our analysis, each *sector* (beneficial use) has been assessed from the perspective of the strengths and weaknesses as part of a SWOT analysis to the transboundary water and related resources development in the basin:

SWOT Analysis	Helpful to achieving the development objective	Harmful or limiting to achieving the development objective
Internal attribute of the sector or *beneficial use*	**Strengths** resulting from good management	**Weaknesses** resulting from poor management
External attributes or conditions	Opportunities	Threats

This analysis is intended to set the stage for subsequent analyses of the *trade-offs* between sectors, regional and possibly countries in formulating development scenarios which optimise opportunities for the Kagera basin as a whole.

In carrying out our analysis, we have in the back of our minds the following questions:

- How can we use the *Strengths*?
- How can we mitigate the *Weaknesses*?
- How can we exploit the *Opportunities*?
- How can we defend against the *Threats*?
- Our analysis emphasizes the *Strengths* and the *Opportunities*. The *strengths* are particularly important as they are internal – i.e. directly linked to water and related resources management and development.

15.2 Development drivers

15.2.1 Cross-cutting factors

Water and natural resources management in any particular region are necessarily constrained by:

- the available natural resources - the *biophysical setting* - within the context of the basin ecosystem,
- the human beings who live in and are an active participate in this ecosystem - the sociological setting – i.e. the *peoples* of the basin,
- the *economic* driving forward - the economic setting, and
- the way the peoples choose to govern themselves and manage their resources - the *institutional* setting.

With regard to the Kagera River basin, these cross-cutting aspects have been presented and discussed in detail in sections 2 to 5 of this monograph.

15.2.2 Human drivers

Sustainable development of water and related resources is necessary for human economic development. As inhabitants of planet earth and its various watershed ecosystems we have basic needs and aspirations to advance our physical, economic and spiritual well- beings. The main forces providing both *opportunities* and *threats* underlying the demands place on water and related resources are 1) population density and future population growth, 2) health, and 3) education.

Population growth/density

As discussed previously (ref. Section 4.2) 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 utilisation 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.

Health

Health indicators in the region are presently poor (ref. Section 4.3.3). However, Kagera basin governments are committed to improving preventative and hospital health care availability to their populations. Health care can increase demands on water and related natural resources as life spans increase and the importance of safe potable water supplies and sanitation is provided. Improve health enables societies compromised by high rates of endemic diseases such as HIV/AIDS and malaria to further develop.

Education

Present low levels of education (ref. Section 4.3.4) limit development through weaknesses in human capacities to take advantage of improved techniques and technologies. Education can be a factor in enabling transitions from subsistence livelihoods, as most of the basin population is at present.

It is generally accepted that high population densities and grow rates are caused or aggravated by poverty and gender inequality, with consequent unavailability and lack of knowledge of contraception. Education is recognized as a key to establishing sustainable population growth.

Food security

Closely linked to the high population growth, to the low productivity of agriculture and very small farms in most places, the food insecurity in the Kagera Basin is now also globalized and becomes at the same time an internal factor and an international threat. The current crisis on staple food, especially cereals is affecting the poorest, and food production is revealed (if necessary) as one of the major challenge. According to the FAO, food prices have raised 53% from February 2007 to February 2008.

15.2.3 Water and resource use constraints and issues

As the focus of this monograph is on the sustainable development of water and related resources in the Kagera River basin, the related issues and constraints – expressed in this analysis as mainly *weaknesses* - are important to identify and assess. This analysis is based on:

- The *Rapid Rural Appraisal* (RRA) survey carried out in the Kagera basin countries in 2003 as part of Project preparation. The RRA was carried out through systematically conducted consultations with communities and government officials (WSP International AB et. al., 2003). This appraisal was reinforced by reports written by their national consultants from each of the four countries.
- Our views and opinions developed following assessment of the large amounts of data and information provided from previous programmes, projects and studies, as well as interviews with many key managers and decision-makers in the basin countries and the NELSAP, and the judgement of the key experts on our team. This represents a synthesis of the relevant *weaknesses* identified under the analysis of each of the *beneficial use* sectors (Sections 6 – 13) of the monograph.

The views and priorities expressed following should be further refined and validated through a participatory approach with the basin stakeholders. The relevant issues and constraints have been grouped into four categories as follows. It is recognized that this is a subjective grouping, which may be improved following further consultations:

1. Limited land availability, high population densities and erosive soils

- There is a continued reliance on subsistence agriculture throughout the basin.
- *Continuing land degradation and loss of soil fertility*. This is mainly caused by deforestation resulting from continuing use of firewood for cooking, heating and brick-making, in the past exacerbated by civil wars and movements of refugees, displaced persons and soldiers. There is indifference of local people to the maintenance and reforestation of publicly owned land. Radical terraces on sloping farmland are expensive, and some believe they take up too much space and are therefore unacceptable in Rwanda and Uganda. In Burundi food for work has supported the construction of terraces with the result that farmers have no sense of ownership and terraces are poorly maintained. There is unrestricted cultivation of wetlands and river banks. Little manure is available for fertilizing the land, as cattle herds have been decimated during decades of civil conflict. There is insufficient access to pasture and no fallow land available for grazing due to population pressure. Low levels of improved farm inputs, primitive agricultural methods and absence of chemical fertilizers mean low yields. As population pressure increases more land is cultivated including steep hillsides causing soil erosion to accelerate. There are weak research, extension and other agricultural services available. And there are unclear economic policies and regulatory environments related to agriculture.
- *Deforestation and absence of reforestation activities*. There is an absence of successful reforestation projects or agro-forestry campaigns. This was explained by a lack of consensus on who should reforest and how. Communities are reluctant to invest labour in reforestation projects, where tenure rights are unclear and rights to cut down the trees in the future may be restricted. Communities are also reluctant to grow live hedges for erosion control, when cattle will graze and devour them (except for Euphorbia shrub species which are not palatable). While some farmers may be interested in agro-forestry, the small size of most holdings is a serious constraint.
- Deforestation and soil erosion have negative effects on the Kagera River causing increased sediment load in the river with negative impacts on hydropower and irrigation

infrastructure. Soil erosion is resulting in increased nutrient load in the river as well as in Lake Victoria leading to problems with water hyacinth and eutrophication.

- *Wetlands exploited and degraded.* Wetlands are considered public property to which all have access. Some farmers cultivate small plots for food production in the rainy season; others cultivate swamp and riverine banks of the Kagera in the dry season when they have no other water source. In many areas wetlands are the sole source of water for drinking and livestock watering. No laws or bylaws are in place to restrict cultivation, and no participatory management framework has been introduced. Millions of people have been displaced by civil war and lost their ancestral land and have to depend on wetlands to eke out a living. Many donor-funded wetland development projects have proved unsustainable, because farmers are unwilling to continue maintenance after the money is spent and the donor has left. The degradation of wetlands means a reduction of buffers against environmental disasters, such as flooding, as well as a gradual disappearance of the environmental functions of wetlands, such as breeding grounds for fish and birds.
- *Land tenure*: The traditional inheritance system, and the overall limited land and water resources base, especially in Burundi and Rwanda, results in land fragmentation and creates disputes within families. Farm households, dependent on subsistence agricultural production, retain too small plots to ensure food security and hence encroach on protected areas, such as nature reserves. Absence of tenure security discourages investment in and improvements on agricultural lands.
- Unplanned migration of pastoralists with their cattle. Pastoralists traditionally cross with their cattle into the national parks to Tanzania and Uganda to obtain grass and water for their animals, sometimes burning grass and often coming into conflict with natural predators, park wardens and local resident farmers. In March 2003 pastoralists with 80,000 cattle crossed the Kagera river and papyrus swamps from Rwanda into Tanzania, where they remained for the entire dry season. As a result of such migrations, diseases such as foot and mouth are transmitted across borders. No regional plan exists to manage the annual transhumance or to prevent disease transfer, and no land use plan has been put in place in the border zones to allow for grazing. The migration of pastoralists is a constant source of friction in the border zone, apart from causing environmental destruction.
- Water hyacinth growth. Insufficient attention has been accorded to water hyacinth control, and no incentives are offered to gather up the weed in Rwanda and Burundi. Water hyacinth as well as papyrus proliferate because of the abundance of nutrients in the river system. Control by weevils works less well in the moving waters of the river than in Lake Victoria. The growth of the hyacinth is caused upstream, as mentioned, by the nutrient load in the river. In the lake the hyacinth interferes with navigation and contributes to the destruction of the natural ecosystem, which in turn negatively affects fish stocks.
- There is an unclear economic policy and regulatory environment related to agricultural development
- Weak research, extension and other agricultural services.

2. Droughts and limited irrigation development

- *Insufficient water for grazing*. Prolonged drought affected parts of the basin during 1999-2001. Valley dams constructed to store water for the dry season watering of livestock do not fill up, if rainfall is scarce. Fodder is not available, and even if it were people would not be able to afford it.
- Although significant areas of irrigation potential have been identified in the Tanzania portion of the basin, it appears that *little if any of this potential has been exploited to-date.*

3. Limited access to potable water and sanitation

- *Lack of clean water for household use.* Most communities have no year-round access to either potable or non-potable water supply. There is no easy access to standpipes or potable water due to excessive distance of supply from the dwelling, upland placement of settlements, no infrastructure in place, broken pumps, poor maintenance of government supply. Communities are unwilling and/or unable to pay for standpipe water on a daily basis. Boreholes and springs dry up frequently in the dry season, springs are often polluted with sediment in the dry season, and groundwater may be unpalatable due to excessive mineralization.
- *Poverty is obviously a major constraint*: there is a strong conflict between capacity to pay by villagers and the density of standpipes. In most cases, water supply in villages is a kind of trade-off between the two, leaving anyway a large fraction of people unable to afford clean water.
- *Malaria and diarrhoea are endemic.* Many rural communities in the basin live in close proximity to wetlands and stagnant water, while health centres are often distant and treatment prohibitively expensive. As a result of drinking water unfit for human consumption, many suffer from diarrhoea and gastro-intestinal diseases.
- *Untreated sewage flows into the Kagera.* Sanitary drainage is virtually non-existent in the heavily populated urban centres within the basin, e.g. the city of Kigali. In rural areas sanitary latrines are usually not affordable, and landing stations on the Kagera have few public toilets. There are no regulations enforced regarding industrial sewage.

4. Limited access to electrical energy

- *Biomass almost the only source of energy.* No alternative fuel source is available for cooking other than firewood or charcoal in urban areas.
- Electricity is prohibitively expensive and in any case seldom available in rural areas.
- Plants for biogas have been introduced only in a few locations within the basin.

15.2.4 “Water Poverty” in the Kagera River Basin

The linkage between water and poverty is complex and non-linear. Not all poor people lack adequate water resources and not all people who live in dry areas are poor. Water is used in a variety of both productive and consumptive activities and contributes to rural and urban livelihoods in many different ways. Lack of access to drinking water is itself an indicator of poverty, but the role of water in human well-being is far more complex than simply access to drinking water. Food crop production, fishing, agro-processing and health can all influence and are influenced by the quantity and quality of available water. Rural upper catchments largely contribute to livelihoods by providing valued primarily ecosystem services to downstream urban, agricultural, and industrial users. As the principal water user, agriculture offers important, if complex, opportunities for improvement of livelihoods for both consumers and ‘producers’ of water.

The following paragraph will show two different ways to address the “water poverty” subject in the Kagera River basin.

- On the one hand, we describe a world Water Poverty Index and its assessment for the Kagera River basin riparian countries. The WPI attempts to link poverty to factors relevant water and related resources.
- Based on the descriptions and assessments carried out in this report, we will present a summary synthesis of the main components of the WPI from the perspective of the Kagera River basin and present them synthetically in a water poverty matrix.

The Water Poverty Index (WPI)

In an attempt to link human welfare (poverty) with water, a *Water Poverty Index* (WPI) was developed by Lawrence et. al. (2002) and Sullivan et. al. (2003). The purpose of the WPI is as follows[165]:

- To provide a better understanding of the relationship between the physical availability of water, its ease of abstraction, and the level of welfare;
- As a mechanism to prioritise water needs;
- As a tool for monitoring progress in the water sector (e.g. towards the Millennium Development Goals);
- To help improve the situation for the one to two billion people facing poor water endowments and poor adaptive capacity.

The WPI uses a methodology comparable to that of the UN Human Development Index to enable measuring countries’ position relative to each other in the provision of water in relation to human welfare. The WPI was developed as a holistic tool to measure water stress at the household and community levels. It was designed to aid national decision makers at community and central government level, as well as donor agencies, and to enable determination of priority needs for interventions in the water sector.

The index combines into a single number a cluster of data directly and indirectly relevant to water stress. There are five major components each with several sub-components:

1. **Resources:** Physical availability of both surface and groundwater, taking into account variability and quality as well as total amount of water.
2. **Access:** Access to water for human use, including distance to safe sources, time needed for collection per household and other significant factors. Access also includes water for irrigating crops and industrial uses.
3. **Capacity:** Effectiveness of people’s ability to manage water. Capacity is interpreted in the sense of income to allow purchase of improved water, and education and health, which interact with income and indicate a capacity to lobby for and manage a water supply.
4. **Use:** Different uses of water, including domestic, agricultural and industrial.
5. **Environment:** Evaluation of the environmental integrity, and related to water and of ecosystem good and services, from aquatic habitats in the area.

The WPI adds value as compared with other more simplistic indicators of water stress (e.g. the *Falkenmark index*, ref. section 2.4.7) through a more comprehensive assessment of factors required to enable existing use and sustainable development of water and related resources.

[165] Centre for Ecology & Hydrology, Natural Environment Research Council, U.K. http://www.ceh.ac.uk/sections/ph/WaterPovertyIndex.html

The WPI is far from a perfect indicator and certainly more useful at national and regional levels than in a sub-basin context. Recent worldwide valuations[166] are presented in Figure 15.2. Not surprisingly the WPI for most of sub-Saharan Africa, including the Kagera River basin countries, is “severe” or “high”.

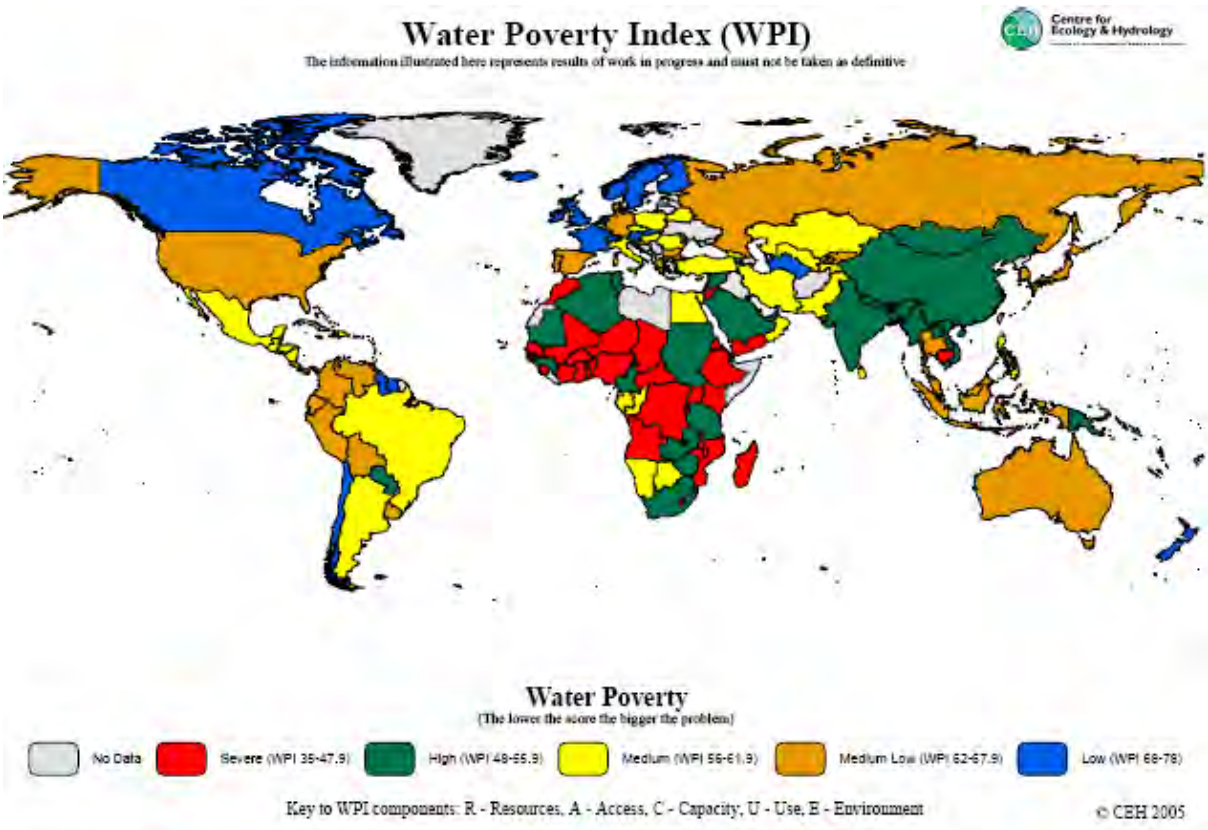


Figure 15.2 – World Water Poverty Index

166 Centre for Ecology & Hydrology, Natural Environment Research Council, U.K. http://www.ceh.ac.uk/sections/ph/documents/WPIworldmap_2.pdf

Water poverty indicators in the Kagera River basin

The WPI as determined above indicates that the Kagera River basin faces severe water poverty. However, as an integrated index, it in itself does not explain precisely the reasons. Any such index is limited in explaining the reality when its purpose is to show in one dimension any multi-dimensional and complex reality.

The descriptions and analyses presented in the *setting* and the *beneficial uses* sections in this monograph has provided an understanding of most of the factors contributing to a severe water poverty in the Kagera basin. Following, we have synthesised in a subjective manner the main WPI components inspired by the strengths and weaknesses described in the monograph. This index is closely linked to the table and footnotes below, themselves closely linked to the descriptions and analyses in entire monograph.

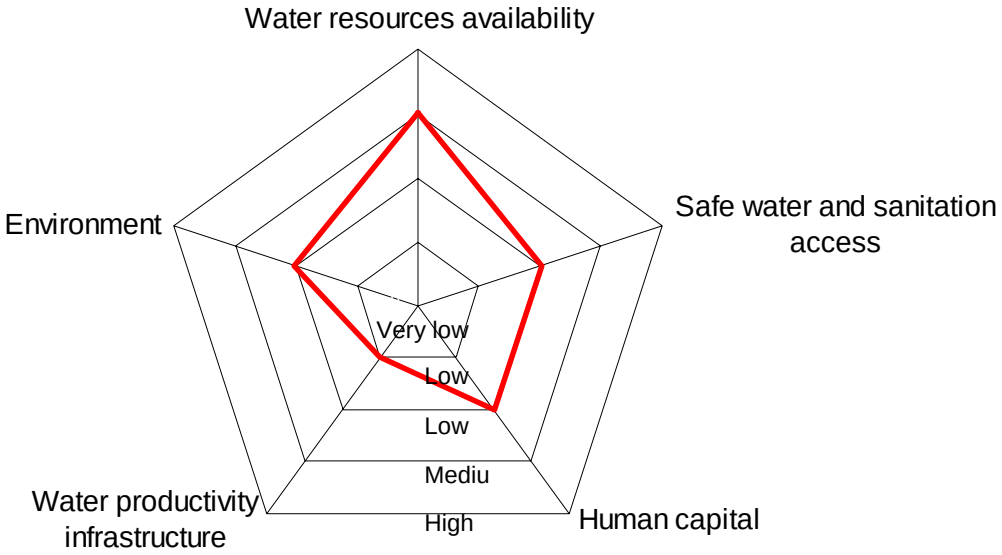


Figure 15.3 – Main water poverty indicators in the Kagera River basin

Table 15.1 – Water poverty sub-components and variables used in Figure 15.3

Indicators	Level	Indicator variables
Water resources availability	Medium[167]	- Quantitative availability of rainwater, surface water or groundwater.
Safe water and sanitation access	Low [168]	- Quality of the available water. - Potable water and sanitation coverage. - Water related diseases.
Human capital	Low[169]	- Human resources. - Regional institutional capacity. - Local institutional capacity.
Water productivity infrastructure	Very Low [170]	- Irrigation development. - Fisheries development. - Hydropower development. - Navigation development.
Environment	Low	- Treatment for waste waters. - Protection of wetlands. - Protection of natural anti-erosion means.

15.2.5 External factors that could influence Kagera basin development

A number of external factors could influence Kagera River basin development both positively and/or negatively providing additional *opportunities* and *threats*:

External international market conditions

External international market conditions may well affect the ability of Kagera basin countries with importation and exportation of commodities. For example, tea and coffee may appear to offer good possibilities as export crops and therefore for crop diversification, however, as international prices are subject to external markets, uncertainty can influence the benefits from these crops.

[167] For a more descriptive assessment of water availability, refer to section 10.1. In hydrologeographical Zones I and II, and part of Zone IV, the availability of water resources is enough to supply a quickly growing population. However, in Zone III, and part of IV it is not. We suggest that averaging the index for the larger area with quite high water potential and a smaller area with low potential results in an overall "medium" designation for the Kagera basin.

[168] Even if water is available, its quality is not always safe for human consumption end its final treatment rare. Water may be polluted because of the lack of sanitation or treatment for waste waters. The water related diseases are a real issue in some parts of the basin.

[169] The population is high and a real opportunity for the basin as far as the proportion of young population is very important. However without improved education and health and increased investment in development of secondary services and industries, this large population has limited capacity to support development that will transform the economises of the Kagera basin from the present reliance on subsistence agriculture. Therefore the overall assessment of human capital is “low”.

[170] The irrigation development is low (especially the plain irrigation schemes) and the fisheries, hydropower and navigation uses very low developed.

Food prices on the World market

The sharp increase of cereals and other foods on the World market during 2007 and 2008 demonstrates the vulnerability of the poorest countries, those who need importing to make their balance. It is most probable that such a crisis is not only stemming from *bad years*, but is rather structural, with major changes in the food market in general. The UN released the information in May 2008, that 22 countries are particularly vulnerable to food prices escalation; they include Burundi, Tanzania and Rwanda.

This is critically demonstrating the need for a higher food security and efforts to be paid towards higher productivity in agricultural production.

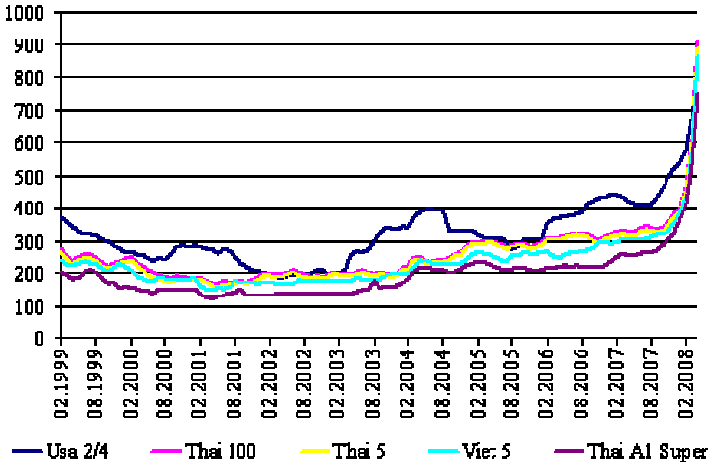


Figure 15.4: Evolution of rice prices for export USD/ton – UNCTAD 2008

Energy and oil

The same sharp increase in oil prices can also be considered without doubts as a trend on the long term. There is no chance, considering the proven oil reserves and the growth in consumption from emerging countries, that oil prices will return to levels such as in 2000, i. e. around USD 30 per barrel.

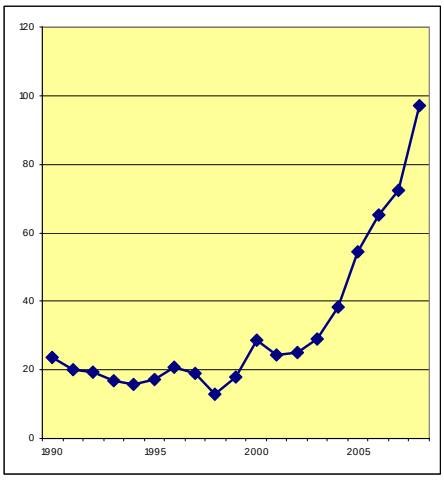


Figure 15.5: Evolution of Brent oil prices USD/barrel

Oil prices around USD 130 or more definitely change the economic conditions for many activities, obviously transportation, but also anykind of power use. The production of electricity is also to be reconsidered; some dams/plants which were previously found not economically feasible could prove to be of interest. This is potentially directly interesting the Kagera river basin and potential hydropower projects which have been screened out to date.

Regional political stability

Continued political instability in the eastern regions of the DRC offer the possibility of creating political and economic uncertainty in Burundi, Rwanda and Uganda. On the other hand, the natural resource base of the DRC offers significant opportunities for development not least as a major source of hydroelectricity – i.e. the "battery of Africa". In Burundi, until such time as a full peach agreement is reach with the last active reel group in the country, continued uncertainty will limit the opportunities for foreign and direct investment and development in the country[171].

Climate change

Climate change impacts remain uncertain and may well impact the region positively or negatively (ref. also section 2.3.2). The results of one climate change risk assessment for the Equatorial Lakes region carried out under the SSEA report on hydropower development in the region (SNC-Lavalin International, 2007) are:

- Overall, for the northern and central-west regions of the study area, there is a high probability of increases in runoff, and thus possible increases in power generation, compared to historic data. This is the region where most of the proposed hydropower development options are located. Therefore, the impacts of climate change are expected to be positive.
- For the southern region, there is a high likelihood of changes in seasonality of runoff, resulting in lower effectiveness for flow regulation of smaller reservoirs.

15.2.6 Enabling governance environment

A key to successfully implementing collaborative transboundary water management is the establishment of *trust* between basin partners. The driving force behind such trust-building is *good governance*, finally evidenced by the emergence of a *shared vision* for the joint development and management of the shared basin's water and related resources. As an *external* condition to the water governance environment (e.g. political stability, etc.), governance may be seen as an *opportunity,* in some cases, and a *threat* in others. As an internal factor, as expressed through water resources management structures and institutions such as river basin organization, governance may be seen from the perspective of *strengths* and/or *weaknesses*.

Among the many definitions of governance, the one that appears the most appropriate from the perspective of IWRM is "…the manner in which power is exercised in the management of a country's economic and social resources for development."[172] This concept of governance is concerned directly with the management of the development process, involving the public and the private sectors. It encompasses the functioning and capability of the public sector, as well as the rules and institutions that create the framework for the conduct of both public and private business, including accountability for economic and financial performance, and regulatory frameworks relating to international relations, as well as national companies, corporations, and partnerships. In broad terms, then, governance is about the institutional environment in which nations and citizens interact among themselves and with government agencies/officials (ADB, 1999).

There are four basic elements of good governance: (i) accountability, (ii) participation, (iii) predictability, and (iv) transparency (ADB, 1999). These are discussed in further detail in the context of Kagera River basin transboundary IWRM:

[171] See David Phillips, Marwa Daoudy, Stephen McCaffrey, Joakim Öjendal and Anthony Turton "Trans-boundary Water Cooperation as a Tool for Conflict Prevention and for Broader Benefit-sharing" see the section "Kagera case study" – 2006 - Prepared for the Ministry for Foreign Affairs, Sweden

[172] Webster's New Universal Unabridged Dictionary, London: Dorset & Baber, 1979.

Accountability: Accountability is imperative to make public officials answerable for government behaviour and responsive to the entity from which they derive their authority. This may be achieved differently in different countries or political structures, depending on the history, cultural milieu, and value systems involved. Accountability encourages peace, stability and economic development as well as encouraging high level demonstration of political commitment to transboundary water management – without which international River Basin Organizations (RBOs) cannot succeed.

Participation: The principle of participation derives from an acceptance that people are at the heart of development. They are not only the ultimate beneficiaries of development, but are also the agents of development. In the latter capacity, they act through groups or associations (e.g., non-government organizations [NGOs] and river basin organizations) and as individuals.

Participation is related to accountability. At the grass roots level, participation implies that governments are flexible enough to offer beneficiaries, and others affected, the opportunity to improve the design and implementation of water resource management and development activities and projects. This increases “ownership” and enhances results. Being close to their constituents, NGOs can provide governments with a useful ally in enhancing participation at the community level and fostering a “bottom-up” approach to economic and social development.

In the context of transboundary water resources management, participation takes place at various levels including between the respective governments and their relevant organizations (ministries of water resources, environment, etc.) and by the stakeholders directly affected by the water resources development activities (e.g. through water user associations, etc.). International River Basin Organizations are thought to be keys in enabling appropriate international participation in transboundary river basins such as the Kagera River, Lake Victoria and Nile River basins.

Predictability: Predictability refers to (i) the existence of laws, regulations, and policies to regulate society; and (ii) their fair and consistent application. The importance of predictability cannot be overstated since, without it, the orderly existence of citizens and institutions would be impossible. The rule of law encompasses both: (i) well-defined rights and duties, as well as (ii) mechanisms for enforcing them and settling disputes in an impartial manner. It requires the state and its subsidiary agencies to be as much bound by, and answerable to, the legal system as are private individuals and enterprises.

Predictability can be enhanced through appropriate legal and institutional arrangements. In the context of transboundary IWRM, institutional arrangements revolve around respect for customary international law, negotiation and agreement of appropriate international treaties, legal frameworks, and establishment of appropriate River Basin Organizations.

Transparency: Transparency refers to the availability of information to the general public and clarity about national and international government rules, regulations, and decisions. Thus, transparency both complements and reinforces predictability.

Transparency in government decision making and public policy implementation reduces uncertainty. To this end, rules and procedures that are simple, straightforward, and easy to apply can be negotiated within the framework of transboundary treaties and institutions (e.g. RBOs). As well, access to accurate and timely information about the water resource management can be vital for decision making by the respective governments and the private sector. Arguably on grounds of efficiency alone, such data should be freely and readily available. Data and information sharing arrangements can also be facilitated by appropriate transboundary treaties and institutions.

15.2.7 Development of resources for human benefit

In discussing and assessing the beneficial uses of water and related resources Section 6 through 13 of this monograph), we have identified a number of priority action, projects and programmes requiring investment – either private or public – to enable these resources to be developed in a way which has a positive influence on human development. We have attempted to estimate the amount of investment required to achieve important progress in poverty reduction; however, with the exception of the water and sanitation programme where the links to achieving the MDGs are made, we did not estimate the net benefits, nor carry out an indepth economic analysis. Such an estimate would have required time and human resources far beyond those available during this consultancy.

A summary of the recommended programmes and projects to be implemented in this development scenario follows.

Agriculture, Livestock and Forestry (Section 6)

This discussion and analysis concludes that there are important opportunities to develop this sector, firstly through implementing all activities in the context of an *Integrated and Community-based Watershed Management Programme*. This programme includes proposed activities and investments in:

- **Soil and water conservation:** including terracing, water harvesting and reforestation/agroforestry;
- **Intensification of agricultural production:** including use of improved and modern inputs (seeds and fertilizers, etc.) implementation of irrigation and water management schemes, and livestock development and rural incomes diversification schemes; and
- **Policy support, including training and capacity-building activities and programmes:** for agricultural research, agricultural extension, agricultural market development and rural financial systems and agricultural credit development.

Environmental Management (Section 7)

The environmental resources of the Kagera River basin are an asset to be carefully managed to enable their sustainable utilization today and in the future. In support of their sustainable management, the following activities have been proposed for investment and implementation:

- **Environmental Management Information System for the Kagera River Basin:** In the context of whatever basin management institutional and legal framework is finally agreed, this will include establishment of a water resources development and environmental monitoring programme responsible for surface and groundwater surveys and water quality monitoring. The programme will support the following studies:
- A detailed survey to develop inventory of the existing protected areas / biodiversity hotspots and establish their legal status and boundary demarcations to prevent future encroachment into these areas. In addition, all important wetlands must be surveyed documented and declared protected areas.
- Environmental economic valuation of the existing environmental resources such as pasture / rangelands, wildlife, water resource, wetlands, etc., to determine / establish their real economic values. This information should be used as one of the criteria for economic investment in the basin.
- Development of management plans for each of the protected area.
- **Harmonization of Environmental Management and Quality Standards:** Develop and harmonise policy, legal and institutional mandates regarding implementation of environmental management and economic investments in the basin. This should include environmental quality standards and Environmental Impact Assessment (EIA) guidelines

for all investment projects in the basin. An effective river basin organization or management unit for the Kagera River basin could facilitate the negotiation of agreed transboundary EIA guidelines.

As a cross-cutting factor, the environmental management initiatives will also support investment programmes put forward under other beneficial uses notably the Integrated and Community-based Watershed Management Programme presented in Section 0 and the implementation of the Potable Water and Sanitation Programme presented in Section 10.4.

Fisheries and aquaculture (Section 8)

Although low in comparison to agriculture, an important food resource is presently available and can be exploited in a sustainable manner for food production and poverty alleviation within the Kagera basin. The following programmes are proposed to enable development of this resource:

- **Aquaculture development programme:** Numerous small lakes / wetlands are available throughout the basin, but fish scarcity is currently high due to over-exploitation of the natural fish stock in most of the existing lakes. A programme of developing aquaculture ponds and associated facilities is proposed. The benefits of such a programme could be:
- Increased availability of food protein for the local communities.
- Increased income by selling fish.
- Creation of employment.
- Protection of aquatic environment of the existing lakes – which could lead into increase in fish stock in the basin lakes.
- Time saving by local people, which is usually lost in capture fisheries by local people
- **Fisheries management in association with multi-purpose dams:** The reservoirs created by the proposed hydropower dams in the Kagera River basin (Rusumo Falls and Kakono) offer the possibility to develop fisheries production. The fisheries management facilities associated with these dames could include boating facilities (docks, etc.) ice production, service centres, refrigeration, pisciculture, fish processing (e.g. smoking) facilities, etc. which are estimated to cost approximately USD1 million per dam.

Energy and hydroelectricity (Section 9)

The hydropower potential of the Kagera River basin is about 490 MW of which only about 44 MW, or less than 10% has been developed to date. Given present day economic, social and environmental constraints, only about 216 MW of the remaining potential is considered feasible, including about 36 MW of small and mini hydropower projects, mostly in Rwanda. The development scenario presented herein recommends proceeding as soon as possible with the following:

- **Kagera River Mainstream Hydroelectric Projects:** The Rusumo Falls (61.5 MW) and Kakono (53 MW) Projects have been identified as necessary and sound investments under the SSEA (2007) and are recommended to proceed soon.
  Some other hydropower schemes such as Nyabarongo and Kishanda valley scheme could also be considered, according to the evolution of energy prices and with sound mitigation of impacts.
- **Small and Mini Hydropower Development:** Small and mini hydropower development appears to offer a solution to remote communities in the Kagera River basin with a total capacity of about 36 MW appearing to be feasible.

Hydropower development alone is not sufficient to meet long-term Kagera basin demands. A regional, transboundary and multi-sector (i.e. hydro, thermal, geo-thermal, methane and wind) approach, such as that put forward in the SSEA (2007), will be required to provide electricity necessary for transformational development in the region in the long-term.

Water supply and sanitation (Section 10)

Improving access to and use of water and sanitation facilities is an important requirement for sustainable human development in the basin as it will likely significantly improve the health and wellbeing of the population. A number of programmes and projects are proposed in the context of the discussion of development scenarios:

- ***Rehabilitation of existing non-functional water sources***: To minimise the actual and future potable water deficits in the most cost-efficient manner, first of all the non-functioning water supplies in the basin need to be rehabilitated, initially focused on the areas with lowest water supply coverage.
- ***Construction of new and improved water sources***: A next step would be to develop the groundwater resources in the areas where cheaper spring water supply is not feasible. The initial focus should be on the urban centres. Assuming that rehabilitation of existing sources has led to an average increase in the basin-wide coverage to 65% based on the existing population in the basin, it means new sources will be constructed to arrive at the 2015 MDG targets. This additional coverage will need to be ensured through shallow wells and boreholes, as it can be assumed that the spring potential will have been largely exhausted.
- ***Sanitation and hygiene awareness campaigns***: The national policies in the Kagera basin are to promote the building of latrines by the population. Therefore, no subsidies are provided for household sanitation. However, extensive sanitation awareness campaigns will need to be held to convey the message that sanitation saves lives.
- ***Institutional strengthening, capacity-building and sector management:*** In the whole of the basin, decentralisation is a key policy, but the capacity at the provincial / district level is still weak. The component is intended to increase both i) the institutional and technical capacity at provincial / district level, and ii) the level of advocacy, promotion, and public awareness of the need for potable water and adequate sanitation as a means to get out of poverty.

Navigation (Section 11)

Although indications from previous studies indicate that the potential for navigation as a commercially viable means of transport in the Lower Kagera River basin are not encouraging, this conclusion is made without the benefit of an objective feasibility study.

- **Kagera River Navigation Feasibility Study:** Such a study is estimate to cost USD 500,000, and is proposed to be carried out in 2010 as part of the investment development scenarios for the basin.

Pro-Poor Tourism (Section 12)

As summarized in Section 12.1, *pro-poor tourism* development offers opportunities to alleviate poverty in the Kagera basin. Developing these opportunities will involve partnerships with governments and the private sector.

- **Kagera River Basin *Pro-Poor* Tourism Development Study:** It is recommended that a comprehensive, basin-wide Kagera River Basin Pro-Poor Tourism Development Programme be developed and implemented within the context of the responsible river basin organization finally established.

15.3 Development indicators

A variety of indicators can be monitored and measured to assess whether or not development activities are in fact alleviating poverty and improving livelihood conditions such as:

- ***Increased life expectancy:*** An obvious indicator of improved human development would be increased life expectancy as noted by country-wide data. Increased life expectancy would be expected with improvements in many sectors including health and education. Factors related to water management includes potable water supply and sanitation, improved agricultural productivity and increases in rural electrification.
- ***Increased economic capital:*** Evidence of increased economic activity may be see though increased visible private sector investment activities and measurable "poverty reduction" as determined by increased national GDP/GNP figures.
- ***Increased social capital:*** Social capital is the trust, reciprocity, and norms and networks of civic engagement in a society that facilitates coordinated action to achieve desired goals (ADB, 2001). Evidence of increased social capital include increased participation of civil society organization, participation of women, and evidence of effective governmental and civil society institutions and legal arrangements. In the context of water resources management this includes the negotiation and adoption of international treaties and protocols enabling cooperation and establishing and sustaining appropriate institutions such as river basin organizations to implement joint actions.

15.4 Decision support tools: numerical models

The undertaking of water basin resources management requires decisions to be made at different levels based on sound and scientific information base coupled with analytic tools that are agreed upon by all riparian countries. Decision support systems (DSSs) are based on computerized numerical models which can describe and predict the behaviour of basin and river systems under a wide range of input conditions. They facilitate the understanding of the current functioning of water resources management and to forecast the impacts of different development scenarios. Examples of interventions that can be investigated with such DSSs are:

- Land use/ land coverage changes
- Climate change
- Water supply demands
- Environmental and fisheries impact assessments
- Irrigation abstractions
- Revised crop / land use patterns
- Changes in existing dam operation
- Impacts of new dams and reservoirs
- In-stream regulation
- Inter-basin diversions
- River improvement works
- Flood works in floodplains and tributaries

A number of river basin modelling tools have been developed in Nile and Victoria basins in the past which have included the Kagera basin, and these are summarized below.

The present Kagera River basin monograph and the associated database/GIS has been implemented in such a way as to support any future modelling and scenario analysis, and consequently to facilitate future investments in the region. It is anticipated that this monograph will provide useful inputs to the development of a decision support tools designed to support the water resources and the water uses on the Kagera River basin.

Other databases and modelling initiatives exist or are under development for the Kagera River basin and should provide inputs for future modelling efforts (see following paragraphs for more details about these programmes), including:

- the simple hydrological model of Kagera River basin using remote sensing data developed as a M.Sc. thesis (Haguma, 2007),
- the Nile Decision Support Tools (DST) developed under a previous NBI project during the period 2001 - 2003, and
- a comprehensive Nile Decision Support System (DSS) which commenced development under the NBI in 2007.

These last two programmes concern the full Nile River basin, including the Kagera River basin. The countries in the Nile River basin, through the NBI, are engaged in serious dialogue on the future development of their shared water resources. A number of investment projects are under preparation through the two NBI Subsidiary Action Programs (SAPs), whose broad objective is to bring benefits to the basin countries on a *win-win* basis. The future Kagera River basin model should be fully integrated with the Nile DSS.

15.4.1 Existing decision support tools

The hydrological model of Kagera River basin using remote sensing data

In the research of D. Haguma (Master of Science thesis under UNESCO-IHE supervision, ended in 2007), remote sensed data and global data have been used and evaluated to develop a hydrological model for Kagera River basin. The model was developed using the Soil and the Water Assessment Tool (SWAT) which is a continuous time and hydrological model used for river basin scale modelling. Satellite datasets and global datasets were used to generate the inputs for simulating daily/monthly flows for the Kagera basin. All the precipitation datasets had almost the same temporal and spatial distribution; however the precipitation depths varied from one data set to another. The simulated flows showed clear differences of model response to those precipitation data sets. The SWAT model performance was low, due to poor quality of precipitation data, low model resolution and the variability in topography, climate and landform of the study area. Nevertheless, it is expected such an initiative could give methodological inputs to future modelling ones.

The Nile DST

The Nile River Basin Decision Support Tool (Nile DST) constitutes a component of the NBI Nile Basin Water Resources Project, implemented in the Nile River basin by the Food and Agriculture Organization of the United Nations (FAO). The Nile DST was developed in the period 2001 – 2003 through a collaborative effort of the Nile Basin countries, and the Georgia Water Resources Institute at the Georgia Institute of Technology (Georgia Tech), USA. This prototype software models the entire Nile Basin system and assesses the tradeoffs and consequences of various cross-sector and basin-wide development scenarios. The system allows the impacts of various levels of regional coordination to be examined, and serves as a cornerstone for information integration.

Concerning the Lake Victoria Basin, the Nile DST used a lot of information from the FAO Lake Victoria Water Resources Project (LVWRP). LVWRP began in 1996 and was about development of water resources information systems, mathematical models and tools in support of a harmonized, regionally coordinated water resources management in the Lake Victoria basin. It was thus a regional project in the three riparian countries of the Lake Victoria Kenya, Tanzania and Uganda. The LVWRP focused its efforts on establishment and delivery of:

- a water resources monitoring network,
- a geo-referenced database system containing both point and spatial data layers,
- a water resources management decision support system, and
- capacity building on technology and know-how for a harmonized, regionally coordinated water resources management.

The LVWRP and the following larger-scale Nile DST are of limited usefulness for the present Kagera River basin. The LVWRP did not consider the Burundian and Rwandan parts of the Kagera River basin. The Nile DST did consider the Kagera basin but a too low resolution for the basin-wide water resources management assessments.

However, it should be noted that when the Nile Council of Ministers released the Nile DST in February 2003, it represented the first time that all the basin states were able to use a common water resources assessment tool. The Nile DST therefore represents an important element of the common knowledge base and it was also an essential step in arriving at a univocal language for discussing water use issues as it contributes to the Nile DSS.

The Nile Basin Decision Support System – the Nile DSS

The Nile Basin DSS is a component of the Water Resources Planning and Management Project of the NBI Shared Vision Program, officially launched on January 18th 2006. It is expected to provide the necessary knowledge base and analytical tools to support the planning of cooperative joint projects.

The primary objective of the Nile Basin DSS is to develop a shared knowledge base, analytical capacity, and supporting stakeholder interaction, for cooperative planning and management decision making for the Nile River Basin. An essential feature of the Nile Basin DSS should be that it is an agreed upon tool that will be accepted and used by all riparians in the management of the shared Nile water resources. Essential components of the proposed Nile Basin DSS are:

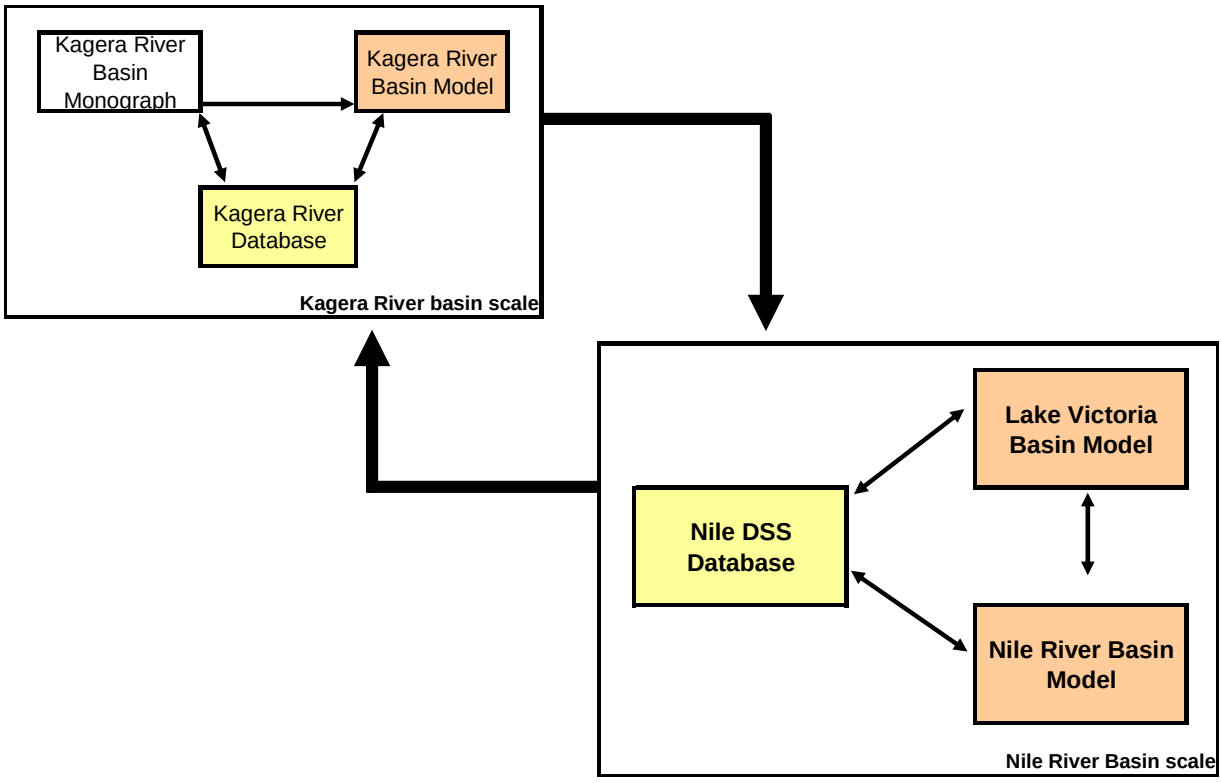
- a comprehensive knowledge base,
- Nile River Basin Modelling System,
- set of tools, including those used for multi-criteria analysis,
- Nile Basin-wide communication system, and
- human and institutional capacity strengthening targeted at enhancing capabilities of riparian experts on continued use and maintenance of the DSS.

This monograph has benefited from the national baseline assessment reports recently prepared by the National DSS Specialists in each of the four Kagera basin countries. These reports were prepared to provide basic input to the Nile Basin DSS development. A goal of this monograph, which includes the development of a database and GIS, should also be an important contribution to the larger-scale Nile River Basin DSS. Consequently, one of the success keys of the Kagera River basin projects, including this monograph, will be to be linked to the Nile Basin DSS agreed tools.

15.4.2 Proposed decision support tools

A Kagera River basin water resources model

The previous paragraphs concerning former and on-going modelling initiatives have described the importance of water resources models in assisting water resources management decision-making. We conclude that the presently available tools are currently not adequate for assessments at the Kagera River basin scale. Development of a *simple river basin hydrological model* is proposed under the Kagera Project. When such a Kagera-basin-scale model is developed, it is recommended that it should be done in such a way so as it can be integrated in the Nile Basin DSS[173] presently under development.



Every river basin is different. Models developed for large basins such as the Nile River may not in fact be appropriate for assessment of impacts and decision-making in smaller basins such as the Kagera. Specific modelling tools may need to be developed for each river basin to appropriately model the impacts of development activities and other external factors such as climate change. Furthermore, in the case of the Kagera River basin, there are limited possible large-scale development interventions that could have significant impacts on river flow. The most significant will be the two major proposed hydropower projects: *Rusumo Falls* and *Kakono*. Based on simple assessments, it may be realistically anticipated that flow regime changes with these projects will be limited and with limited downstream impacts. More important to the development of the Kagera basin in the context of the L. Victoria and Nile basins will be models which enable:

- *water quality* and *environmental impact assessments* due to land use and land and water management changes, and
- the assessment of the impacts of *climate change* on flow and water quality.

[173] However, integrating any small-scale model such as the Kagera basin-scale one into any more general Lake Victoria basin-scale or Nile basin-scale model will be one of the challenges of the new Nile DSS.

15.5 Possible development scenarios for the Kagera River Basin

15.5.1 Investment Scope for Kagera River Basin Development

In developing the descriptions and analyses of the *setting* and the *beneficial uses* of the water and related resources of the Kagera River basin, we have identified a number of opportunities for development and investment. These potential areas for investment have been described in the conclusions and recommendations of each of the sectors and are summarized in this section for consideration by basin stakeholders and decision-makers.

We stress this is a preliminary proposal with very provision *order of magnitude*-type estimates. However, we feel that by putting these forward now, we will stimulate discussion and also begin the process of attracting investors keen to approach transboundary development in this region in a an integrated and comprehensive manner.

The opportunities are briefly summarized following according to sector. We have used a 20-year time horizon (2008 – 2027) for these investments, recognizing that as time passes so does the uncertainty (ref. Figure 15.6). The details underlying the estimated values noted above are provided in the respective sections of the monograph. A proposed Kagera Basin IWRM – Institutional Development and Capacity Building Programme is discussed in the following section.

15.5.2 Scenarios in basin development planning

Scenarios allow planners and decision-makers to look at options in the phasing and implementation of future developments. Scenarios are often studied with the support of computerized numerical hydraulic models (ref. Section 15.4), allowing us to ask "what if?" one or other option is exercised in moving forward with investment decisions. In their fullest capacity, scenarios, supported by fully-enabled decision support systems, allow comprehensive physical (e.g. hydraulic and hydrodynamic), economic and social assessments of proposed development interventions.

It may be noted that scenarios are only as good as the quality of the present-day information, the underlying assumptions about the future and the forecast tools. The longer-term the forecast, the greater the uncertainly, as noted in Figure 15.6.

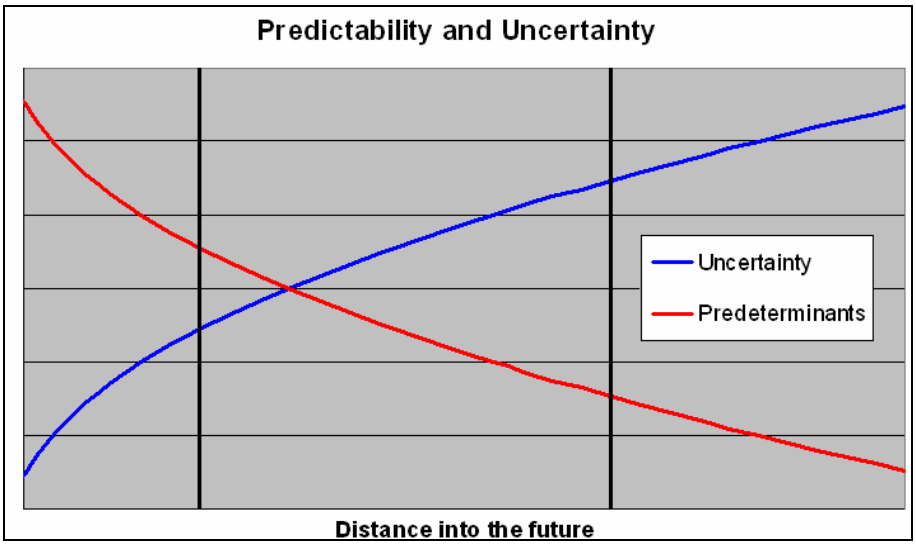


Figure 15.6 – Development Scenarios –uncertainty increases with time to the future[174]

[174] Source: FAO sponsored Forum on Nile Basin Development Scenarios – "Food for Thought", 19 July 2007, Volta, Italy. ref. FAO Nile, Entebbe.

Development scenarios allow us also to assess potential benefits (social and economic) and costs (environmental and social) associated with proposed development activities. Such valuation can also set the stage for discussions and negotiations between countries and regions on *trade-offs* that may be necessary to enable *optimisation* of mutual benefits for all basin stakeholders – i.e. *win-win* solutions - one of the advantages of an *integrated* approach to water and related resources management. Such an approach is considered important, especially in the upstream context of the Kagera River basin of development activities in the basin on the downstream Nile River basin riparians.

A *benefits-sharing* approach where *trade-offs* are discussed, negotiated and agreed by all basin partners – enabling *reasonable and equitable* use and assessment of *all relevant factors* (Wouters et. al. 2006). Equitable and reasonable utilisation seeks to attain an optimal utilisation, *"…securing the maximum possible benefits for all watercourse States and achieving the greatest possible satisfaction of all their needs, while minimizing the detriment to, or unmet needs of, each."*

This concept of benefit sharing enhances *solidarity* between the upstream reaches and downstream riparian countries. Such an approach could for example result in the following understandings:

- Rwanda and Burundi would be seen as not isolated upstream riparians considered to be entirely responsible for land and water management issues including the struggle against soil erosion. The size of future programmes for fighting erosion could accordingly be expanded.
- The international community and donors should become more conscious of this big issue and bring a larger support to relating activities.

15.5.3 What is a Scenario?

A scenario is an ensemble formed by a description of a future situation and the path of events which would permit one to pass from the baseline situation (most likely the present) to the future situation.

One distinguishes, in fact, two major types of scenarios:

- those constructed from past and present trends which describe likely scenarios (exploratory scenarios) which are objective and value-neutral.
- those constructed from alternative images of the future and may describe futures that are either desirable or undesirable (scenarios of anticipation or normative scenarios) and which are value-laden and conceived in a retrospective and subjective way.

These normative scenarios (often called scenarios of anticipation) may indeed be the most likely or the most contrasted, assuming they take into consideration the most probable or the most extreme among the possible hypotheses.[175]

[175] From "Strategic Foresight, problems and methods" – LIPSOR, Michel Godet, November 2006, http://laprospective.fr/

15.5.4 Nature of three scenarios envisaged

Referring to the above definition, a common approach is to mix one exploratory scenario and one or several normative scenarios.

In the case of the Kagera River Basin, we will proceed with three different scenarios, such as:

- Scenario 1, explanatory, which is based on the current observed trends, could be called also “business as usual”,
- Scenario 2, scenario of anticipation strongly based on agriculture, due to the rural majority of the population, search for food security, fight against the major threat represented by erosion and loss of fertility,
- Scenario 3, scenario of anticipation, mostly based on specific efforts paid for alternate economic developments and drivers, higher development in electricity production,

In all three cases, as already mentioned, the scenarios address what pertains to the field of water and IWRM. They are not aimed at addressing all sectors policies, since IWRM is already a complex issue in itself, and moreover, a river basin is not the relevant entity for economic planning, education, or health for instance.

However, each scenario is determined in the general environment (the drivers), would they be internal or external.

Thereof, a first definition of the drivers is feasible as an enumeration and the possible status of each of them in the future. It is also possible to build some clusters gathering the different drivers according to their nature.

15.5.5 Analysis of drivers and factors determining scenarios

GLOBAL FACTORS						
Effects of climate change	Minor changes	More droughts and floods	Temperature increase			
Prices on food markets	Come back to stability and "normal" prices	Keep very high				
Prices on energy markets	Keep high	Still raising on oil				
REGIONAL FACTORS NOT DIRECTLY LINKED TO NATURAL RESOURCES						
Enabling governance environment	Satisfactory, not more	Progresses in some fields	Higher rank of democracy			
Regional political stability	Satisfactory, not more	Fruitful cooperation	Higher level of integration			
Population growth / Density	Still very high	Slowing down	Sharp deceleration			
Access to international markets	No changes	Satisfactory, not more	Higher level of access to market			
Urbanization	Current trend	High but not well organized	Very high with specific invetments			
Economic development	Still agricultural based	Agriculture & agroprocessing	Shift towards services & finance			
Health	Keep in the present situation	Real improve in general health conditions				
Education	Keep in the present situation	Given a high rank of priority				
BASIN WIDE FACTORS INFLUENCING NATURAL RESOURCES						
Land use	Keeps on traditional basis	Expansion towards new lands, irrigation	Large decrease in farmers' population			
Fight against erosion	Still slow and high rural population	Large investment for erosion control	Large efforts, rural population decrease			
Irrigation water consumption	Small schemes only	Large scale irrigation	Large scale irrigation & use of wetlands			
Access to water & sanitation	Efforts, but still low rate	Medium	Significant coverage			
Access to energy	Still fuel wood as the basis	Mixed electricity & others	Large share of electricity			
BASIN WIDE FACTORS INFLUENCING AGRICULTURE						
Agricultural markets	Institutional arrangements for sub-sector	Development of quality standards	Transport and logistical investments	Reinforcement of private sector capacities	Access to credit	No change
Intensification	Higher use of fertilizers	Higher use of improved seeds	Cash crop development	Improve of pest management	No change	
Irrigation	Plain irrigation development (large scale)	Marshland irrigation development	Rainfed agriculture development	No change		
Livestock holding	One cow for one family	Large-scale livestock	No change			
Land degradation	Erosion control	Agroforestry	Water harvesting	No change		
Land tenure	Clarification and improvement of laws	Set up a land use registration	No change			

Group 1 - Global factors. They are not specific to the region nor to the basin; they are worldwide but definitely have a great influence on IWRM in the Kagera river basin as well as for natural resources at large. It must be accepted that there is no way for the Peoples of the Kagera river basin to influence on these factors. They will have to adapt and find strategies in order to cope with this global context and its evolution with time.

Group 2 – Regional factors not directly linked to natural resources. These factors are essentially in the hands of decision makers at regional scale. Their ability in promoting governance and enabling environment in general, will deeply influence, even if not directly, the sound management of natural resources and livelihood of the Peoples.

Group 3 – Basin wide factors influencing natural resources. These factors are directly impacting on the management of natural resources. They belong directly and entirely to policies and activities which can bring a strong momentum to development or, on the contrary, hamper it and keep on the wrong track.

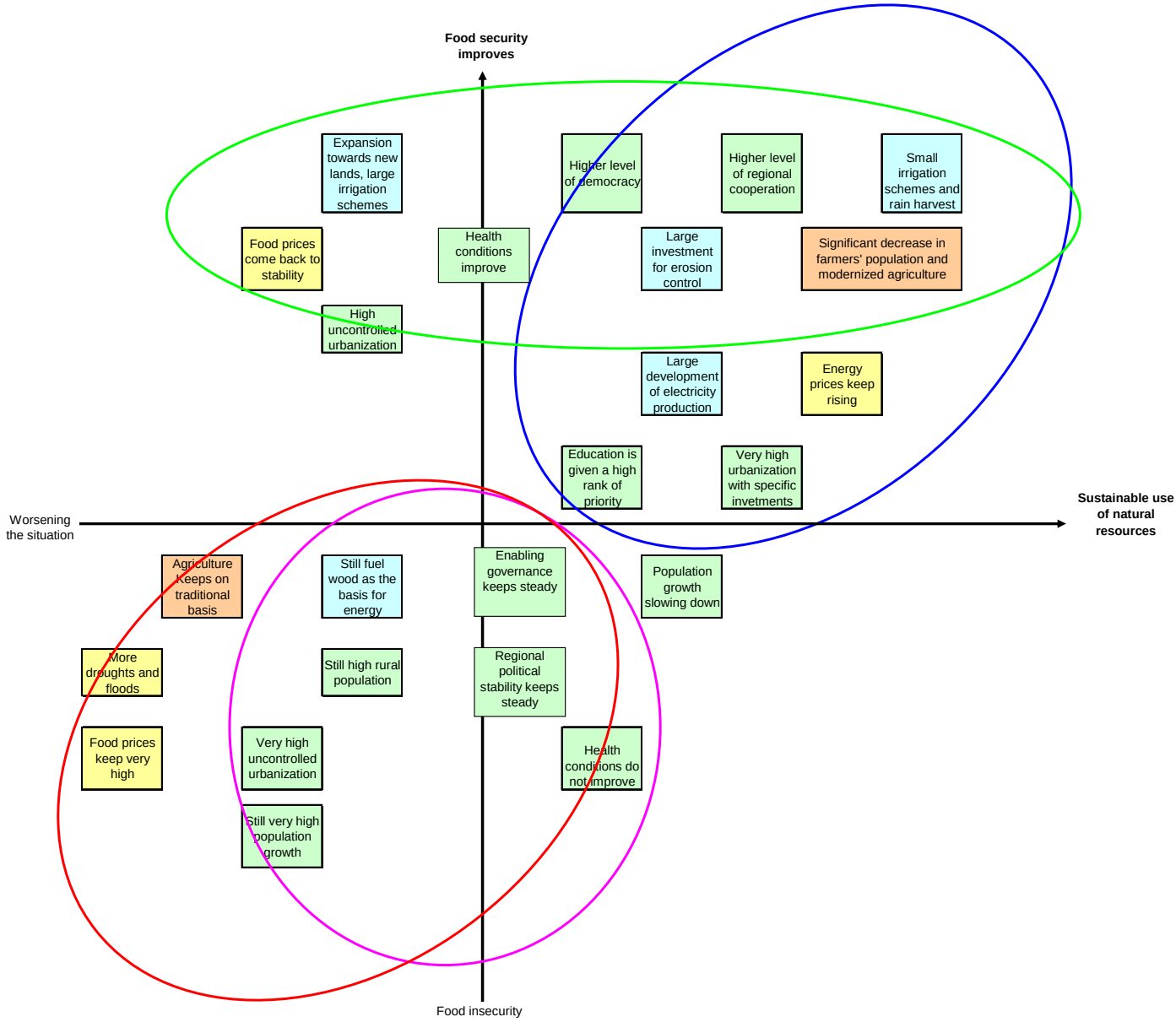
Group 4 – Basin wide factors influencing agriculture. These factors are to be considered by themselves, since agriculture, food security, rural population livelihood, are key issues all along the river basin.

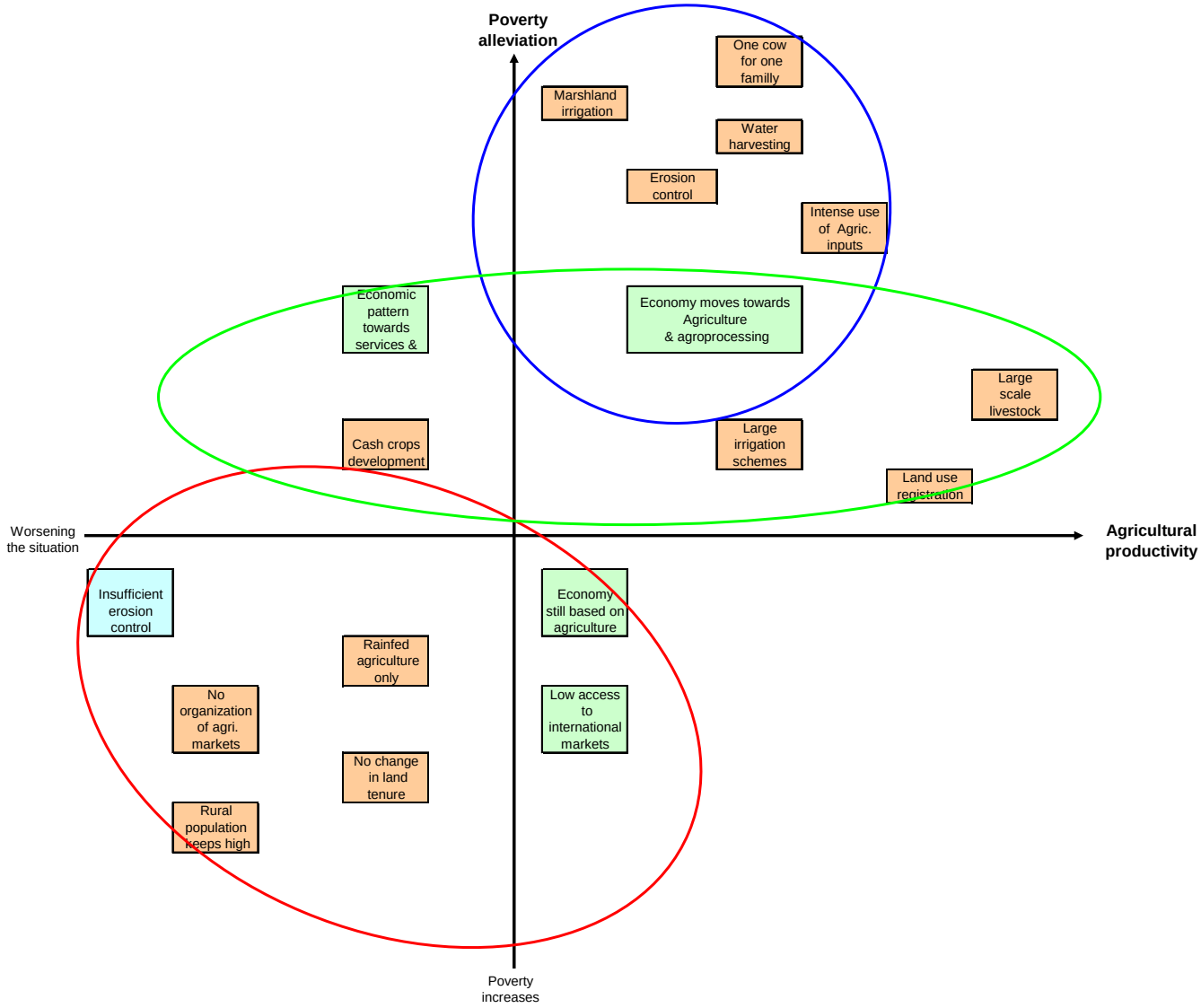
At a second step, it is desirable to understand how the various drivers scrutinized organize and interact towards each others.

In this purpose, we will consider three main axes which represent the key objectives for IWRM in the Kagera river basin, namely:

- Poverty alleviation
- Food security and agricultural productivity
- Sustainable use of natural resources

The distribution of the various drivers and their possible situation can then be summarized on two sketches:


Food security improves
Expansion towards new lands, large irrigation schemes
Higher level of democracy
Higher level of regional cooperation
Small irrigation schemes and rain harvest
Food prices come back to stability
Health conditions improve
Large investment for erosion control
Significant decrease in farmers' population and modernized agriculture
High uncontrolled urbanization
Large development of electricity production
Energy prices keep rising
Education is given a high rank of priority
Very high urbanization with specific invetments
Worsening the situation
Sustainable use of natural resources
Agriculture Keeps on traditional basis
Still fuel wood as the basis for energy
Enabling governance keeps steady
Population growth slowing down
More droughts and floods
Still high rural population
Regional political stability keeps steady
Food prices keep very high
Very high uncontrolled urbanization
Health conditions do not improve
Still very high population growth
Food insecurity



On these two sketches, each ellipsoid represents a possible combination of the drivers in the future, and then constitutes the skeleton for scenarios.

The red ellipsoid represents a bad situation, more or less the continuation of current negative trends.

The blue one represents the ambition for a new development based on agriculture and the presence of a large rural and farmers population. The priority is given to poverty alleviation.

The green one represents a much higher level of ambition, based on a drastic change in economic pattern and high level of investment.

Given these preliminary definitions, it is now possible to tell the “story” of each scenario envisaged.

15.5.6 Transboundary Integrated Water Resources Management and Cooperation in the Kagera River Basin

Whatever the scenario, it is strongly recommended that specific efforts and funding be dedicated to transboundary IWRM & cooperation in the Kagera River Basin.

Several programmes and projects are proposed to support the establishment and operation of an appropriate institutional arrangement to enable effective Kagera River basin management and development. The overall programme and budget totalling some USD 17.5 million is summarized following and in Table 15.2.

Kagera River Basin Management Unit: In section 5 we recommended the establishment of a Kagera River Basin *Management Unit* within the context of the existing LVBC institutional and legal framework. A preparatory study (USD 1 million), and 4 years of technical assistance (USD 10 million) with the establishment and capacity-building of this *Unit* or whatever alternative is finally determined and agreed to be the most appropriate is provided for this estimate

Support to the LVBC in Elaborating Water Management Rules and Procedures: The LVBC is a relatively *young* organization with a noble mandate agreed upon in the *Protocol* by the five riparian countries. Enabling rules and procedures are required to be negotiated, agreed and put in place to facilitate the implementation of the various administrative and technical provisions of the *Protocol* including, but not limited to: procedures/rules for notification, data exchange and sharing, and flow and water quality management. A provision budget of USD 1.5 million over 3 years is included.

Kagera River Basin – Decision Support Modelling: A simple, yet appropriate set of numerical tools should be available to the Kagera Basin Management Unit to enable staff to assess the impacts of development on changes in flow and water quality in the Kagera Basin. These should preferably be linked to existing and planned tools such as the Nile DSS which is under development at this time. A provision budget of USD 1 million is provided.

Kagera River Basin Development Programme: Once operational, the main role of the Kagera Basin Management Unit will be to facilitate a process of basin development. A variety of activities have been proposed, also in this monograph, and need to be formulated in greater detail in a participatory and basin-wide manner. It is envisaged that such a program would be executed in the context of a Kagera River Basin Development Programme, funded externally with appropriate technical assistance provided over a period of 4 years at USD 1 million/year.

Table 15.2 – Kagera River Basin – Transboundary Integrated Water Resources Management and Cooperation – Technical Assistance and Capacity-Building

Kagera Basin IWRM - Institution and Capacity Building	US$ (million)
Kagera River Basin Management Unit	
Study	1.0
Implementation and capacity building	10.0
Support to LVBC in Elaborating Water Management Rules and Procedures	1.5
Kagera River Basin - Decision Support Modelling	1.0
Kagera River Basin Development Programme	4.0
Total:	**17.5**

15.5.7 Three scenarios for the Kagera River Basin

Priority to food security and poverty alleviation

This scenario is the basis, the first one which was explored, in the meaning that it is addressing the most urgent issues, and at the same time, sounds financially reachable.

The context

The context is also given by a series of initiatives favouring regional and international cooperation. Among others, this is the EAC, LVBC, NBI, NELSAP.

In addition, the political security and stability improve in the region, and a new enabling environment is set up on a sustainable basis.

Finally, all member states along the basin share the same conviction on a necessary win win deal, based on the protection of the most endangered resources (soils, water quality)

The story

Efforts are concentrated on the most urgent issues.

This is clearly relating to improvement of agriculture through intensification and fight against erosion/loss of soils fertility. The policy for “one cow for one family” is a cornerstone in securing the livelihood of farmers’ population.

Some other fields of investment like energy and water supply are also considered as priorities and included in the regional investment programme.

The output

The expected output is an increase in food availability, without further deterioration of the natural resources. It is even expected that rural incomes will increase.

Better water supply and sanitation will participate directly to an improvement of health conditions, with positive impact on the labour force availability.

Electricity is produced in higher quantities and distributed mainly in large and medium cities. This contributes to savings at national scale and participate to the development of new economic activities (agro processing, cottage industry, services…).

Summary of related investments

Overall investments in the Kagera River basin, including all four countries, over this 20-year period have been estimated at more than USD 2.7 billion (ref. Table 15.3, Figure 15.7 and Table 15.4 following). The investments proposed are those which are considered to be essential to the sustainable development and management of the water and related resources. Implementation rates could be scaled either up or down depending on availability of financing and the priorities attached to each sector. The estimated values should be considered as *order-of-magnitude* costs and do not necessarily imply relative priorities. For example, even through hydropower is a relatively smaller total value for investments in the basin, it is well recognized that improved access to electricity is critical for sustainable development. As well, all the proposals included in these scenarios require further more detailed studies and analysis to ensure optimal implementation. The details underlying the estimated values noted above are provided in the respective sections of the monograph.

Table 15.3 – Kagera River Basin development scenario - summary of proposed investments in 'basic scenario' (2008 – 2027)

Monograph Section	Kagera River Basin Development	US$ (million)	%
6	**Agriculture, Livestock and Forestry**	1,789.8	65%
7	**Environmental Resources**	21.5	1%
8	**Fisheries and Aquaculture**	52.0	2%
9	**Energy and Hydropower**	272.0	10%
10	**Potable Water and Sanitation**	615.0	22%
11	**River Transport and Navigation**	0.5	0%
12	**Pro-Poor Tourism**	1.0	0%
15.6.2	**Kagera Basin IWRM - Institution and Capacity Building**	17.5	1%
	Total:	**2,769.3**	**100%**

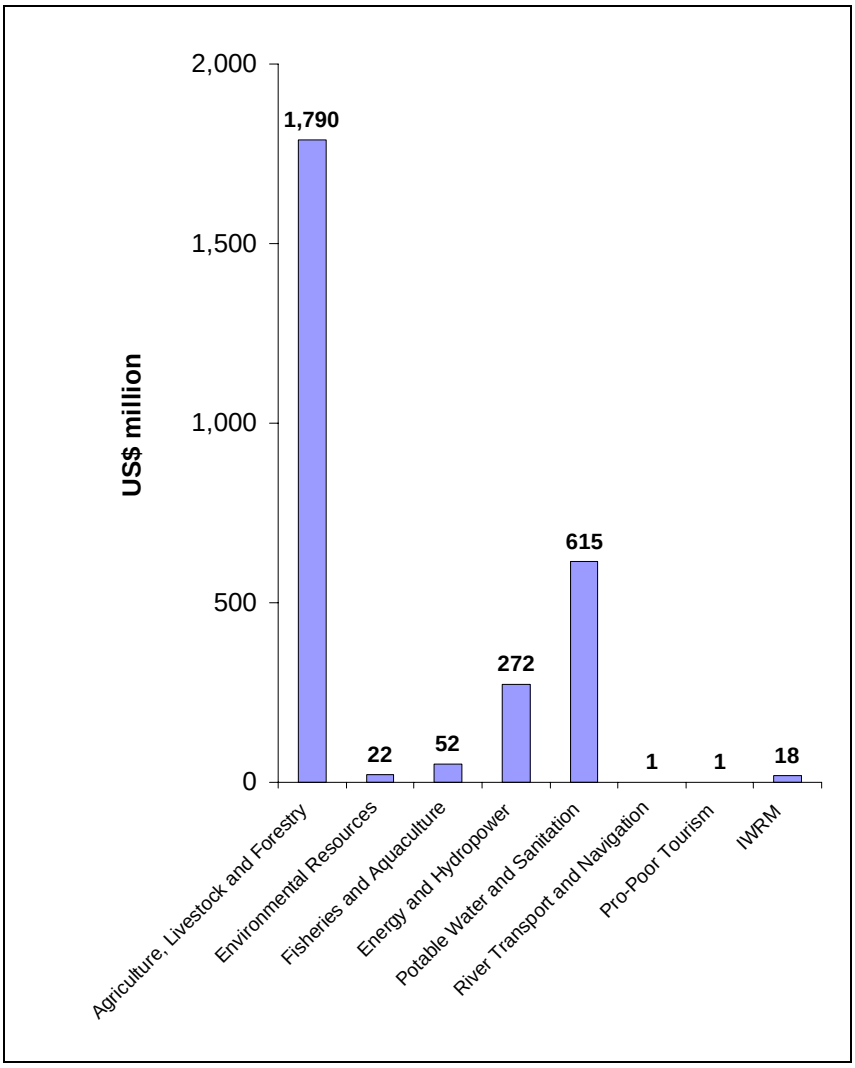


Figure 15.7 - Kagera River Basin development scenario - summary of proposed investments in 'basic scenario '(2008 – 2027) by sector

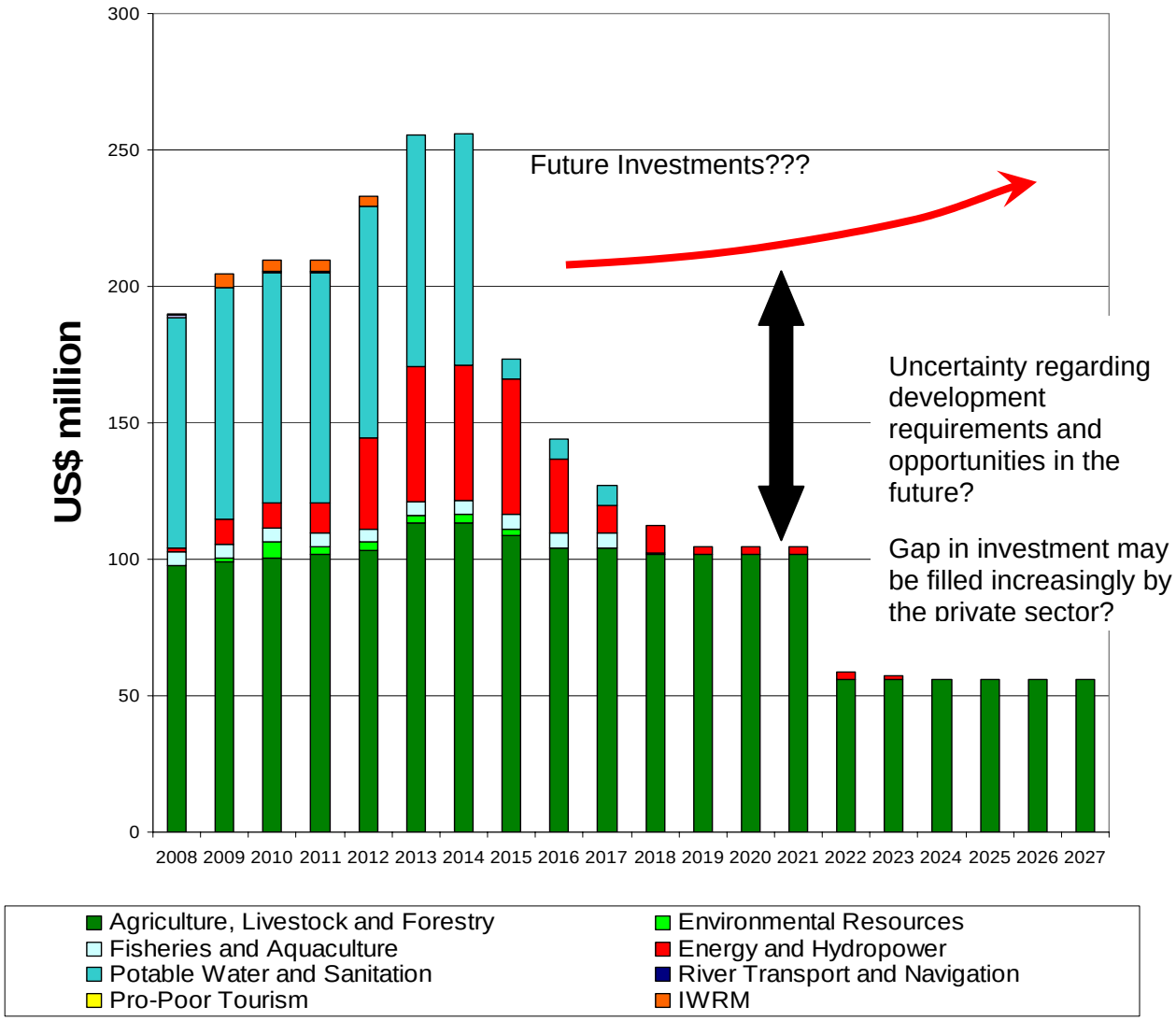
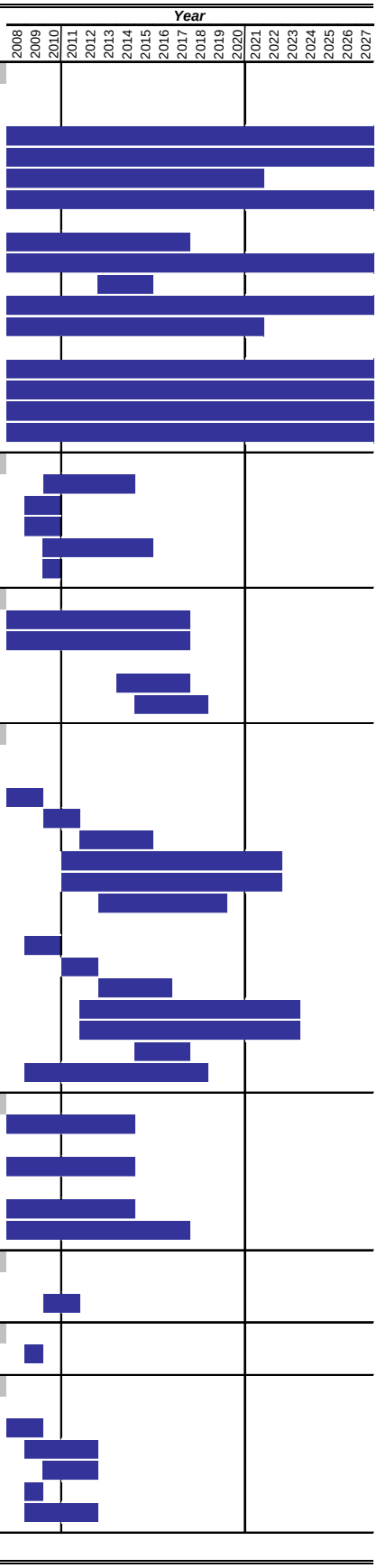


Figure 15.8 – Kagera River Basin Development Scenario – Summary of proposed investments in 'basic scenario'

Table 15.4 – Kagera River Basin Development Scenario – Summary of proposed investments and implementation Gantt chart in 'basic scenario'

Sector, component and activity	Totals (US$million)	
Agriculture, Livestock and Forestry		1,789.8
Soil and water conservation	***329.6***	
Terracing		
Radical terraces (40 000 ha)	142.4	
Gradual terraces (40 000 ha)	67.2	
Water harvesting	70.0	
Reforestation / agroforestry (100 000 ha)	50.0	
Intensification of agricultural production	***1,109.8***	
Improved / modern inputs	20.0	
Plains irrigation schemes (20 000 ha)	100.0	
Plains irrigation schemes linked to Rusumo falls dam (2500 ha)	20.0	
Marshlands irrigation schemes (40 000 ha)	400.0	
Livestock development and rural incomes diversification	569.8	
Policy support - training / capacity building	***350.4***	
Agricultural research	40.0	
Agricultural extension	230.4	
Agricultural market development, proximity services to producers	40.0	
Rural financial systems and agriculture credit development	40.0	
Environmental Resources		21.5
Kagera River Basin Environment Management Information Systen	***5.0***	
Protected Areas - Inventory Study	***1.5***	
Environmental Beneficial Uses - Valuation Study	***1.5***	
Water Resource Development and Environmental Monitoring Proç	***12.0***	
Harmonization of Environmental Quality Standards	***1.5***	
Fisheries and Aquaculture		52.0
Aquaculture development programme	***50.0***	
Aquaculture in natural lakes (1 000 ha)		
Multipurpose dam, fisheries management	***2.0***	
Fisheries management on Rusumo falls dam		
Fisheries management on Kakono dam		
Energy and Hydropower		272.0
Kagera River Mainstream Hydroelectric Projects	***200.0***	
Rusumo Falls dam (61.5 MW)	114.0	
Feasibility study	*2.3*	
Detailed studies and preparatory actions	*2.3*	
Works: dam + central	*90.1*	
Environmental and social management plan	*5.7*	
Resettelment plan	*13.7*	
Local development plan (already taken into account above)		
Kakono dam (53 MW)	86.0	
Feasibility study	*1.7*	
Detailed studies and preparatory actions	*1.7*	
Works: dam + central	*67.9*	
Environmental and social management plan	*4.3*	
Resettelment plan	*10.3*	
Local development plan (already taken into account above)		
Small and mini hydropower development	***72.0***	
Potable Water and Sanitation		615.0
Rehabilitation of non-functional water sources		
Rehabilitation of 16,500 sources, including community awareness	130.0	
Construction of new improved water sources		
Construction of 16,500 new boreholes, including community awarene	300.0	
Sanitation and hygiene awareness campaigns	***110.0***	
Institutional strengthening, capacity building and sector manager	***75.0***	
River Transport and Navigation		0.5
Lower Kagera River navigation		
Feasability study	0.5	
Pro-Poor Tourism		1.0
Pro-Poor Tourism Development Program - Feasibility Study	***1.0***	
Kagera Basin IWRM - Institution and Capacity Building		17.5
Kagera River Basin Management Unit		
Study	1.0	
Implementation and capacity building	10.0	
Support to LVBC in Elaborating Water Management Rules and Prc	***1.5***	
Kagera River Basin - Decision Support Modelling	***1.0***	
Kagera River Basin Development Programme	***4.0***	
TOTAL:		**2,769.3**



Business as usual – slow development despite large efforts

Context

Good initiatives are to be noticed, like the EAC expansion, the NELSAP programme in itself…However, the process remains very slow and some parts of the basin are still insecure, which hampers efforts to reach a higher degree of cooperation and open trade.

This lack of full cooperation and enabling political environment does not contribute to increase funding capacities from the international community and the private sector.

The story

Limited cooperation reveals through various malfunctioning. The priorities in the basin action programme are not clearly expressed. It remains unclear in minds that water quantity is not a real problem, but erosion, soils protection and water quality are the major issues. Some projects of great ambition, but difficult to fund are still considered: for instance the navigation project is potentially very expensive for an uncertain global benefit.

Large equipment of shared interest (Rusumo falls scheme for instance) are still slowly considered and take long time for construction. The Kakono scheme is not constructed during the considered period. The level of electricity produced does not match the demand and there is no real large distribution of electricity in small and medium towns.

Most harming from weak cooperation is that downstream states do not consider participating to erosion control in upstream countries. As a consequence, there is no real win win deal, and erosion keeps increasing while sediment loads affect marshes and the Lake Victoria itself.

Agriculture receive some support in erosion control action, intensification, development of some irrigated schemes but at a lower speed.

The output

Despite a real willingness expressed in sector policies (water, agriculture…), some major problems are not successfully tackled. The socio-economic pattern does not change significantly, with still very small farms, slow development of irrigation, still high rural population densities.

The intensity of investment in rural areas is kept low, except regarding water supply and sanitation, but on a much longer period that previously expected. The main effort made by the countries is therefore more in urban areas and out of the scope of IWRM.

Summary of related investment for business as usual scenario

Overall investments in the Kagera River basin, including all four countries, over this 20-year period have been projected at USD 1.9 billion, at a lower level compared to the first scenario. The major difference with the previous scenario lies also in slower pace of investment, which results in less impacting positive effects.

Table 15.5 – Kagera River Basin Development Scenario – Summary of envisaged investments and implementation Gantt chart in 'business as usual scenario'

Monograph Section	Kagera River Basin Development	US$ (million)	%
6	**Agriculture, Livestock and Forestry**	1 027,3	53%
7	**Environmental Resources**	21,5	1%
8	**Fisheries and Aquaculture**	52,0	3%
9	**Energy and Hydropower**	186,0	10%
10	**Potable Water and Sanitation**	615,0	32%
11	**River Transport and Navigation**	0,5	0%
12	**Pro-Poor Tourism**	1,0	0%
15.6.2	**Kagera Basin IWRM - Institution and Capacity Building**	17,5	1%
	Total:	**1 920,8**	**100%**

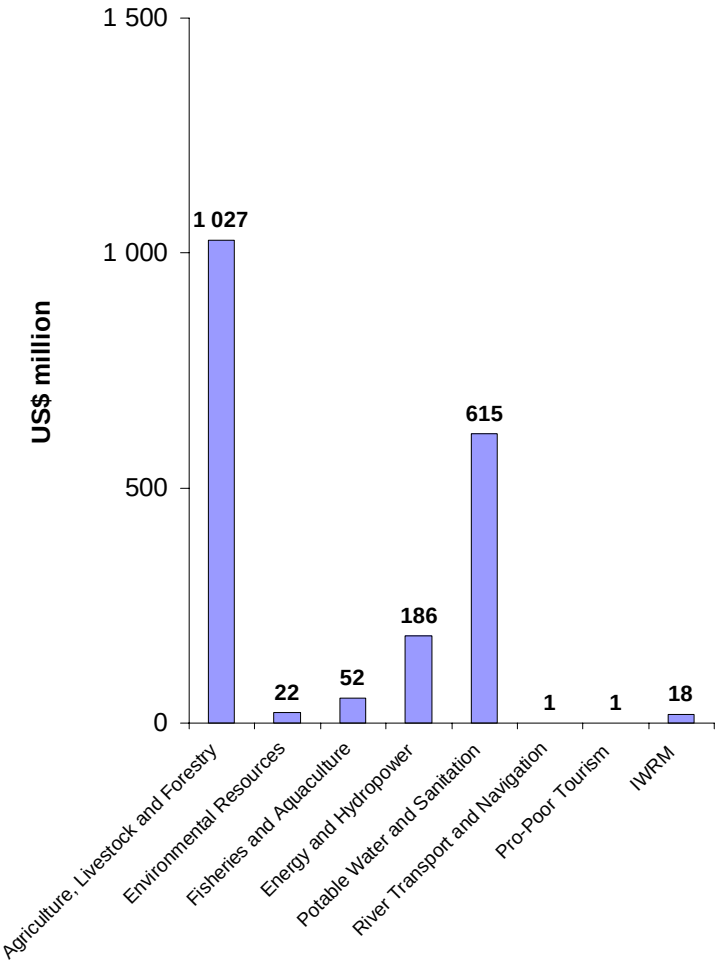


Figure 15.9 – Kagera River Basin Development Scenario – Summary of envisaged investments in 'business as usual scenario'

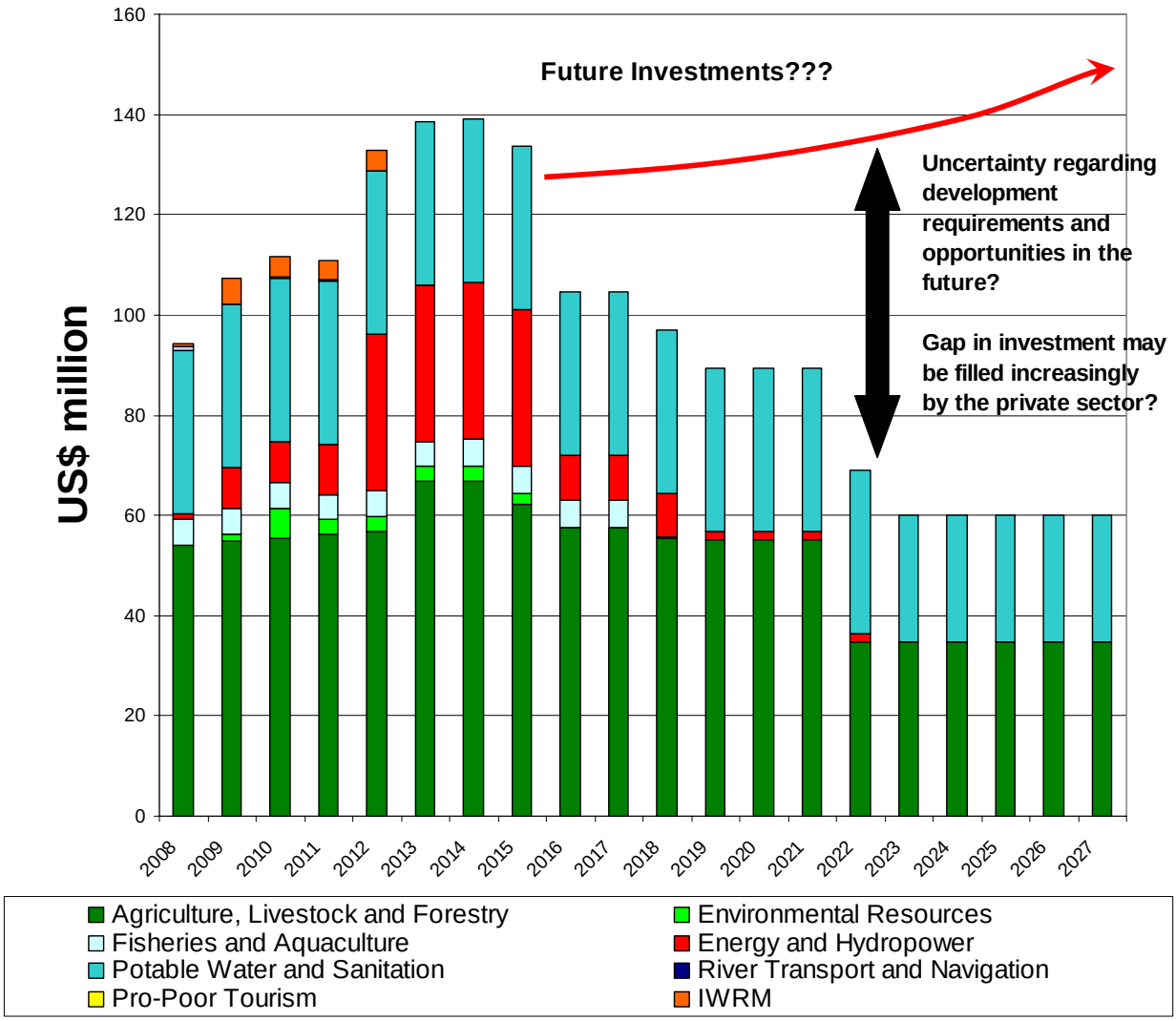
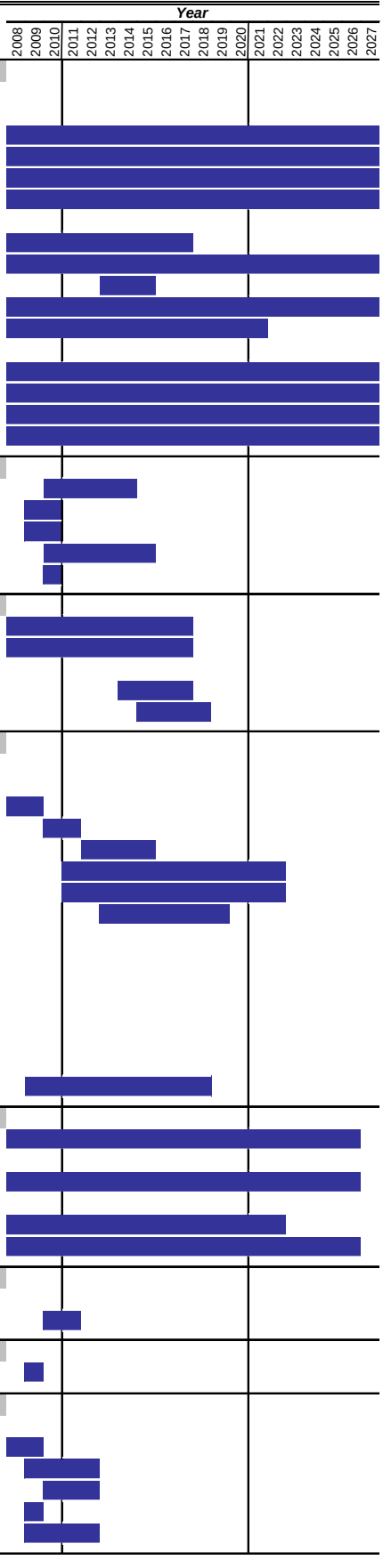


Figure 15.10 - Kagera River Basin development scenario - summary of envisaged investments in 'business as usual scenario '(2008 – 2027) by sector

Table 15.6 – Kagera River Basin development scenario - summary of envisaged investments in 'business as usual scenario' (2008 – 2027)

Sector, component and activity	Totals (US$million)	
Agriculture, Livestock and Forestry		**1 027,3**
Soil and water conservation	***194,8***	
Terracing		
Radical terraces (40 000 ha)	71,2	
Gradual terraces (40 000 ha)	33,6	
Water harvesting	40,0	
Reforestation / agroforestry (100 000 ha)	50,0	
Intensification of agricultural production	***574,9***	
Improved / modern inputs	20,0	
Plains irrigation schemes (20 000 ha)	50,0	
Plains irrigation schemes linked to Rusumo falls dam (2500 ha)	20,0	
Marshlands irrigation schemes (40 000 ha)	200,0	
Livestock development and rural incomes diversification	284,9	
Policy support - training / capacity building	***257,6***	
Agricultural research	40,0	
Agricultural extension	137,6	
Agricultural market development, proximity services to producers	40,0	
Rural financial systems and agriculture credit development	40,0	
Environmental Resources		**21,5**
Kagera River Basin Environment Management Information Systen	***5,0***	
Protected Areas - Inventory Study	***1,5***	
Environmental Beneficial Uses - Valuation Study	***1,5***	
Water Resource Development and Environmental Monitoring Proç	***12,0***	
Harmonization of Environmental Quality Standards	***1,5***	
Fisheries and Aquaculture		**52,0**
Aquaculture development programme	***50,0***	
Aquaculture in natural lakes (1 000 ha)		
Multipurpose dam, fisheries management	***2,0***	
Fisheries management on Rusumo falls dam		
Fisheries management on Kakono dam		
Energy and Hydropower		**186,0**
Kagera River Mainstream Hydroelectric Projects	***114,0***	
Rusumo Falls dam (61.5 MW)	114,0	
Feasibility study	*2,3*	
Detailed studies and preparatory actions	*2,3*	
Works: dam + central	*90,1*	
Environmental and social management plan	*5,7*	
Resettelment plan	*13,7*	
Local development plan (already taken into account above)		
Kakono dam (53 MW)	0,0	
Feasibility study	*0,0*	
Detailed studies and preparatory actions	*0,0*	
Works: dam + central	*0,0*	
Environmental and social management plan	*0,0*	
Resettelment plan	*0,0*	
Local development plan (already taken into account above)		
Small and mini hydropower development	***72,0***	
Potable Water and Sanitation		**615,0**
Rehabilitation of non-functional water sources		
Rehabilitation of 16,500 sources, including community awareness	130,0	
Construction of new improved water sources		
Construction of 16,500 new boreholes, including community awarene	300,0	
Sanitation and hygiene awareness campaigns	***110,0***	
Institutional strengthening, capacity building and sector manager	***75,0***	
River Transport and Navigation		**0,5**
Lower Kagera River navigation		
Feasability study	0,5	
Pro-Poor Tourism		**1,0**
Pro-Poor Tourism Development Program - Feasibility Study	***1,0***	
Kagera Basin IWRM - Institution and Capacity Building		**17,5**
Kagera River Basin Management Unit		
Study	1,0	
Implementation and capacity building	10,0	
Support to LVBC in Elaborating Water Management Rules and Prc	***1,5***	
Kagera River Basin - Decision Support Modelling	***1,0***	
Kagera River Basin Development Programme	***4,0***	
TOTAL:		**1 920,8**



The higher ambition

Context

Thanks to a high level of good governance, democracy and cooperation between riparian states, open trade is set up as the rule at regional and international level.

The international community, donor agencies and the private sector are strongly attracted towards the EAC and LVBC countries and apply for funding large equipments of shared interest.

IWRM is also put on top of the agenda and policies and programmes comply with related principles in a sustainable manner.

Fossil energy prices as well as food prices keep high or even increase again. This is certainly a burden for the peoples, but at the same time, it brings new positive conditions of profitability for some hydropower schemes; the food production is stimulated through intensification and farmers see their income upgrade.

The story

Large funding facilities allow coping with higher energy demand by the construction of several hydropower schemes (not only the Rusumo falls scheme).

At the same time, the grid is developed towards medium and small cities in the basin.

A comprehensive programme of various infrastructures is launched, including transport and urban facilities (one good example of this kind of initiative is demonstrated by the new highway crossing the Bugesera region in Rwanda and linking to Burundi, as well as the new international airport. This is a dramatic change for this small region and the two countries together).

Many of these actions are based on a PPP approach since the private sector has gained enough confidence in business conditions along the basin and the region.

The development of cities allows also for alternative jobs, in the secondary sector. This contributes to release the pressure on agricultural lands, then improving the productivity.

The output

The construction of several hydropower schemes also allows for the development of large scale irrigation in the marshlands. These will be the Nyabarongo scheme and the Kishanda valley scheme, provided that impacts are properly mitigated and resettlement also done. In addition, a specific attention will be on electric lines in order to reach as much as possible medium cities in the basin and significantly expand the rate of people connected to the grid.

In this scenario, we will consider 60,000 Ha of new irrigated marshland schemes.

A holistic large scale approach regarding soils management is now possible with global improvement in socio economic conditions. This includes physical fight against erosion and also securing the land tenure through land use registration. This allows to stop fertility losses and improve the global food production as well as farmers' income. We will consider 60,000 ha of radical terracing as well as specific means for land use registration.

Finally, in the meaning to value the agricultural products, and develop cottage agro processing, it is proposed that a specific revolving fund would be created and accompany actions relating to pro poor tourism development.

Summary of related investment for higher ambition

Overall investments in the Kagera River basin, including all four countries, over this 20-year period have been estimated at more than USD 3.5 billion. The investments proposed are still those which are considered to be essential to the sustainable development and management of the water and related resources. The implementation rate is escalated and a specific effort is put on energy production and distribution. Various feasibility studies remain to be started or updated.

Table 15.7: Summary of proposed investments in 'higher ambition' scenario

Monograph Section	Kagera River Basin Development	US$ (million)	%
6	**Agriculture, Livestock and Forestry**	1 869,0	53%
7	**Environmental Resources**	21,5	1%
8	**Fisheries and Aquaculture**	52,0	1%
9	**Hydropower and electric lines**	888,0	25%
10	**Potable Water and Sanitation**	615,0	17%
11	**River Transport and Navigation**	0,5	0%
12	**Support to cottage industry and pro-Poor Tourism**	94,0	3%
15.6.2	**Kagera Basin IWRM - Institution and Capacity Building**	17,5	0%
	Total:	**3 557,5**	**100%**

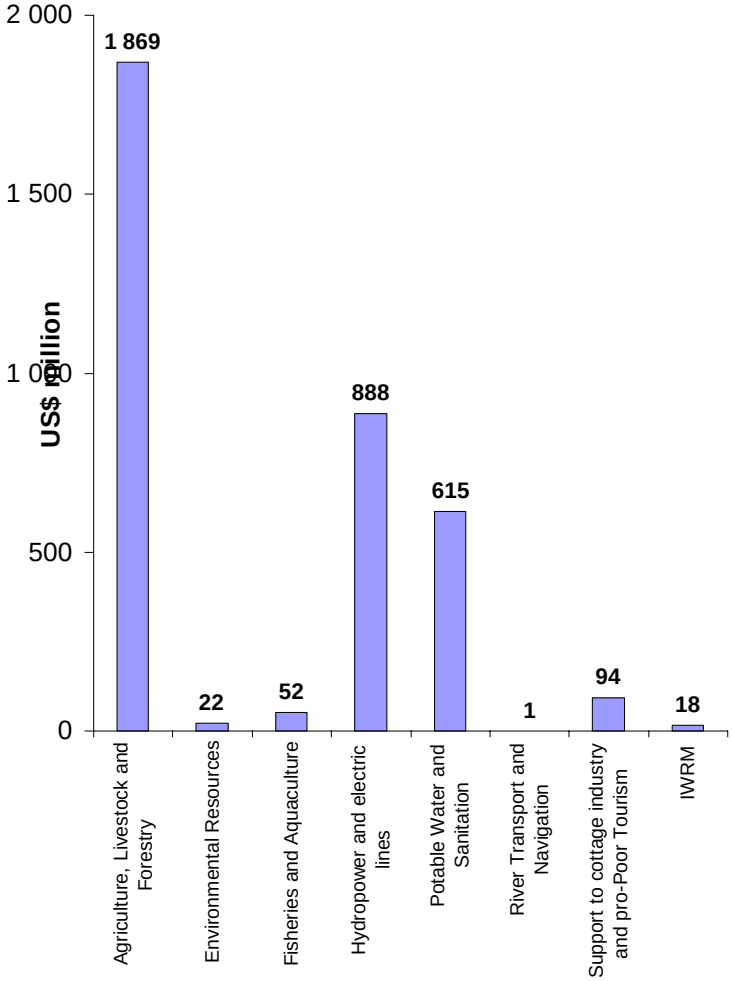


Figure 15.11 - Kagera River Basin development scenario - summary of proposed investments in 'higher ambition scenario' (2008 – 2027) by sector

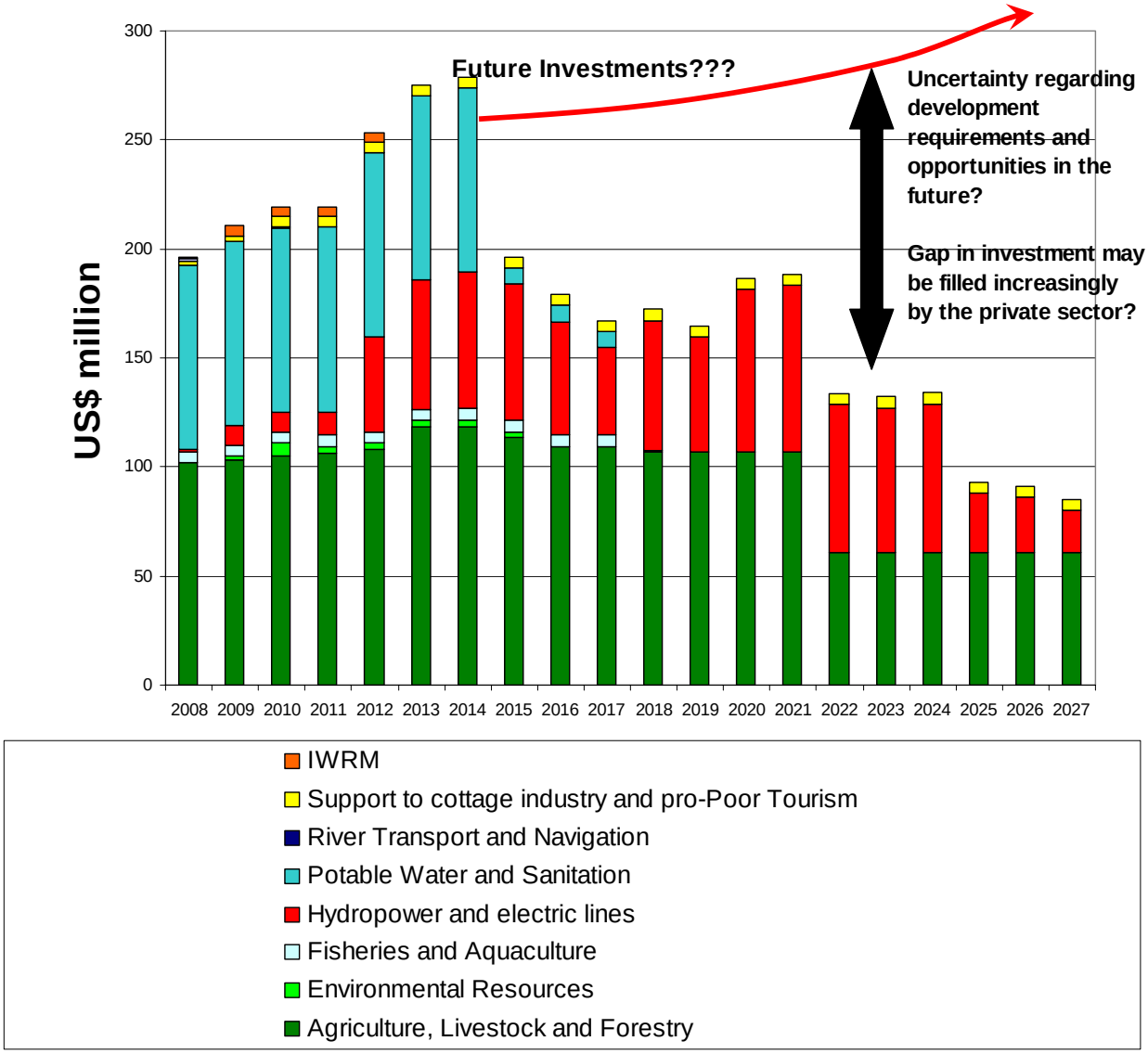
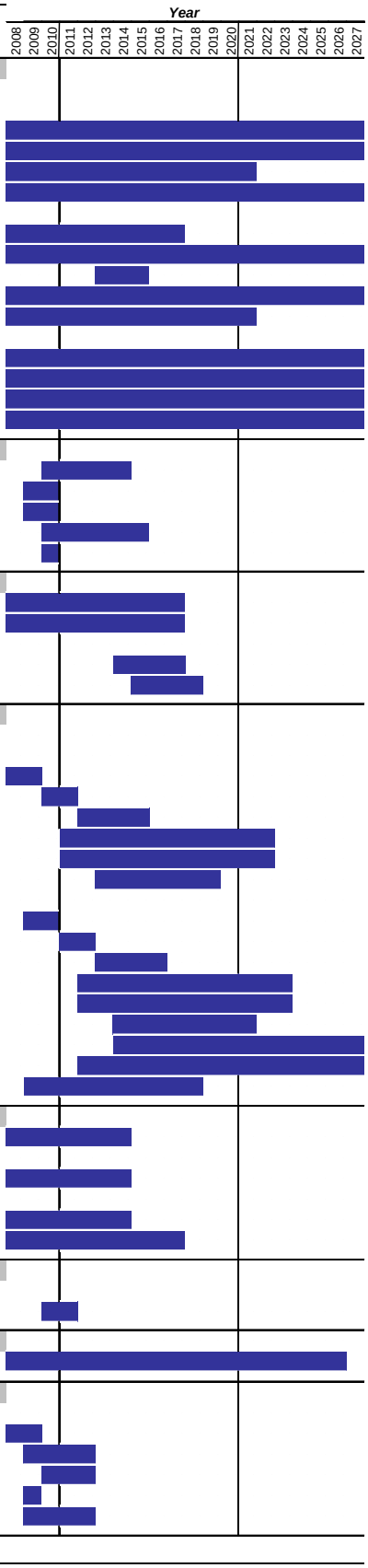


Figure 15.12 – Kagera River Basin Development Scenario – Summary of proposed investments in 'higher ambition scenario'

Table 15.8 – Kagera River Basin Development Scenario – Summary of proposed investments and implementation Gantt chart in 'higher ambition scenario'

Sector, component and activity	Totals (US$million)	
Agriculture, Livestock and Forestry		1 869,0
Soil and water conservation	***400,8***	
Terracing		
Radical terraces (40 000 ha)	213,6	
Gradual terraces (40 000 ha)	67,2	
Water harvesting	70,0	
Reforestation / agroforestry (100 000 ha)	50,0	
Intensification of agricultural production	***1 109,8***	
Improved / modern inputs	20,0	
Plains irrigation schemes (20 000 ha)	100,0	
Plains irrigation schemes linked to Rusumo falls dam (2500 ha)	20,0	
Marshlands irrigation schemes (40 000 ha)	400,0	
Livestock development and rural incomes diversification	569,8	
Policy support - training / capacity building	***358,4***	
Agricultural research	40,0	
Agricultural extension	238,4	
Agricultural market development, proximity services to producers	40,0	
Rural financial systems and agriculture credit development	40,0	
Environmental Resources		21,5
Kagera River Basin Environment Management Information System	***5,0***	
Protected Areas - Inventory Study	***1,5***	
Environmental Beneficial Uses - Valuation Study	***1,5***	
Water Resource Development and Environmental Monitoring Programme	***12,0***	
Harmonization of Environmental Quality Standards	***1,5***	
Fisheries and Aquaculture		52,0
Aquaculture development programme	***50,0***	
Aquaculture in natural lakes (1 000 ha)		
Multipurpose dam, fisheries management	***2,0***	
Fisheries management on Rusumo falls dam		
Fisheries management on Kakono dam		
Hydropower and electric lines		888,0
Kagera River Mainstream Hydroelectric Projects	***200,0***	
Rusumo Falls dam (61.5 MW)	114,0	
Feasibility study	*2,3*	
Detailed studies and preparatory actions	*2,3*	
Works: dam + central	*90,1*	
Environmental and social management plan	*5,7*	
Resettelment plan	*13,7*	
Local development plan (already taken into account above)		
Kakono dam (53 MW)	86,0	
Feasibility study	*1,7*	
Detailed studies and preparatory actions	*1,7*	
Works: dam + central	*67,9*	
Environmental and social management plan	*4,3*	
Resettelment plan	*10,3*	
Nyabarongo dam (28MW)	56,0	
Kishanda valley scheme (180 MW)	360,0	
Electric grid development	200,0	
Small and mini hydropower development	***72,0***	
Potable Water and Sanitation		615,0
Rehabilitation of non-functional water sources		
Rehabilitation of 16,500 sources, including community awareness	130,0	
Construction of new improved water sources		
Construction of 16,500 new boreholes, including community awareness	300,0	
Sanitation and hygiene awareness campaigns	***110,0***	
Institutional strengthening, capacity building and sector management	***75,0***	
River Transport and Navigation		0,5
Lower Kagera River navigation		
Feasability study	0,5	
Support to cottage industry and pro-Poor Tourism		94,0
Support to cottage industry and pro-Poor Tourism	***94,0***	
Kagera Basin IWRM - Institution and Capacity Building		17,5
Kagera River Basin Management Unit		
Study	1,0	
Implementation and capacity building	10,0	
Support to LVBC in Elaborating Water Management Rules and Procedures	***1,5***	
Kagera River Basin - Decision Support Modelling	***1,0***	
Kagera River Basin Development Programme	***4,0***	
TOTAL:		3 557,5



15.6 Discussion on scenarios

It must be emphasized that there are not “good” scenarios on one side and “bad ones” on the other side.

Obviously, the higher the better, as far it keeps realistic with funding opportunities and coherent in the general process of socio economic development, where water resources are only one aspect of the challenge.

The FAO conducted in 2006 – 2007 a vast exercise of “prospect for the future” based on a methodology with scenarios, over the whole Nile river basin, regarding agricultural production and food security[176].

They gathered several times 75 stakeholders along the basin, and made them think about pre determined drivers in the basin, sources of uncertainty, and identify the most important factors for a sound water management and food security in the future.

It happened that these stakeholders designated clearly “good governance” and “enabling environment for trade” as the two major factors to be considered.

Our recommendation is that such a “prospect study” would be quickly initiated in the Kagera Basin, on the same format gathering, say 60-80 stakeholders, on a three workshop basis, under the auspices of NELSAP. This will serve to confirm, complete or contradict the Consultant’s views; and most important it will lead stakeholders to enter in the field of direct commitment, with adoption of shared views.

15.7 Assessment of downstream impacts of Kagera River basin developments

We make a final note that studies should be initiated in the near future with the support of decision support systems (DSS) in both the Kagera River sub-basin and the entire Nile River to assess the impacts of different future development scenarios for these basins. Initial indications are that downstream impacts will be rather limited as a result of the proposed hydropower, irrigation and wetland developments, and the proposed community-based land and water management activities may actually improve water quality through reduced sediment and nutrient loads to the Kagera River and Lake Victoria. The high relative poverty in the region even by African standards highlights the urgency of moving forward with these developments with a high level of investment, sooner rather than later.

[176] Already mentioned, see http://www.faonile.org/whatwedo/scenarios.htm

16. Kagera River Basin Database/GIS Overview

16.1 Concepts

The Kagera River Basin Database developed under this Consultancy comprises mostly *information* (e.g. metadata, maps, etc.) and *knowledge* (e.g. reports, studies, plans, etc.) and is, for the most part, not a repository for basic raw *data*, except when these data are readily available (GIS layers, statistics, etc.) (ref. Figure 16.1 for definitions and example).

The Database provided is primarily a “metadata catalogue”:

Therefore, the three main concepts behind its development are that the Kagera Database are:

- Firstly, a ***metadata database;*** i.e. a metadata “catalogue” and virtual library, that can be queried by users, and where they will be able to retrieve descriptions and details about the raw data or information they are looking for;
- Secondly, an ***information and knowledge database,*** comprising reports, studies, statistics, analyses, processed data, satellite image classifications, etc.; and
- Thirdly, when available, verified and homogeneous, ***raw data databases***, such as GIS layers, satellite and aerial imagery, raw statistics tables, hydrological databases, etc.

The Database is thus including both “data” and “information/knowledge” generally described below with an example from the Kagera basin. It may be noted that a clear distinction between data, information and knowledge is not always the case as there is a continuum in transforming raw data to information and knowledge. The term *metadata* is simply defined as data about data: i.e. descriptive statistical information about the elements of a set of data.

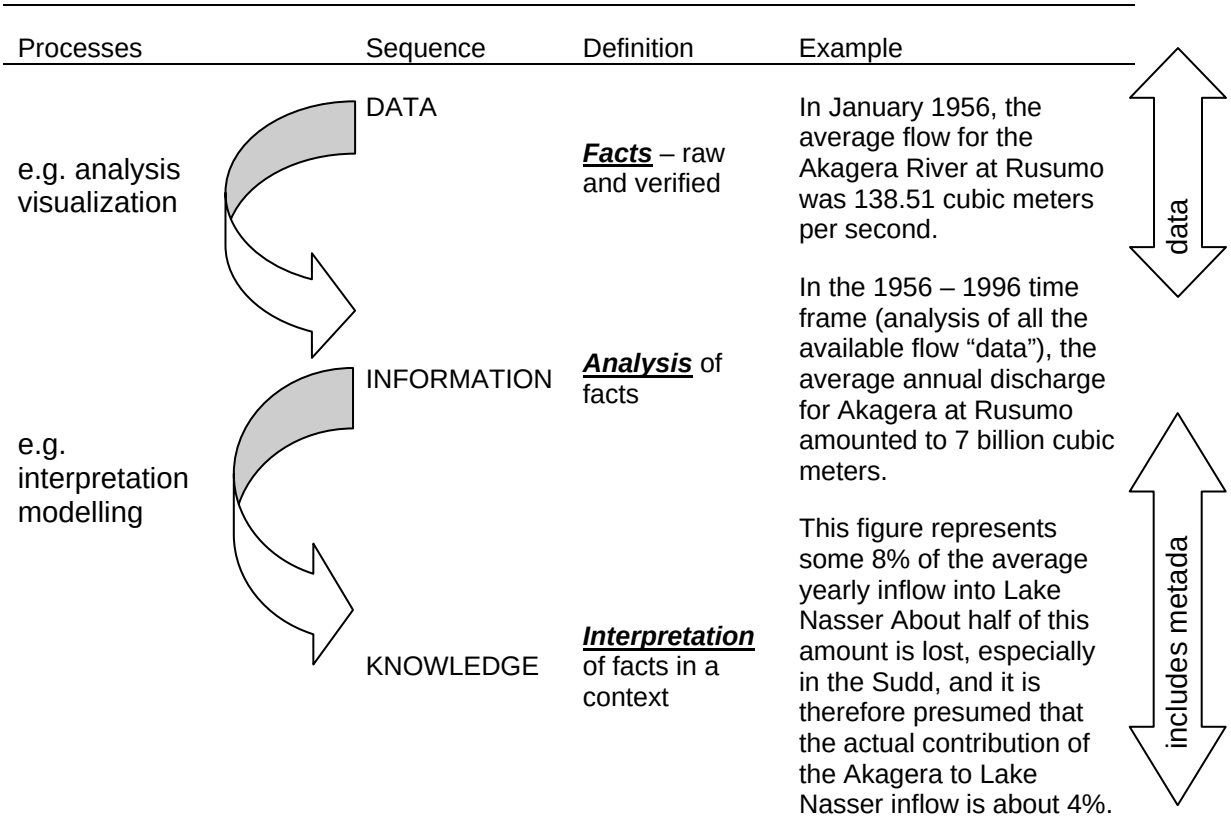


Figure 16.1 – Data, Information and Knowledge

16.2 Architecture

The Kagera Database has been structured and developed as an open architecture, which can easily be built upon and modified in the future. The Database handed over to the NELSAP PMU should not be considered a completed product, but is designed to be updated, adapted and improved on a continuous basis as required.

16.2.1 Physical set up

The Kagera Database has been implemented on a Mircrosoft Windows platform using the standard database software *MS Access* to enable widespread use and inter-operability.

An interface application for managing the database, creation of database tables, methods for data capture, elaboration of interfaces for querying, consulting and editing the database has been developed and filled-in with existing materials.

All the data/reports in various digital formats that have been collected and selected as being relevant for their inclusion in the database have been sorted and arranged into subject categories, and their descriptions have been entered into the metadata catalogue to allow various queries.

For the specific GIS and Remote Sensing formats, an ESRI ArcGIS desktop software platform is used, that can be displayed using the full software or using ArcGIS Explorer as a free and easy-to-use software viewer.

In addition to the requirements in the ToR for this Consultancy, a web based solution is also being proposed, as a complementary and flexible option that will allow any remote user to access, use and update the database.

The physical architecture is described in the diagram next page.

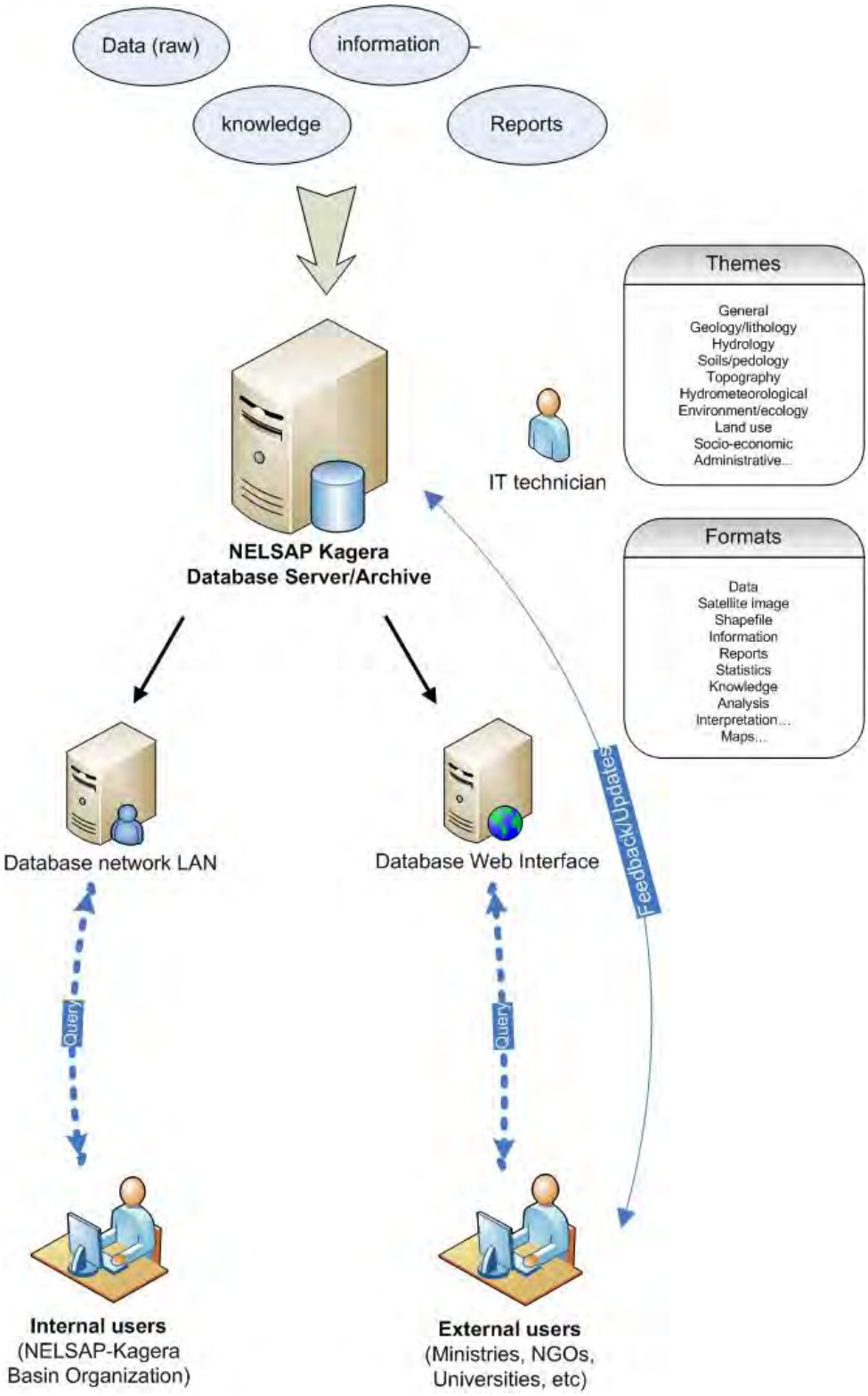


Figure 16.2 – Kagera River Basin Database/GIS – physical architecture

One version of the Database/GIS is provided to the client in electronic form (DVD, or hard drive) including all data, maps satellite images, reports, etc. acquired during the consultancy.

At the time of the reporting, the total weight of the database summed up to about 11 Go (8 Go of studies/reports and 3 Go for the GIS database).

16.2.2 Metadata catalogue

This is a catalogue of data, or in other words, a “virtual library”, accessible through a query builder interface of all the data found, verified and exploited during the assignment including raw data, GIS layers, scanned maps, and other data, reports and studies. For each data type, many fields and attributes are used to describe the data, among them are:

- Format/Type;
- Topic or sub-topic;
- Spatial extent, Data, Provider, Producer etc.

This figure demonstrates how users query the catalogue and extracts relevant information or data:

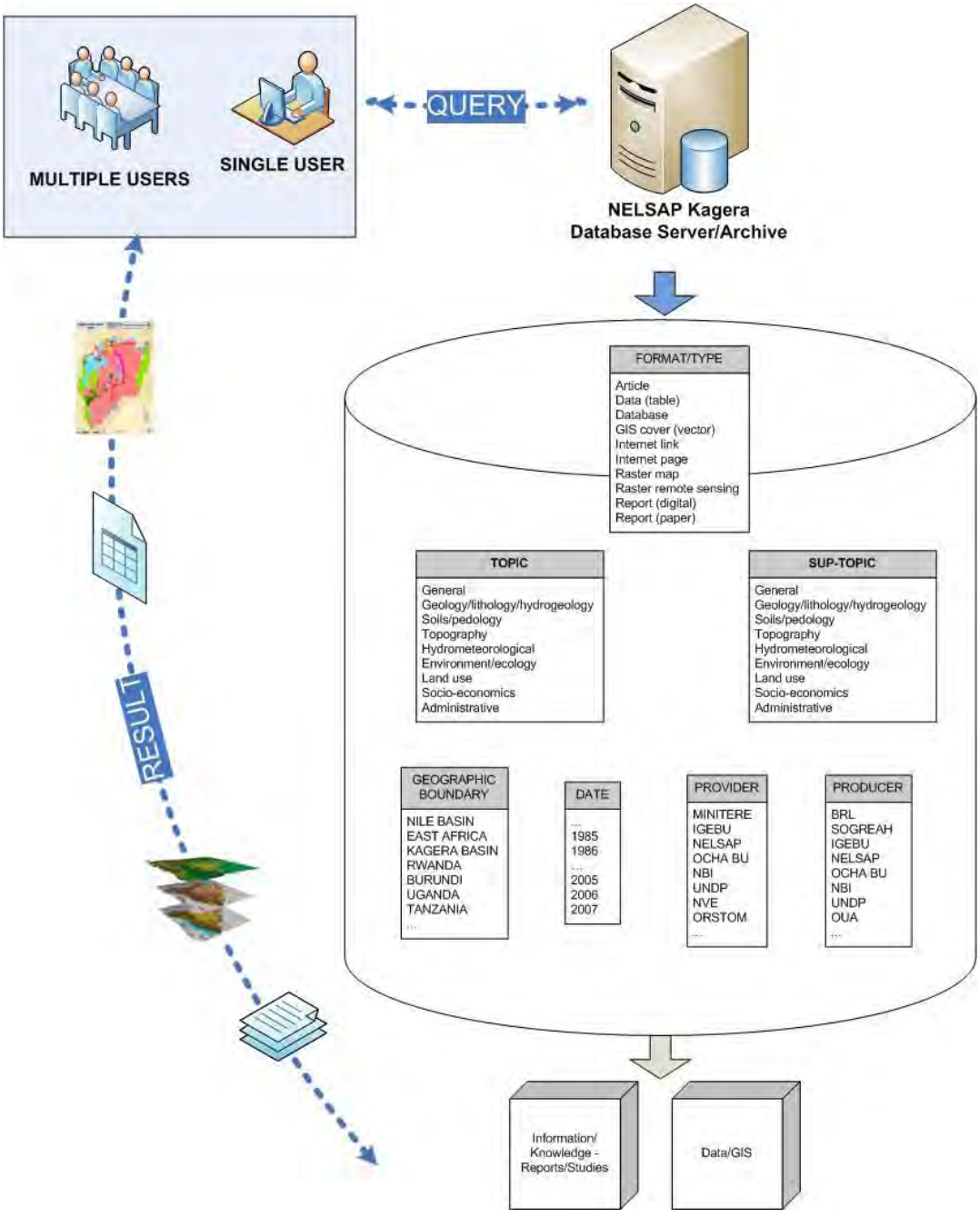


Figure 16.3 – Metadata catalogue – query function

16.2.3 Thematic architecture

The thematic architecture of both data and information/knowledge is described in the diagram below:

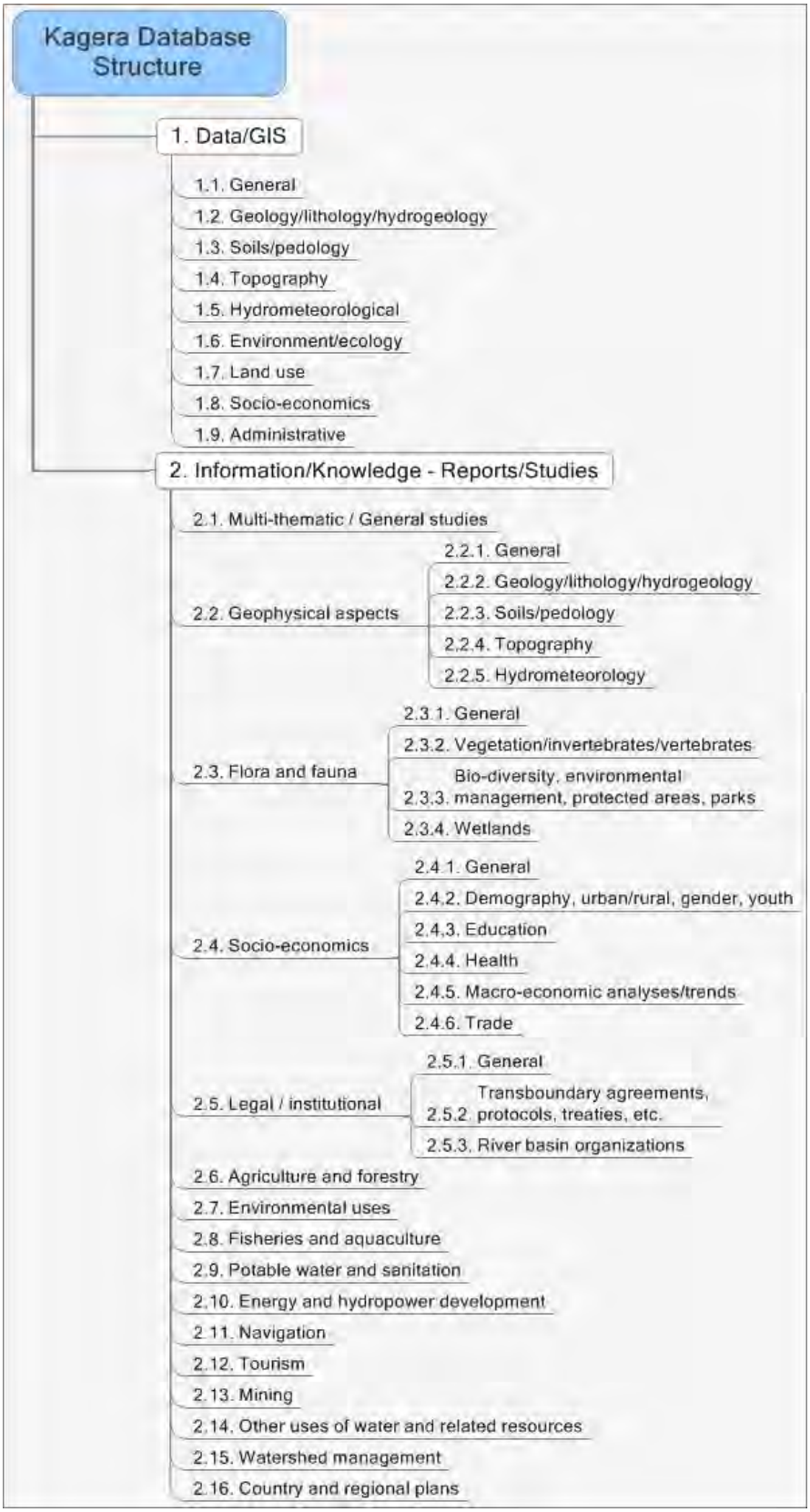


Figure 16.4 – Kagera River Basin - Database/GIS Structure

16.2.4 Spatial component

The sub-structure of the specific GIS database reflects directly the two main types of data format that store spatial information, e.g. raster and vector. To ease the interoperability process, it was decided not to store the database into an ESRI GeoDatabase, as this restricts exchange between different types of software and platforms. The various layers are then stored into folders and sub-folders in their respective formats as described below. A detailed description of the database final structure is described elsewhere.

The formats used are the following:

- For the raster data: Erdas Imagine *.IMG format or *.TIFF.
- For the vector data: ESRI Shapefiles *.SHP format.
- For the GIS layouts: ESRI ArcMap (*.MXD) format.
- For the mapping layouts: Adobe PDF format (*.PDF).

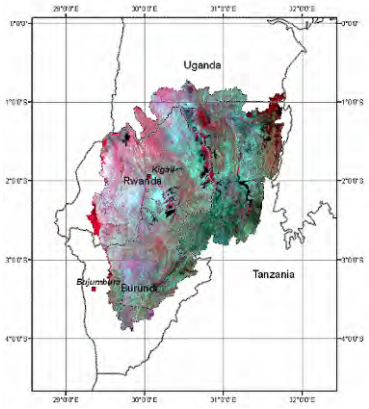
To build a regional database, and to avoid projection displacements, it is necessary to re-project all the layers to an harmonized projection. The projection chosen is a WGS84 projection, with the following parameters:

- Geographic Coordinate System: GCS_WGS_1984
- Datum: D_WGS_1984
- Prime Meridian: Greenwich
- Angular Unit: Degree.

16.3 Database content description

16.3.1 Data

The database is containing the following relevant data (raw and verified by others) for the four Kagera River basin countries extracted from various sources (Nile DST database, NVE, TAMP, etc.). An emphasis has been put on datasets with a regional extent with a homogeneous content.



Raster data

Three main types of raster datasets have been used and stored:

- Low Resolution imagery : EarstSat, SRTM;
- High Resolution imagery: Aster, Landsat, DMC, raw or classified;
- Very High Resolution: various satellite and aerial images are available on certain zones, but are only referenced and not stored because of their particular licensing restrictions.

Vector data

For the four countries of the Kagera River basin, the main vector datasets were already available thanks to previous initiatives mainly from the Nile DSS and the National University of Rwanda, that have been involved in previous activities and projects of regional scale where the vector data collection process had already been done (from Ministries, NGO's. etc). It was then possible to re-use them for this study.

The main basic layers with a regional extent and with a acceptable spatial homogeneity are:

- Country boundaries;
- Roads;
- Main cities;
- Lakes and wetlands; and
- Soils.

However, it is important to note that most of those layers are of limited quality and have to be taken carefully as they do not represent any official layer from a specific authority and as they were not checked for quality as this can only been done by the data provider.

The homogeneity of the vector databases among the four countries is also very difficult to meet and some vector layers are very heterogeneous from one country to another (particularly for roads density, country boundaries).

Additional vector layer were also used and are provided in the GIS database:

- The PNGRE database for Rwanda;
- The FAO Africover database for the 4 countries;
- The FAO Kagera Transboundary Agro-ecosystem Management Programme (TAMP) developed by the Geographic Information Systems & Remote Sensing Research and Training Centre of the National University of Rwanda (CGIS–NUR);
- The NVE Database for hydrological, land use land cover and erosion assessment;
- Social and economic data – e.g. demographic data as made available by countries.

16.3.2 Information and knowledge

Reports and studies

Most of the records that have been added to the virtual library are in form of electronic copies of the many reports and studies that were identified and collected during the course of the Project. Those reports and studies have been produced by a wide variety of agencies and ministries over the past 30 years and more.

The most important documents referenced in the Kagera database are:

- The Kagera River Basin studies (as available) carried out in 1976 under the UNDP (Norconsult and Electrowatt consultants) producing a 13 volume overview, sectors analyses, pre-feasibility studies and indicative basin plan. Unfortunately, copies of all of these studies were not found during the consultancy.
- Available documents and studies produced under the former Tecconile and Hydromet projects.
- Outputs from the Lake Victoria Environmental Management Programme implemented by the World Bank under GEF-funding.

- The recently completed Strategic/Sectoral, Social and Environmental Assessment of Power Development Options in the Nile Equatorial Lakes Region, Final Report, February 2007, produced for the NBI by the consultants SNC-Lavalin International.

Maps

Based on the vector and raster spatial database, a certain number of maps have been produced, which describe essential bio-physical, economic and social aspects of the Kagera River basin integrated from the perspective of the basin, rather than as presently available, country-by-country.

On one hand, and after production, those maps have been validated by the experts in their respective fields to improve the accuracy and to propose relevant and up-to-date representations, and on the other hand they have served to enhance to describe and represent the spatial aspects of the topics covered in the monograph.

All maps have been issued in a separate A3 volume (Kagera River Basin Atlas). Maps may also be used in the main report within the text in A4 size and smaller as appropriate.

16.4 Immediate use and future evolution

The effective usefulness and expectancy life of the Kagera database will imply that the following statements are taken into account and met in one or more of its propositions/solutions.

16.4.1 Immediate use

The database will immediately be useful in support of the three following initiatives under consideration at this time:

The NELSAP Kagera Project and other sub-projects (e.g. development scenarios, etc);

The Nile DSS, although it is expected that the breadth of subjects of the Kagera database may be broader (e.g. not only hydrometeorological, but also environmental, social, economic data and information) than at least the initial database for the Nile DSS; and

The proposed simple hydrological model for the Kagera River basin – to be implemented shortly under the Kagera Project;

It also provides the basis for a broader Management Information System (MIS) for the NBI and/or for any future transboundary river basin organization that may finally be responsible for the Kagera River basin.

A 3 day training training programme was carried out by the Consultant in Kigali during the period 5 to 7 November 2007 to some 40 trainees from the four Kagera basin countries. Important subjects raised during this training were:

- Options for describing the database,
- Organization of the data and information within the database structure,
- Use of the software and interface options developed in support of the database for: data capture, updating and querying the database.
- The GIS software applications, and in particular those used to support the presentations of the Monograph, and
- The possible evolution and future application of the database, as it continues to provide a basis for use by the various stakeholders after the conclusion of the Consultancy.

16.4.2 Hosting

Eventually, which organization will be the “host” and who will have access to the web site and/or database once the project is finalized still needs to be agreed upon.

The following propositions/suggestions can be made:

- Hosted by a future Kagera River Basin Organization (if created) or “Kagera Basin Management Unit” (ref. section 5.4.2): this would be the more logical option, but under assumption that this regional set up is operational in the short term;
- Common hosting and integration into the Nile DSS: this regional integration option would provide a real dynamism and will avoid duplication of efforts, taking also into account that both Mara and Sio-Malaba-Malakisy datatabases should as well be integrated within the DSS.
- Common host with other Kagera River basin databases such as TAMP FAO or others.

Technically, the web interface option proposed is additional to the ToR of the Consultancy, and hosted locally (by a national ISP) or internationally would certainly ease the successfully implement of any of these hosting options.

16.4.3 Maintenance and updating

As stated earlier, it is intended that the database be constantly updated, adapted and improved, as it has been primarily designed toward this objective.

In order to achieve this goal and maintain a database dynamic and provide to the users updated documents and relevant answers to their queries, the following points should be addressed internally:

- Constant maintenance and troubleshooting for users;
- Technical improvement, based on *veille technologique* and users remarks ;
- Updating and regular additions to the metadata catalogue;
- Networking mechanisms to allow regular inputs from stakeholders and partners, researchers, decision makers. Here a regional user network, internal or in partnership with other regional initiatives or databases could be set up.

Minimum requirement would be the recruitment of a technician with the following background:

- DBMS, archiving, library management, GIS an asset;
- Responsible for data quality control, homogeneity, access rights, troubleshooting;
- Based at PMU or within the future hosting institution.

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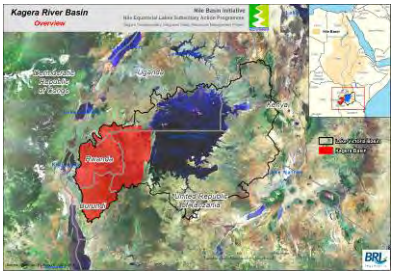
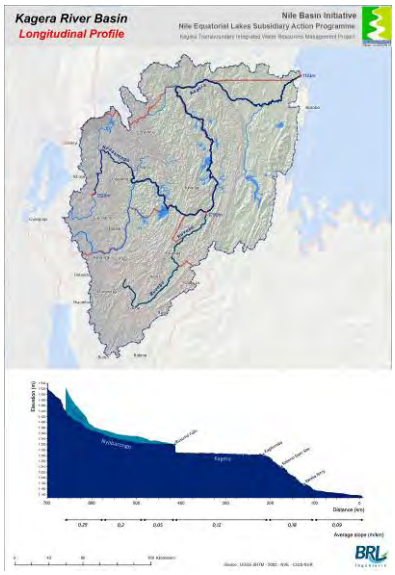
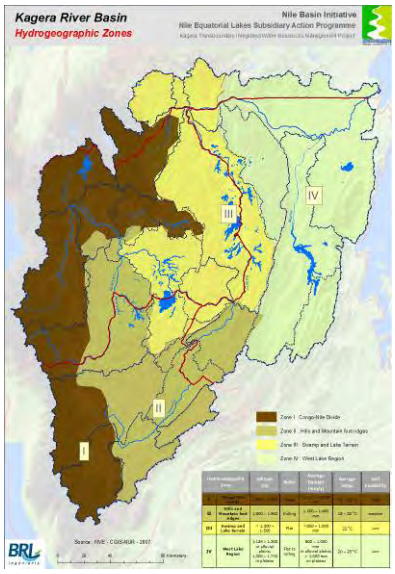
18. Index - Kagera River Basin Atlas



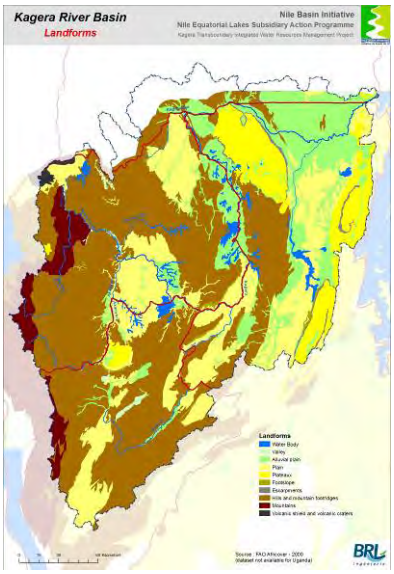
Basin context overview



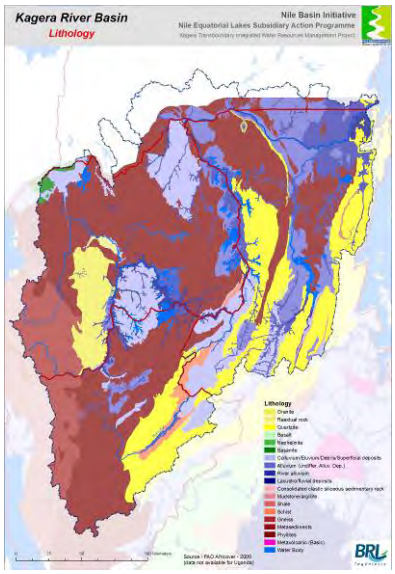
Kagera River longitudinal profile



Hydrogeographic zones

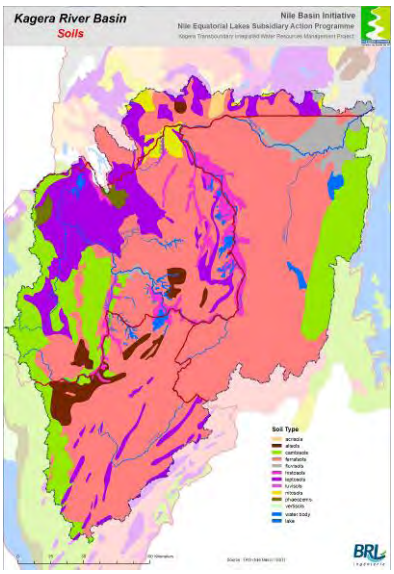


Landforms

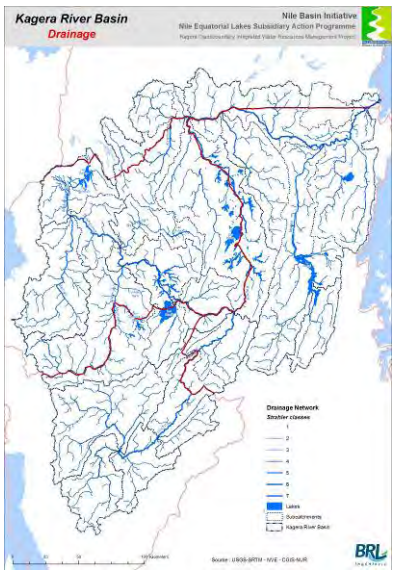


Lithology

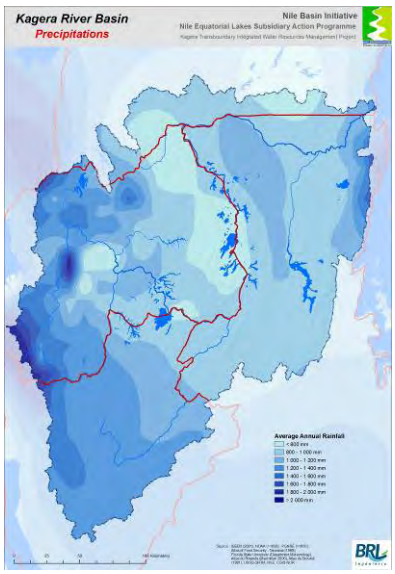
Elevation



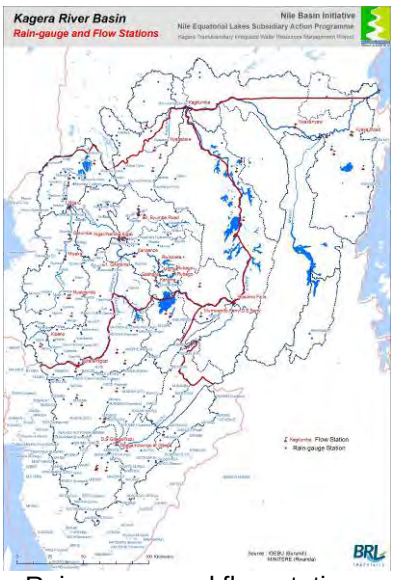
Soils



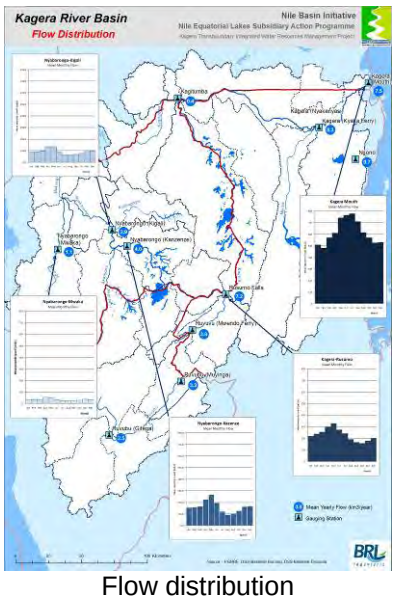
Drainage



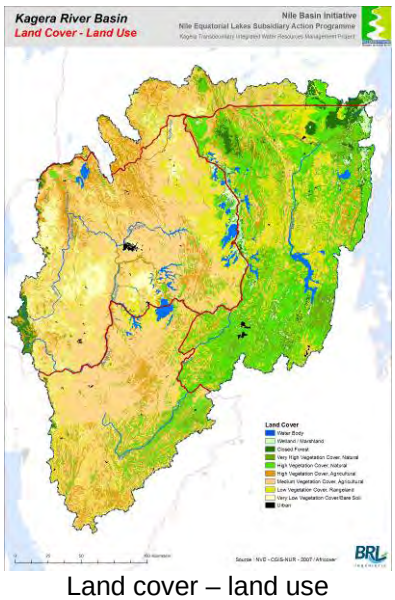
Precipitations



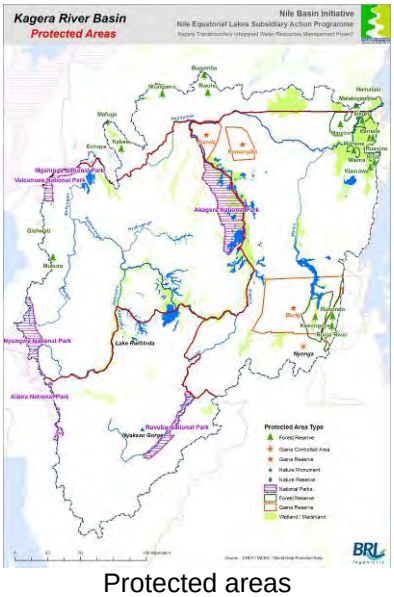
Rain-gauge and flow stations



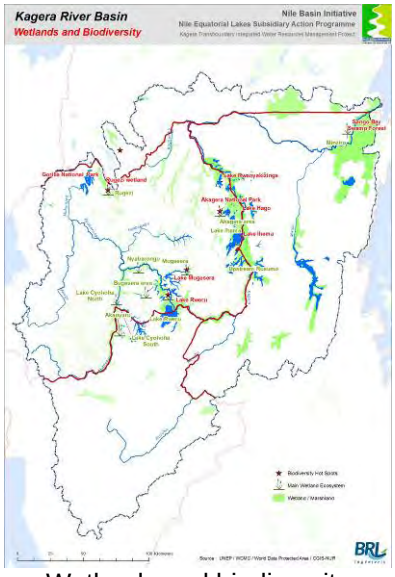
Flow distribution



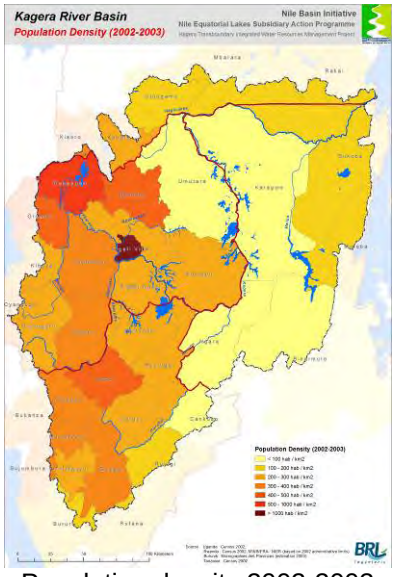
Land cover – land use



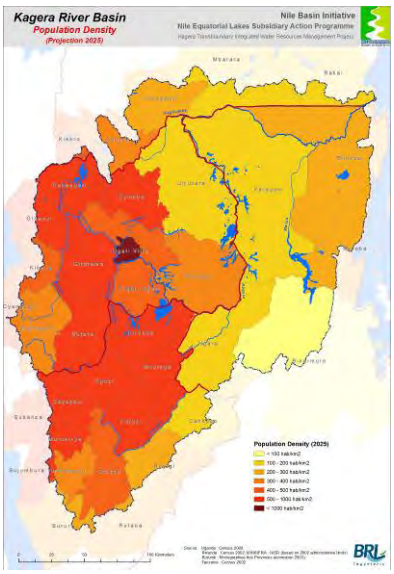
Protected areas



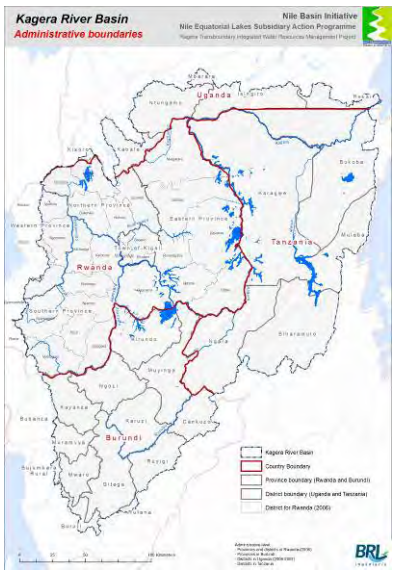
Wetlands and biodiversity



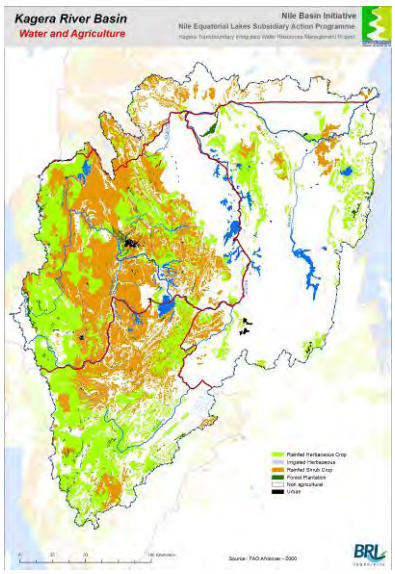
Population density 2002-2003



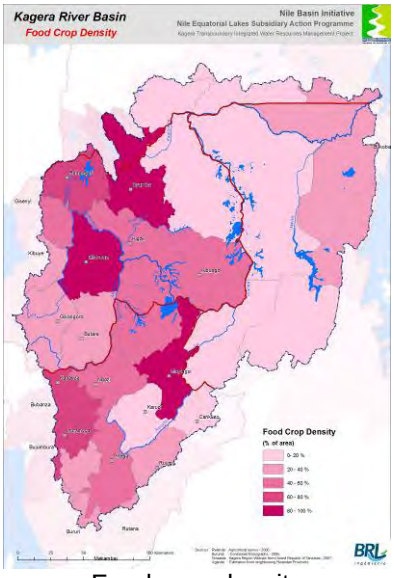
Population density 2025



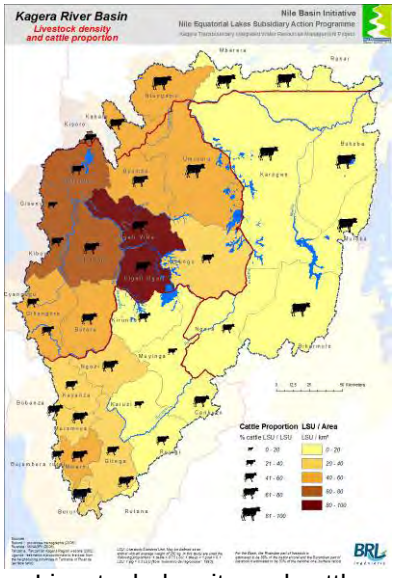
Administrative boundaries



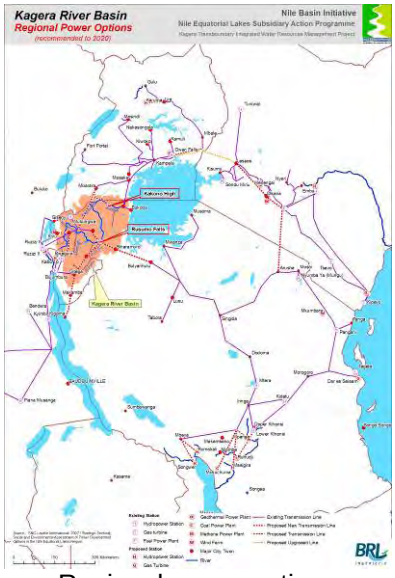
Water and agriculture



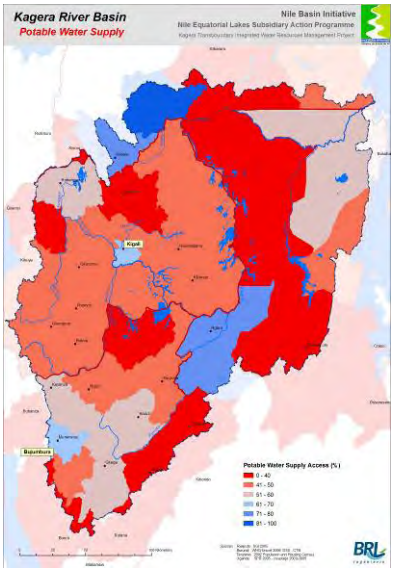
Food crop density



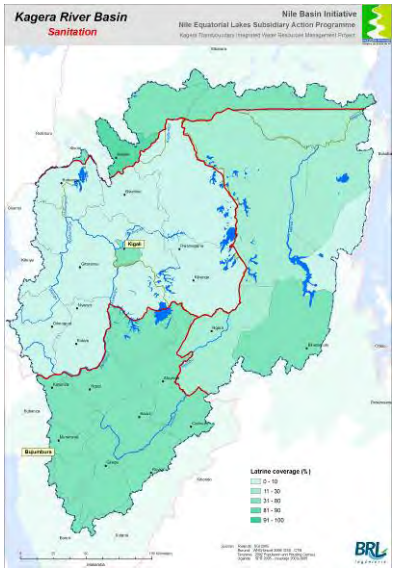
Livestock density and cattle



Regional power options



Potable water supply



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Inception Workshop - 1 August 2007- Dar es Salaam

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Regional Workshop – 3-4 November 2007, Kigali - Incomplete

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