

NILE BASIN INITIATIVE

Nile Transboundary Environmental Action Project

**BASELINE STUDY FOR WATER
QUALITY
MONITORING IN BURUNDI**

Final Report

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Bujumbura, March, 2005

NILE BASIN INITIATIVE

Initiative du Bassin du Nil

Burundi Water Resources Baseline Report

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LIST OF ACCRONYMS AND ABBREVIATIONS

IGEBU:	Geographic Institute of Burundi
INECN:	National Institute for Environment & Nature Conservation
INSP :	National Public Health Institute
MINATET:	Ministry of Land, Environment & Tourism
ONG:	Non-governmental Organization
PAE:	Environmental Action Plan
PNUD:	United Nations Development Program
PNUE:	United Nations Environmental Program
DGHER:	Rural Water & Energy Department
REGIDESO:	Water & Electricity Production & Distribution Corporation
SNEB:	National Environmental Strategy of Burundi
UB:	University of Burundi
NTEAP:	Nile Transboundary Environmental Action Project
UNICEF:	United Nations International Children's Emergency Fund
IBN:	Nile Basin Initiative
POP:	Persistent Organic Pollutant
ASBL:	Non-profit Making Association
PMI:	Small and Medium Size Industries
OMS:	World Health Organization
ISABU:	Burundi Institute of Agronomy
SAC:	Quality Control & Analysis Society
s.a	Public Limited Company
FACAGRO:	Faculty of Agronomy
NTU:	Nephelometric Turbidity Unit
µS/cm:	Micro siemens per centimeter
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
DGEE	General Water & Electricity Administration
LACA	Chemical Testing & Control Laboratory

Executive Summary

The present research focuses on one vital resource: water, a commodity without which no living creature can exist. Water is a two-edged weapon. If it is protected it is the source of life but if it is contaminated, it is a source of diseases and death.

The Nile Transboundary Environmental Action Project is a project now being implemented within the framework of the Nile Basin Initiative. The present research is a baseline study for checking the quality of water in Burundi.

Burundi (27834 square KM) is on part of two main hydrographic basins of the African continent sharing almost equitably the country's territory, that is 13,800 square km for the Nile river basin and 14,034 square km for the Congo River basin.

The National Water Resources Management Policy in Burundi was set up in 2001. General principles on which different water use areas must be based are defined. The strategies consist of, on the one hand, undertaking urgent actions, and, on the other hand, working out and implementing structures and mechanisms for lasting development of water resources. In spite of the current demographic increase, the quality of water from rivers and lakes is not analyzed regularly. What is known is the fact that drinking water remains unavailable, less used or only accessible from far for a still important part of the population which is, consequently, suffering from different water diseases.

The environment code indicates that the bacteriological, physical and chemical analyses should be carried out by registered laboratories. Laboratories analyzing water quality are not numerous. We visited some of them, such as the laboratory of REGIDESO, a public company producing, distributing and commercializing water and electricity.

On the institutional side, the ministry in charge of environment was established in 1989, but water resources are under the authority of several ministries. That is the reason why overlapping, and even rivalries in sharing responsibilities and pluralities of offices are being observed in the water sector.

Legally, a number of laws were put in place. It has been realized that these texts are incomplete and that some of them should be updated; most of these texts are not implemented.

It should be pointed out that Burundi is signatory to a number of international conventions related to management of water resources.

The Government is one of the main shareholders in water quality management. In a way or another, communities are also involved in water quality management. People abide by government's regulations but we have realized there is little awareness on their side. NGOs are also involved in water quality management. As there is no systematic water quality analysis, little information circulates and, in such conditions, it is hard for contributors to assess the level of awareness.

Because of the geographic position and relief, Burundi is part of the two main African hydrographic basins; that is the Nile river basin and the Congo River basin.

Burundi in general and the Nile river basin in Burundi in particular, are drained by several quite dense rivers, that is the river Rusizi, the Ruvubu river, the Kanyaru river and the Malagarazi river, which make up the main Burundian hydrographic network.

The estimate of the average Burundian contribution to the Kagera River, which is the main affluent of Lake Victoria, is 3.1 million cubic meters per year. The greatest parts of the waters in Burundi, which flow to the Nile River, are drained off by the Ruvubu River. Swamp areas make up ecosystems of great importance if we consider the surface they cover and food production from that surface. Swampland represents 112,028 ha.

In 1989, the Faculty of Applied Sciences (F.A.S) at the University of Burundi carried out analyses of surface water quality. samples were taken from five rivers, ie, the Nyamuswaga river, the Kanyaru river, the Mubarazi river, the Ruvubu river and the Ruvyironza river and from three lakes, ie, Lake Choba, Lake Rwiginda and Lake Rweru.

According to this study, rivers waters in Burundi, in general and in the Nile basin waters in particular, were non-polluted fresh waters.

The situation has changed today. 42% of the surface of Burundi shows high sensitivity to underground water pollution. Generally, river waters are characterized by some bacteriological pollution,

caused by cattle wandering, high demographic density, lack of latrines waste disposal, natural environment and mining.

As the quality of water is not analyzed regularly, such conclusions are drawn from very limited studies carried out after the FSA study.

Water quality management is characterized by a lot of deficiencies in the Burundi. There are quite numerous contributors to water management. But very few contributors are really interested in quality management.

So far key baseline water quality Monitoring indicators must be highlighted. However, concerning water for agriculture, a preliminary systematic study is recommended to describe the current situation.

CHAPTER I

INTRODUCTION

Burundi belongs to the Nile Basin and hosts the southernmost source of the river. The Nile Basin occupies the tenth of the total area of the African continent. Burundi is closely following the activities of the Nile Basin Initiative.

Launched in February 1999, the NBI is a transitional mechanism which puts in place an agreed framework for the fight against poverty and socio-economic development. It is guided by a shared vision, one which aims at ‘the achievement of socio-economic development through the equitable utilization of the common water resources of the region and equitable distribution of benefits for all’.

To achieve this vision, the NBI has formulated a Strategic Action Program composed of two components:

- The Shared Vision Program
- The Subsidiary Action Programs

Within the framework of the shared vision program, a project called “Nile Transboundary Environmental Action Project” has already set off its activities. The present study is a response to one of the concerns of this project, namely water quality concerns. “In order to ensure water quality control, it is provided that baseline studies and tests on water quality be conducted in the basin”

The objective of the study is, on the one hand, to provide improved data on water quality and on the other hand, to bring to light the major problems of water quality in the Nile basin area in Burundi. Once identified, these problems will require key baseline indicators for water quality control so that progress in these indicators can be measured consequently. On the level of the Nile basin, the different baseline studies will be translated into standardized analytical methods, and into increased monitoring capacities for a limited number of water quality parameters through harmonized methods.

The mandate of the Consultant is to prepare a report on the status of water resources in the Burundian territory that falls within the Nile Basin.

Then the Consultant proceeds to work out the all the aspects of water quality, conducts a critical analysis on these aspects and propose

recommendations in the form of key baseline indicators for water quality control.

In order to achieve this, the Consultant is expected to employ the most effective methodology that would allow access to a maximum of information:

- Use a realistic questionnaire for the collection of the correct information
- Review the existing documents on the Nile Basin, in particular those dealing with water quality
- Review the documents of the departments involved in water quality management
- Interview the different officials concerned by water quality management
- Prepare a concise and clear report

All these elements make up together “Water Quality Baseline Study in Burundi” presented in this document which is divided into seven major parts.

After this introductory part, follows the second chapter which deals with the status of water quality in Burundi. In this chapter, a particular emphasis is given to the major lakes, rivers and wetlands, the main causes of source-point pollution and non source-point pollution and the institutions involved in the management of the water sector.

The third chapter deals with water resources management practices. It spreads out the policies, the strategies of water resources management and water quality control activities.

The fourth chapter provides data on water quality in certain sampling stations. The chapter brings into light the results of the analyses conducted by FSA in 198 and SAC in 2005.

The fifth chapter gives an inventory of water quality analysis laboratories existing in Burundi. It gives at the same time details of the appointed personnel and the equipments.

The sixth chapter shows the identified gaps in water quality management.

The last chapter spells out the recommendations in view of filling the identified gaps in water quality control, giving emphasis to baseline key indicators.

CHAPTER II

The Status of Water Sector in Burundi

II.1. The Main Lakes, Rivers and Wetlands in Burundi

Burundi, by its geographical position, and its relief, belongs to two major basins in the continent which divide the country into almost two equal parts. These two major basins are the Nile Basin which is 13.800² km and the Congo Basin which is 14.03² km. The country as a whole is washed by a dense network of water ways. The water ways, the swamps and the lakes represent almost the 10th portion of the total area of the country and give a particular significance to the hydrographic resources of the Burundi (See Annex). The swamps occupy an area of 112.028 hectares (See Annex). The rate of rainfall in Burundi varies between 80mm to 200mm. 54% of precipitations are lost to evaporation, 34% through infiltration and 12% through runoff.

The average rate of annual precipitation is 1011m³/s or 1244 mm divided as below:

- Average evaporation/transpiration: 692 m³/s or 872 mm
- Surface Water: 319 m³/s or 402 m
- Ground Water: 237 m³/s or 299 mm
- Runoff Water: 82 m³/s or 103 mm
- Shared Resources: 335 m³/s or 422 mm
- Exported Water: 621 m³/s or 783 mm

II.1.1. The Lakes of Burundi

II.1.1.1. Lake Tanganyika

We are not going to focus on this lake because it belongs to the Congo basin, an area which is not the target of the present study. However, we think it is worthwhile to point out that this lake is a true treasure for both Burundi and the other riparian countries around the lake, namely, Democratic Republic of Congo, Zambia and United Republic of Tanzania. This lake represents an immense fresh water reserve (an area 31.9002 km² and a volume of 18.800³ km), that some describe it as a living museum, thanks to its biological wealth and the endemic nature of some of these resources.

II.1.1.2. The North Lakes

In addition to Lake Tanganyika, there are other small natural lakes in the North of the country. The biggest ones are Rweru (10,000 Hectares) and lake Cohoba (6.700 Hectars). These lakes are characterized by a shallow bed, but they are more appropriate for pumping irrigation. The other lakes are Rwinda, Gacamirinda, Kanzigir, Gitamo, Narungazi, Rwungerr, Marunxzi and Inampete. The water of Lake Rwhindi is alkaline and is contaminated by animal fecal substances.

Lake Cohoba is in the extreme North of Burundi. It is both affluent and effluent of Kanyaru which pours into the Nile. Its water is alkaline and is contaminated by fecal substances.

This lake represents the only source of water for the populations in the area. In this context, the populations are also exposed to bilharzias and malaria infection in this lake. The production capacity of this lake is 63 kg per year.

Gacamirinda, Rwhinda and Narungazi lakes are also both affluent and effluents of the Knayaru while Kanzigiri and Rweru lakes are affluent and effluents of Kagera and Nyabarongo. These different lakes represent tourist potentials with their beautiful blue waters surrounded by a ring of dark green papyrus. Rwhinda lake, nicknamed Bird Lake for hosting migrant birds, has been transformed into a natural reserve.

The break out of the crisis in Rwanda in 1994 drove a massive number of refugees into the Bugesera region and, still worse, a period of drought followed. The need for wetlands drove the local farmers to clear buffer zones and destabilize the water supply system from the lakes and this, in consequence, resulted in the dry up of the North lakes.

II.1.2. The Rivers of Burundi

Four major water courses make up the hydro network in Burundi. These four water courses are Rusizi, Ruvubu, Kanyaru and Malagarazi.

In this part we will also focus on the main river in the Nile basin area while noting that in the great lakes region, the Nile has two sources:

- The source of the Nile located in the lakes in the high lands in the extreme end of central and eastern Africa.
- The remotest source of the Nile overlapping with the source Mwongo in Rwanda n the far end of North and Rvvironza in Burundi

Malagazi and Rusiz which flow into Lake Tanganyika are the main rivers in the Congo basin. The Nile basin receives the waters of Kanyaru and Ruvubu which come from an area relatively well drained.

II.1.2.1. River Ruvubu

Ruvubu , the most important river in Burundi, is the main river that feeds into the River Nile. Its basin area is 10200² km.

It flows practically through the whole center of the country where its major tributaries concentrate. Flowing from its sources in the crest in Ngongo at the height of 2300m, it heads towards the North-east to join Nyambarongo River and Kagera River.

On the left bank, this river of 285 km, is fed by Kinyankuru, Ndurumu and Nyakigazi streams. On the right bank, the streams feeding into it are Nkokoma, Mubarazi, Ruvironza Nyababa and Kaynogazi.

The Ruvuvbu river is considered to be the most important water course in the Burundi with a an average flow of 90³ to 110³ km per second in Muyinga (a province in the North of Burundi). This is equivalent to two milliards cubic meters per annum, while the main five rivers of the Kanyaru basin represent together a rate of flow of 8.3³ meters, the equivalent of 0.26 milliards cubic meters per annum.

The average contribution of Burundi to Kagera, the main tributary of Lake Victoria is estimated to be 3.1 milliards cubic meters per annum.

Table 1: Average monthly and annual flow rate of Ruvubu (1974-1992) in m³

Month	Maximum	Average	Minimum
September	68.45	52.91	43.12
October	79.42	59.00	45.12
December	111.94	81.83	52.51
November	122.82	96.83	74.41
January	122.62	95.96	73.99
February	129.34	106.50	83.66

March	148.37	115.64	90.36
April	175.83	141.73	109.79
May	183.82	144.58	107.54
June	116.10	86.04	68.68
July	68.65	59.45	52.72
August	6059	51.23	45.41
Annual Average	115.66	90.08	70.61

Source: Evariste SINARINZI

II.1.2.2. River Kanyaru

Kanyaru, the main tributary to the Rwandan main river Nyabarango, drains the North of Burundi. It shapes the frontier with Rwanda that extends to 100 km and receives a certain number of water courses on the right bank. In terms of their length, these water ways have no significance. As mentioned above, the far North of the country lake Cohoba is a tributary of Kanyaru. This lake has the peculiarity of being both the feeder and effluent for this river, being its deposit in the high lands.

II.1.3. The Wetlands of Burundi

On analyzing the ecosystems, the emphasis should be placed on the swamps, taking into account their economic and ecological significance. The importance of wetlands resides in the vast areas they represent (112028 hectares) and the activities they secure.

On the other hand, the plants and the soils of wetlands purify water and eliminate high concentration of nitrogen, of phosphor and in certain cases, of toxic chemical substances.

Half of the afore mentioned area of swamps has been cultivated and secures 10% of the food production

Two essential tools for the management of swamps are in place today, namely, Pilot Scheme for the Development of Swamps (in place since 200) and a legislation on swamps which will be an integral part of the revised land code.

II.2. The Main Causes of Source-point and Non-source-point pollution

As indicated above, though there is no sufficient data and information on pollution, it is recognized that the quality of water is threatened by bacteriologic and organic pollution. This situation is revealed by some rare rapid assessment studies.

Water quality depends on general on the quality of the environment. Let us now establish the distinction between surface water and ground water.

II.2.1. Surface Water Pollution

II.2.1.1. Organic Pollution

There is little data available on surface water quality. The waters of the rivers and lakes do not undergo regular quality analyses. The water courses are characterized by a certain bacteriological pollution occasioned by animal waste, high demographic density, lack of latrines waste dumping and the natural habitat. The surface waters not undergoing proper treatment, are rarely safe for human consumption.

The table below gives an idea on pollution caused by human waste, taking into account the weakness of sanitation coverage in the rural areas.

Table 2: Net Rate of Sanitation Coverage in Rural Areas (2003)

Type of Latrine	Total Number of Latrines	Targeted Population (Household)
Traditional Latrines in good condition	209056	209 056
Latrines V/P	3203	3 203
Improved Latrines	15918	15 918
Septic	940	940
Total	229117	299 117
Total Household		1 053 117
Net Rate of Coverage		

Source: Annual Report on the Status of Environment, Edition 2004

Organic pollution is concentrated in the parts of the rivers situated close to coffee processing plants where the self-purifying capacity of water could be overrun momentarily.

II.2.1.2 Chemical and Other Forms of Pollution

In general, apart from the handcraft exploitation of minerals in Burundi, the problems of water pollution arise in the level of water courses. We know For example, industrial activities pose threats to water quality in the water courses by dumping mineral wastes into the water beds. In this context in particular, the mine of Kabarore pollutes Nwogere, the tributary of Kanyaru. Given the magnitude of the problem, the worry for water pollution threats from heavy metals or toxic substances or even by arsenic emanating from the mines is also justified.

II.2.2. Ground Water Pollution

The bulk of ground water is situated in the IMBO and KUMOSO area which are not part of the Nile basin portion covered by this study. The region of Bugersera is the poorest (Nile basin) in terms of ground water resources.

On the level of quality, on average, 42% of the total area of Burundi show high level of ground water quality pollution. This pollution is due to the lack of hygiene in rural areas and to human activities which extend to the water source.

The load of fecal germs in ground water is considerable and in some places appalling. The rate of polluted sources rises to 13% in dry seasons and reaches up to 51% in the rainy seasons.

II.3. The Water Sector Management Institutions

It is an established fact that, wherever the case may be in the world, in order to be efficient, decisions have to be taken within the appropriate political, legal, and institutional frameworks. We should not minimize the importance of identifying the legal, institutional and political methods to tackle the different dangers surrounding water resources.

It is, also worth to note that there is a multitude of dispersed stakeholders involved in the management of the water sector,

stakeholders which we try to analyze in terms of the level of involvement and awareness..

II.3.1. Political, Legal and Institutional Framework for the anagement of Water Resources.

In Burundi, the environment, in general, falls within the responsibility of The Ministry of Land, Environment and Tourism created in 1989. This ministry is responsible for the planning, coordination, and implementation of programs related to environment and monitoring of environment. Three institutions with managerial autonomy fall under its authority:

- National Institute for the Protection of Environment and Conservation of Nature (INECN)
- Geographic Institute of Burundi (IGEBU)
- National Office for Tourism

The INECN administers forests and protected areas, while The Department of Forests oversees tree planting outside the protected areas, including agro forestry.

In 1980, the government of Burundi, taking note of the importance of meteorological, climatologic, hydrological and cartographical data, established the .IGEBU with a clear mission of promoting and strengthening the geographical activities in the fields mentioned above.

On the institutional level, the fact is that water resources fall under the authority of several ministries involved with the water sector.

In general, the institutional make-up is marked by overlapping and, for that matter, by rivalry for responsibilities and attributions. The ministries involved in water resources management are:

- Ministry of Land, Environment & Tourism responsible for the formulation and execution of the national policy on questions of land and environmental management, especially by fixing and implementing the appropriate policies for territorial management, the protection and conservation of natural resources: water bodies, forests, wild fauna and flora.
- Ministry of Community Development having under its power the planning and supervision of rural development actions, notably

in the hydraulic framework, in the framework of rural sanitation and power supply.

- Ministry of Agriculture & Livestock which hosts the main agents of environment transformation, namely, farmers whose production is possible only through water resources.
- Ministry of Public Health the programs of which must take into account hygiene concerns in general and water hygiene in particular.
- The Home Ministry which administers the communal entities the government has entrusted with the responsibility of water supply to their respective populations
- The Ministry of Transport, Post & Telecommunications having under its authority lake and river navigation
- The Ministry of Mining and Energy, presiding over REGIDESO which produces, distributes and markets water and electricity in the urban centers.
- Ministry of External Relations & Cooperation

The legal framework regulating the management of water resources is composed of the following texts:

- The Public Health Code
- The Decree-Law N° 1/41 of November 26, 1992 on the establishment of public water management
- Order N° 52/160 of November 16 1995 regulating fishing in the lakes
- Decree N° 100/241 of December 31, 1992 regulating the disposal of urban waste water
- Decree N° 10/10 of June 30, 2000 on Environment Code
- Decree N° 100/114 of 31/02/2004 on the restructuring the National Environmental Commission.

On the level of international law, Burundi is party to the following conventions:

- UN Framework Convention on Climate Changes
- Bale Convention on the Control and Elimination of Transborder Transfer of Dangerous Wastes
- Stockholm Convention on Persistent Organic Pollutants

- Ramsar Convention on Wetlands
- Convention on the Sustainable Management of Lake Tanganyika

II.3.2. The Key Actors in Water Resources and Linkages

Water has two uses; potable use and non potable use. Alongside surface water, Burundi is also endowed with significant amount of ground water. The key actors in the water sector differ in accordance with these different categories of water sources. Amongst these actors, some have interests in the quality of the resources

The Government as a key actor has been described as the body with the ultimate responsibility for water quality. It acts through its different ministries, departments and institutions supported by its political as well as legal management tools.

II.3.2.1. The Institutions Involved in Water Quality Management

Water quality management is obviously a government affair. Environment falls within the authority of the Ministry of Land, Environment & Tourism. Health falls directly under the authority of Public Health Ministry.

The Geographical Institute of Burundi (IGEBU) secures the provision of meteorological and hydrological data on a regular basis. It is accountable for its actions before the Ministry of Land, Environment & Tourism.

The National Institute for Environment & Nature Conservation falls within the authority of the same ministry. It ensures the administration of natural forests and protected areas and before its laboratory broke down, it used to monitor pollution by conducting analysis on industrial waste.

Land, Environment & Tourism General Directorate is responsible for the coordination of environment and water resources monitoring activities.

The General Directorate for Rural Water & Electricity (DGHER) secures the supply of water in the rural centers because REGIDESO limits its activities to urban centers. This directorate does not have its own laboratory, but it enforces laboratory tests to ensure healthy potable water to the public

General Directorate for Public Health is responsible for hygiene and health. It is therefore involved in water quality issues given that most cases of disease incidence observed presently in Burundi stem from the consumption of unpurified water.

The University of Burundi, The General Water & Electricity Administration and REGIDESO have laboratories for water quality analysis. The laboratory of REGIDESO, which is really functional, enjoys a very high public demand. The other laboratories, such as BRARUDI, belong to NGOs or to the private sector.

II.3.2.2. The Capacities of Institutions Involved in Water Quality

The capacities of the institutions involved in the management of water quality are limited for several reasons:

- The impacts of socio-economic crisis that broke out in 1993. Certain meteorological and hydrological stations and pluviometer posts were destroyed\
- Lack of sufficient qualified staff and agents in the management of water quality. This problem concerns all the institutions.
- Obsolete laboratory equipment (FSA)
- Lack of reagents in the laboratories (INECN, FSA)
- Lack of capacity for institutions to procure new equipment or to ensure the maintenance of the existing ones (a piece of equipment breaks down and it is removed)

II.3.3. Involvement of Grassroots and NGOs

In order to fulfill its commitment of extending water service to rural areas, the Government has established an entity named Department for Community Water Services with a financial autonomy. Today each province has its own department. The role of the Community Department is as follows:

- Oversee the daily functioning of facilities
- Ensure the maintenance of water catchment installations, the reservoirs, the canalization and taps
- Hire the appropriate organisms for large-scale maintenance works

The communal water management entities can be considered as an example of grassroots involvement in water quality management. The control of water quality in the rural area is exercised before and after channeling. Before channeling water sources judged not potable can be abandoned.

After channeling, a water source can be contaminated and in this case the local communities as witnesses can take part in the major water works.

The involvement of communities can be seen in particular when the water source is judged not potable. The communal water management units have a supervisor at the top. They are in charge of ensuring the protection of channeled water in the source and in the reservoirs.

The NGOs also intervene in the process of water supply effort in rural areas (and urban areas). Presently, the international and local NGOs and agencies which support this sector are:

- The Norwegian Refugee Council
- International Rescue Committee
- OXFAM Quebec
- CISV
- International Committee of the Red Cross
- TEARFUND
- Self –promotion Support Organization
- CEPBU

II.3.4. The Level of Awareness on the Issue of Water Quality Monitoring & Management & Information Exchange

A salient aspect of the water sector in Burundi at the present time is weak circulation of information. In general, the populations are hardly able to perceive the benefits of potable water for health. “ Before the crisis, half the population had access to potable water at an affordable distance of less than 500m. Despite the inappropriate practices in water uses and hygiene, water supply efforts are not accompanied by measures for the improvement of sanitary conditions

Whether in terms of water quality monitoring, in terms of water quality management or information exchange, it is observed that the level of awareness is low.

CHAPTER III

Water Resources Management Practices in Burundi

The government of Burundi is aware of the importance of water in the daily lives of both rural and urban populations. Water resources play a significant role in the socio-economic development of the country. There is also a universal consensus that no development of any kind is possible without the abundance sound management of water resources.

III.1. Policies and Strategies of Water Resources Management

The National Water Resources Management Policy was put in place in 2001. It is a tool of water resources management which spells out the general principles for the utilization of water in the different fields such as agriculture, potable water service, industry, energy and the protection of environment. It is the document that indicates how to reconcile the different interests of water users.

II.1.1. The Main Axes of the Water Resources Management National Policy

- Access for all to potable water
- Access for rural areas to hydro power
- Increased rational utilization of water to meet the basic needs of the population (agriculture and livestock)
- Sustained protection of water resources
- Enhancement of coordination mechanisms and capacity building in the water sector management

The National Water Resources Management Policy takes into account the fact that Burundi shares its resources with the neighboring countries and it is a stakeholder in the two international hydrographic basins.

This policy provides guidelines for cooperation with the riparian countries for the equitable sharing and management of transboundary waters. It happens that a water course is blocked off by silt build-up or by change of river bed. This can give rise to border

disputes amongst the riparian countries. The National Water Resource Management Policy calls, to avoid such situations, for programs aiming at common development and protection of water courses.

III.1.2. The Basic Principles of the National Water Resources Management Policy

These principles take into account the social, economic and cultural particularities of Burundi and cover the following areas:

- The political commitment for the sustainable development of water resources
- Cooperation, respecting the national sovereignties, in water resources management
- Awareness building amongst water users
- Water is social free good
- Involvement of women and children in the management of domestic water
- Protection of water quality and environment
- State obligation to meet the basic needs of the population in water resources
- Multidisciplinary water management arrangements
- Responsibility of riparian countries in their commitment to develop and protect water courses
- Water has a myth dimension

III.1.3. Sustainable Development Strategies for the Water Sector

III.1.3.1 Short-term Strategies

- Full information on the water potentials of the country
- Establishment of a national institution for the coordination of the water sector
- Assessment of potential water pollution risks and the enforcement of the resource protection measures

N.B: This third strategy envisages five sub-strategies one of which deals with the definition of national standards and public awareness and different users on the protection of water quality.

- Water control measures in view of increasing agricultural and livestock outputs
- Raising awareness on the level of all government organs, in the private sector and among the populations to create a strong perception of the real value of water
- Building human capacity in the field of water resources
- Enhancement of cooperation in the field of transboundary water sharing and management

These short-term strategies are good , but they lack an essential element: the means of implementation. The Government of Burundi alone does not have the capacity to assume the costs. Therefore there is a need to add strategies for the mobilization of financial resources.

III.1.3.2. Medium and Long-term Strategies

- Assessment of demand for water and increase in the rate potable water supply for all the populations
- Development of water resources to widen access to hydro-power
- Promoting the culture of planning in the industrial sector in the utilization of water
- Securing, management and monitoring of information on water
- The management of water-related disasters

III.2. Formulation and Enforcement of Norms, Guidelines and Regulations on Water Quality

On the national level, there are no norms on water quality standing alone yet, but they rather exist as a part of the short-term strategies of the country.

III.3. Water Quality Monitoring Program

In the current context, it is difficult to talk of water quality monitoring programs. The Environmental Code provides that the authority in charge of environment should be informed regularly of the degree of water pollution in the public sector, based on the physical, chemical and biological criteria.

On the other hand, the periodicity, the modalities and methods of analysis conducted on the level of sample taking sources or on the level of production, supply, storage treatment and distribution of water for human consumption are fixed by a rule put in place jointly by the ministry having within its functions an authority on water issues, the Ministry of Public Health and the ministry concerned with environment. The enforcement provisions of the environmental code are not yet in place. This joint rule is not yet signed. This delay, coupled with the problem of human and financial resources deficit, keeps most of the decree and other provisions on environment and water inactive.

III.4. Practices and Strategies of Water Resources Assessment

The different stakeholders in the water sector conduct assessments of water resources according to their missions and to the capacities at their disposal..

DGHER coordinates all the activities of water supply in the rural area. It is a data bank for all water supply activities. It ensures the analyses of water portability through organizations possessing laboratories. In this respect, the benchmarks adopted are the WHO standards. In terms of quantity, the table below gives the status of water supply in 2003:

Table No 3: Rate of potable water supply in the rural areas in 2003

Water Point	Number	Number of Household Served
Fitted Operational Sources	13 282	360102
Fountains	3 036	83 417
Private Water Points	2479	2 479
Operational Wells	205	6 313
Total	19 002	462 311
Total Households	1 053 955	

Net Rate of Service	42.9%
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Source: Annual Report on the Status of the Environment, 2004 Edition

The IGEBU conducts assessments of water resources by analyzing the samples taken by meteorological and hydrological stations and from pluviometric posts. The REGIDESO carries out physico-chemical, chemical and bacteriological analyses. It conducts tests on waste and treated water in different stages of treatment. The INECN carries out tests on waste waters undergoing heavy metal pollution. The samples are obtained at the industrial or factory outlets.

Water resources also include fish production. The principal sources of fish products which are the North Lakes do not undergo any evaluation practices or strategies. Hydropower is also another form of water resources.

The hydro-power potential is under-utilized due to investment costs. The strategy envisaged is the development of hydro-power infrastructure and the promotion of the use of peat within the limits of environmental acceptability.

III.5. Water Quality and Pollution Control Activities

The Environment Code stipulates that the bacteriological, physical, and chemical analyses on potable water should be carried out by laboratories approved by the ministries in charge of public health, water resources and the environment, in accordance with the established methods and the inputs used for the treatment of potable water. This provision derives largely from Decree-Law No 1/41 of 26 September, 1992 governing the structuring of public water concerns

Presently, the provisions of the Environment Code are not yet applied. On the level of Government, the only laboratory really operational is that of REGIDESO, a public corporation for the production and distribution of water and electricity. The INECN acquired a laboratory to carry out analysis on water pollution caused by industries. The testing parameters were heavy metals such as lead, zinc, cadmium and chrome. For lack of resources, the laboratory has ceased functioning.

The laboratory of REGIDESO focuses on physicochemical, chemical and bacteriological criteria in its activities. As this corporation serves

only urban centers, water in the rural centers does not undergo any quality control. In the rural areas, there is no operational system of potable water quality monitoring in place so far. The only effort on this issue is a project in the design phase with the support of UNICEF

CHAPTER 1V

Water Quality Data in the Sampling Stations

Amongst the tools to be used in the strategic approach to water resources management, is a warning system which will monitor and control threats posed by overexploitation and natural disasters or pollution. Measurement or observation stations which respond to different applications are part of the monitoring tool.

The physical control of water resources is about establishing the inventory, the measurement, or the identification of resources by statistical techniques or others in order to determine effects or quality. In certain respects, physical control results are ineffective for the assessment of the purity of the resources. Therefore, a more effective and composite approach of analysis capable of reflecting the status of alternation, degradation or otherwise of the resources is needed. The appropriate method of analysis required here would be analytical control which is a process of physicochemical, bacteriological testing.

The conclusions we are going to present in this chapter concern analysis activities conducted on water quality by two different institutions (SAC and FSA Burundi University) at different dates (1989 for FSA and 2005 for SAC) and on different samples (lakes and rivers for FSA and harnessed water sources for SAC). The FSA has brought to light some physicochemical parameters of water quality of the main rivers of the Nile basin in Burundi. SAC has conducted physicochemical and bacteriological analyses on harnessed sources. The purpose of bringing together these different studies is to have a complete picture of the situation and not to draw comparison between them.

IV.1. Sampling Stations

IV.1.1. The Analyses of FSA

Table 4: River Sampling

Name of the River	Sample Taking Site
Nyamuswaga	Under Ngozi-Tangara Bridge
Kanyaru	Under the national Road 01
Mubarazi	Under the National Road 15

Ruvubu	Under the National Road Bridge 19 Bac
Ruviyronza	Under the national Road

N.B: River Nyamuswaga is branch of River Kinyankuru which is, in turn, a tributary of River Ruvubu. The bridge over Rivubu under which the sample was taken is situated at a longitude of more less 30 degrees 31 to the East and a latitude of 2 degree 48 to the South

As for River Kanyaru, the sample was taken under the National Road 01 at a longitude of more or less 29 degrees 40 to the East and latitude of 2 degrees 46 to the South.

Table 5: Lake Sampling

Name of Lake	Sampling Site
Lake Cohoba	Gest House at Mutwenzi
Lake Rwihinda	Mutwenzi
Lake Rweru	Rutongo

IV.1.2 Analyses Conducted By SAC

SAC conducted analyses on 398 different water sources in five provinces namely, Kayanza, Bururi, Ngozi, Karuzi and Muyinga. All these provinces, safe Bururi, fall within the Nile basin area.

NB: We wish to repeat that there are no regular water quality analyses in Burundi. RGIDESO is the only organism that carries out water quality testing for its water supply works in the urban centers. The sampling stations are not permanent; rather they vary from one study to another.

Prior to the break out of the socio-economic crisis in 1993, IGEBU used to run a network of meteorological and hydrological measurements which included for the Nile basin area the following stations:

- 30 main climatologic stations providing benchmarks
- 35 pluviometric stations
- 21 hydrometric stations for the measurement of water flow

For its works, REGIDESO takes samples on different levels:

- Waste Water
- Purified water in different phases of treatment (plants)
- Distributed water (all the districts, pumping stations, reservoirs)

It is worth noting that when it was functioning, the INECN laboratory used to take samples from the industrial waste waters on the outlets of factories.

IV.2. Water Quality Data

IV.2.1. FSA Results

Table No 6: River Water Results

River Parameters	Nyamuswaga	Kanyaru	Mubarazi	Ruvubu	Ruvyironza
Turbidity	23	440	2560	165	300
Temperature (C°)	20	21	21	22	20.5
PH (value)	4.4	6.7	6.7	6.9	7.2
Suspended material (mg/)	10	450	1980	200	100
Liquidated Oxygen (mg/)	6	9	9	5	8
Ammoniac	<0.02	<0.02	<0.02	<0.02	<0.02

Table No 7: Lake Water Results

Lake Parameters	Cohoba		Rwhinda		Rweru	
	10/10/1988	09/04/1989	10/10/1988	09/04/1989	10/10/1988	09/04/1989
Turbidity	22	24	20	36	40	46
Temperature (C°)	23.4	26	24.3	26.5	26.5	26
PH (value)	8.5	8.6	8.7	8.3	7.8	7.5
Suspended material (mg/)	40	50	35	250	90	120
Liquidated Oxygen (mg/)	6	8	7	6	8	5
Ammoniac	<0.025	<0.02	<0.02	<0.02	<0.02	<0.02

According to these studies, the waters of Burundi in general and those of the Nile basin in particular, are very fresh and free of pollution. That was back in 1989.

Today the situation has changed. In general, the waters of waterways are characterized by a certain bacteriology resulting from

animal intrusion , high population density, lack of latrines, waste accumulation in the natural environment and mineral wash.

IV.2.2. The Results of SAC

We will not be able to present all the results of SAC in the five provinces, but we will give the parameters of three sources described as (potable water and good quality, potable water and very good quality and potable water and excellent quality)

SAC has given the interpretation of the results obtained in comparison with the internationally accepted standards, in particular those of the WHO.

On the 389 sources of water:

- 48 sources (12.3%) have been branded as “potable and of excellent quality
- 140 sources (35.9%) have been declared “potable and of very good quality”
- 161 sources (41.3%) have been judged “potable and of good quality”
- 35 sources (8.9%) have been classified as “potable and of sufficient quality”
- 5 sources (1.2%) have been judged poor quality “not potable”

Characteristics upon which SAC worked out the evaluation of these sources can be referred to in annex 4.

At the closure of the chapter, we could say there is no ground for comparison between river or lake parameters and those of a water source, but this information contained in the two studies complete one another and gives an idea on the quality of water in Burundi, even if they were conducted at different dates. In the past, river waters used to be very fresh and none polluted. Today pollution has become a reality. According to Mr. Prosper KIYUKU, chemical fertilizers (nitrates, phosphates) and habitats close to water sources, threaten water quality. According to Mr. Fulgence NDAYITWAYEKO, a water source could be potable prior to catchment and become contaminated subsequently for lack of sound management.

CHAPTER V

INVENTORY OF LABORATORIES AND THEIR PHYSICAL AND TECHNICAL CAPACITIES

The word inventory inspires in the reader the feeling that water quality laboratory tests in Burundi are numerous. This is far from reality. The information we present in this chapter is compiled from witnesses and officers of different laboratories who have agreed to answer the inquiries.

V.1. Number and Type of Laboratory Equipment

We have collected information on the laboratories of REGIDESO, FACAGRO, INECN and SAC. A number of equipment is similar in terms of functioning but different in respect of models and life span.

REGIDESO Laboratory:

- PH-meter WTW
- Oxygen meter
- Conductivity Meter WTW
- Hottes Kottemann
- Filtration Sartorial Ramp
- Spectrophotometer Milton Roy
- Turbidity Meter Dr Lange
- Incubators MEMMERT
- Furnace Heraus
- Vapor sSerilizer

FACAGRO Laboratory

- Air ovens
- Autoclavers
- Microscope
- Cultivation Sites
- Glassware

- Bain Marie

ISABU Laboratory

- pH-meter
- Conductivity Meter
- Spectrophotometer
- Furnaces
- Filtration Sartorial Ramp
- Glassware
- Air ovens
- Bain Marie

BRARUDI Laboratory

- pH-meter
- Hottes
- Spectrophotometer
- Turbididy meter
- Incubators
- Furnaces
- Sterilizer
- Ramps
- Air Ovens
- Titrmeters

INECN Laboratory:

- Spectrophotometer Merk and Hach 2000
- Air Oven
- Muffle Oven
- Conductivity Meter
- Oxygen Meter

- pH-Metr
- Other lab accessories

SAC Laboratory:

- pH-meter Hanna
- Oxygen-meter Hanna
- Conductivity Meter Hanna
- Hotte
- Spectrophotometer
- Turbidity Meter Hach
- Incubator
- furnace
- Air Oven
- Tetrimer Hach

LACA:

- Atomic Absorption Spectrometer AA700
- Atomic Absorption Spectrometer PE 4100
- X-ray Fluorescence Spectrometer
- Ionic Chromatograph DX-100
- Calorimeter

N.B: This equipment is insufficient. Those already broken down have no possibility of being repaired. On the other hand, the personnel appointed there are insufficient. The consequence of this is that certain types of tests are not possible in one or another of these laboratories. Such is the case of heavy metals tests.

V.2. Water Quality Assurance Programs and Laboratory Accreditation

As we have already indicated, Burundi does not so far have national norms in its legal texts. The stakeholders in water quality refer to WHO norms or to EU norms.

It is difficult to talk of water quality assurance at a time when there exists no organ for the control of different analyses being carried out. Each laboratory carries out its own analyses and produces all sorts of information and misinformation. What to trust ? What not to trust? These are the questions to clarify.

The accreditation of laboratories, no matter what the environment code says, and in spite of the problems mentioned above, does not yet seem to be included in the agenda of the Government.

V.3. Qualification of Water Quality Analyses Laboratory Staff

In REGIDESO, the appointed staff consists of three persons, namely:

- PH-D in Ecology (fresh water) and Masters in Oceanography
- Chemistry and Biology Education Bachelor Degree (the officer in charge of the laboratory)
- A technician A1 in chemistry
- A technician A2 in chemistry from the School of Public Works

In FACAGRO the laboratory the staff is composed of a researcher with Masters in microbiology and an A3 technician. In INECN the staff is composed of two holders of a Bachelor degree one of whom is environmentalist. In SAC there is no permanent staff.

V.4. Staff Training Program of Laboratory Staff

The talk of staff training is out of touch with reality in the context of a total lack of reagents.

V.5. Other Existing Tests on Environmental Monitoring

The laboratory of INECN had the specific merit of monitoring pollution caused by industrial waste water at the outlet of factories, but it had to halt its activities for lack of resources. In general it has been

revealed that environmental damage can take place in a number of ways in Burundi ,but the country does not have the means to monitor them by conducting tests.

CHAPTER VI

IDENTIFIED GAPS IN THE MANAGEMENT OF WATER QUALITY

As clarified earlier, the number of stakeholders in the management of water resources is big. We also pointed to the absence of a coordinating mechanism for their interventions. On the contrary, those involved in the management of water quality are few in number. The bottom-line is that gaps identified in this field can be summarized into weak capacity in all its relevant forms.

VI.1. Legal and Institutional Capacity

The Ministry of Land, Environment & Tourism was established more than ten years ago, but it faces difficulty in enforcing the texts in place. On the other hand, some of these texts need updating or completion by other texts and the Ministry does not have the necessary means to carry out this work.

The Ministry of Public Health, the Ministry of Energy & Mines (REGIDESO), the Ministry of Community Development (DGHER) and the Ministry of National Education (University of Burundi) are stakeholders in the issues of water quality, but there is no partnership amongst them. There is no coordination mechanism in place for the different interventions. The remaining weaknesses, which will be analyzed, derive totally or partially from this first category and are , at the same time, linked to one another.

VI.2. Lack of Sufficient Qualified Staff

In Burundi, we normally deplore the lack of computer technicians, competent accountants, specialized doctors, but we rarely hear complaints about the lack of qualified staff on the techniques of planning and management of water resources, although water is a vital resource.

Presently, nation-wide, there are eight hydrologists by profession. The worrying fact is that the training of such human resources has ceased. The eight ones received their training abroad (Romania, Algeria) for lack of capacity building at home.

VI.3. Weak Technical Capacities

The General Rural Water & Energy Department, which supplies or oversees the supply of potable water to rural areas, does not have its own laboratory. It requires the stakeholders in the water supply networks to carry out analyses in the existing laboratories which are not sufficient in number.

The main public laboratories are located in REGIDESO and the University of Burundi. Other stakeholders such as the private sectors and NGOs use mobile laboratories. Other permanent private sector laboratories are used for commercial ends.

VI.4. Lack of Regulatory Instruments

The National Water Resources Management Policy calls in its strategies for the definition of national norms and awareness raising of the population and different water users on the protection of water resources.

The stakeholders determine the portability of water on the basis of other standards which are not necessarily convenient to Burundi (WHO EU norms). WHO establishes, for each parameter, a set of recommendations which should be adapted to each country, taking into account the sanitary status and economic situation of the country, for the formulation of national regulatory norms.

VI.5. Lack or Insufficiency of Data and Information

This situation results from the precedent problems. If qualified staff lacks, if technical capacity is weak and there are even no regulatory instruments e, we could not then realistically expect to have sufficient information. The annual report on the status of the environment, 2004 edition, states that there is a very few data on ground water. The information obtained from the National Water Resources Management Policy indicates the lack of regular water quality analyses. This logically explains the paucity of data and information in this field.

VI.6. Low Private Sector involvement

This weakness in private sector participation can be explained by institutional weaknesses. The public awareness campaign has not

yet borne its fruits. The private sector enters the field of water quality management when there is a promising market for water catchment and water portability analyses. When the authorities (DGHER) impose upon the private sector which operates water supply to carry out water quality analyses, this causes a resentment because it entails additional cost for their operation.

At this moment we witness the emergence of human rights associations, women rights and child rights associations. With awareness-raising campaigns, we wish to see the emergence of associations which fight for water quality. These associations are important for the fact that all human beings and all living organisms survive on water.

CHAPTER VII

RECOMMENDATIONS TO NTEAP IN VIEW OF FILLING THE GAPS IDENTIFIED IN WATER QUALITY MONITORING

Potable water or water appropriate for such and such usage is a product. As such, it is very rare to obtain it without some sort of effort. Different actions have to be taken. The different stakeholders involved in this sector, have to work in synergy and not in a dispersed manner.

The actions we propose here concern Burundi and the other riparian countries. As we talk of transboundary waters, we will not sidestep the importance of creating a favorable political environment for the establishment of adequate framework for cooperation in the management of the common water resources. On the other hand, as a net exporter of the quasi-totality of its water resources, Burundi needs to have in place a cooperation framework to negotiate some sort of compensation for its exported water and soil. Each country of the basin has its own specificity that should be taken into account in the actions to be undertaken. In our view, the actions to be undertaken can be classified into four categories: preventive actions, corrective actions, incentive actions and coercive actions. Before going into the details of these four actions, I wish to draw the attention to the importance of establishing the standard key indicators for water quality in Burundi. In the next page, I will give some indications on this subject.

VII.1. The definition of Standard Key Water Quality Indicators

Water has multiple usages: potable usages and non potable usages. Irrigation is an example of non potable usage.

Water as it exists in nature is, by definition, impure.

VII.1.1. Potability Indicators

The first indicator to be proposed here is turbidity. It is related to the measurement of suspended material. It gives the first indication of the intensity of mineral or organic colloid matters. The other indicators are related to organic or mineral impurity. There are also bacteriological indicators.

These indicators have been selected because they negatively affect human health in varying degrees. In general, the physico-chemical characteristics are very good from the point of view of WHO standards. This is why they are not considered in this part.

VII.1.2. Water for Agriculture

In general, the quality of surface waters is adequate for irrigation and fishing. However, there is a need for a definition of this quality and the following indicators have been proposed for agricultural use: sodium, potassium, calcium and magnesium. The variation in these elements affects agricultural and fishing yields. Therefore, it is recommended that a prior and systematic study be conducted on all the surface waters of the Nile basin in Burundi. The current situation needs to be brought under control.

VII.2. Preventive Actions

We insist on this category of actions because as in the fields, it is easier and less costly to prevent than to cure. A population can be consuming or using contaminated water for a long time without the knowledge of the authorities. It is only when an epidemic breaks out that the authorities begin to realize the gravity of the situation.

VII.2.1. Raising the Awareness of the Commercial Sector

If decision-makers are convinced of the importance a healthy environment and of water quality for the lives of the populations and if they are driven by good faith, they will not hesitate in taking the necessary measures to guarantee and monitor water quality. Within five years, the budget allocated to the environment sector should represent 1% of the State budget. Today it represents less than 1%. The increased involvement in the activities of NBI is another reflection of the success of awareness raising efforts.

We strongly recommend that the NTEAP insists on this aspect which constitutes the basis for the success of other actions. It will be a process of identifying the appropriate methodology for awareness-raising at the top.

As was the case with HIV/AIDS, the leaders and the decision makers have to strongly be involved in the search for and maintenance of

water quality. A particular attention needs to be given to women and children. In Burundi, it is they who secure water supply to households.

VII.2.2. Creating a Coordinating Structure for the Water Sector and Strengthening its Information Exchange Capacities

The actions of different stakeholders are not coordinated. The coordination structure to be put in place should differ from the old ones (National Water & Energy Commission and National Environment Commission) which were not efficient for lack of resources and authority. In Burundi, most of the commissions created are consultative. The institution to be created should be independent and have decision-making powers and authority to impose sanctions. The structure should be managing a unified national data bank. The NTEAP project, the Nile riparian countries or any other stakeholder, should have a viable and strong interlocutor. As provided in the short term by the National Water Resources Management Policy, the establishment of this entity need not pose any problem. It is a question of awareness raising and political will. By the start of the third year, the organ and the departments should be operational, the texts governing them having been signed by the competent authority.

VII.2.3. Updating, Completing and Harmonizing the Texts Governing Water Quality Management

Good provisions are of no value without adequate human resources to implement them. It is our belief that the outdated and incomplete texts are of no use even when there are individuals capable of enforcing them.

This task will involve cooperation, given the fact that in the basin some countries are more advanced than others in water quality management. Their provisions could give guidance to the countries less advanced.

We suggest that the NTEAP project support this work of updating and harmonization of provisions governing water quality in the basin. This works should be completed within three years and can be measured against the existence of complete and applicable provisions.

VII.2.4. Identifying the Water Potential

We consider that this action should fall within the list of national priorities. It is not possible to draw a plan for a resource without determining its site. It is imperative to determine the volume of the resource as well as its trends in the short and long term.

In the context of Burundi, as somewhere else, this work has to take into account the demographic parameters.

We wish to remind that water resources in Burundi are globally abundant. However, on analyzing their distribution spatially and the rate of population growth, one discovers that water is still rare and vulnerable. This in itself explains the need for the elaboration of information exchange mechanism.

Given the fact that the waters of the River Nile are international waters, two sites can be proposed for the future water quality permanent sampling stations. For River Ruvubu, the site would be in Muyinga (Muyinga Province) just at its outlet into The United Republic of Tanzania. For River Kanyaru, the site would be in Bugahira Localitt (Kirundo Province) just at its outlet into The Republic of Rwanda.

These proposals take into account that at the exit points from the national territories, these rivers are loaded with a maximum of elements brought by their streams and tributaries. These elements need to be analyzed by laboratories.

VII.2.5. Defining National Water Quality Norms

This action is very urgent. REGIDESO undertakes regular water quality analyses in the urban areas. Even the other laboratories undertake the same analyses but the public ignores the norms to which all these stakeholders refer to establish the portability of water . In case it is not possible to have global standard norms for the whole Nile basin, the NTEAP project could assist each country in adopting its own norms.

VII.2.6. Staff Training in the Water Sector

We have seen that the water sector suffers from acute shortage in qualified human resources. Training in this sector is an imperative necessity. Cooperation basin-wise and on international level should

play a role. Here, once again, some countries are more advanced than others and have universities and other centers dispensing training in the water sector. As every activity has its cost, the NTEAP project and donor institutions could support this activity.

The project can even initiate the establishment of a training center for the whole basin on water issues or strengthen the existing ones and guarantee preferential treatment of populations of the basin. If the efforts of training staff and agents go through, the challenge will be how to preserve them

To determine the success of this work, there will be an analysis of the number of staff and agents sent abroad for training, or the number of riparian countries beneficiaries of training *in situ*. Within five years, 80% of staff and agents are expected to have benefited of the said training, at the rate of ten staff member per year.

VII.2.7. Building/Equipping Water Quality Laboratories

This recommendation takes into account the alarming situation observed in Burundi. In this country, one of the functioning laboratories is that of REGIDESO which is highly solicited by the services of all categories. It is necessary to build and equip other laboratories.

Another problem referred to during our inquiry is the high price for reagents. We think the NTEAP project could help in solving this problem.

It is recommended that by the start of the third year, five laboratories, two of which are private, be fully equipped in terms of tools and reagents. In terms of continuity the laboratories are expected to assume responsibility for the regular procurement of reagents. They are expected to charge some fees for the services they render as they see fit.

VII.2.8. Removing the Confusion between the Role of Management, Protection and Conservation and that of Water Resources Exploitation

This problem is real in Burundi. For example, REGIDESO produces and distributes water in the urban centers. At the same time, it runs laboratories for water quality analyses without any control mechanism in place to oversee the quality analyses being undertaken.

REGIDESO is a public enterprise which is a judge and player in this field of water quality control. It is somehow, in such a manner, undertaking self-assessment.

We wish to recommend that the role of water quality analysis be entrusted to an independent coordinating organism. This structure should have at its disposal a super laboratory which will coordinate the activities of the other laboratories.

VII.2.9. Adopting Clean Methods of Production

This category of action is very vast. Contamination of water resources is practically of human origin.

Sedimentation, eutrophication and the diverse forms of pollution are due to human action. Burundi and the other States of the basin need to come together to identify clean methods of production. It is not practicable to elaborate on this issue given the specificities of each country.

In Burundi, for example, the populations need to come together in order to considerably reduce erosion, conserve rain water, limit animal waste, ensure that households have latrines to avoid water contamination by fecal materials.

Burundi also needs to import or use pesticides, fertilizers or chemical substances presenting the lowest possible risks to the environment and human health, and needs to conform to the established norms and prescriptions.

Within five years, Burundi is expected to have reduced to at least 80% the different point-source and non point-source causes of pollution. The number of latrines, livestock stabling and the quality of water will form the benchmarks for the assessment of this work.

VII.3. Corrective Actions

As announced already at the beginning of this chapter, these actions are intended to redress the situation of waters already contaminated. The organism empowered to undertake such action must impose on industries the pre-treatment of waste water prior to dumping into the river. Certain enterprises like Gitega Brewery are showing understanding, but the experience has to be extended all

around the country. Enterprises and households must come together to see how best to give value to their waste.

Information exchange can also help in redressing certain situations. This is extremely important for shared water resources. Contaminated water in Burundi can cause damage in Rwanda. So an information system or even warning system can set straight many of the irregularities.

VII.4. Incentive Actions

To provide appropriate water resources for use there is a need for coordinated actions. Incentive actions must be given the chance to play their role.

Imposing treatment of waste water on industries before throwing it into the river or lakes, entails additional investment, sometimes at high cost. We recommend that the Government assist these industries by, for example, granting them tax exemption for the import of the required equipment.

The Government can also induce the communities, the private sector and the NGOs into adopting water quality as permanent concern, by annually awarding prizes, for example on the occasion of the National Tree Day, to the best performance in environmental protection (and for that matter, the best performance in the protection of water resources).

Study travels could be organized for model grassroots figures in the protection of environment so that they could discover other experiences (in the basin) or strengthen their own in water quality management.

VII.5. Coercive Actions

Prevention, correction and incentive measures, by themselves, may not be enough to guarantee water quality. We believe that there is a need for strict measures against those who tamper with this vital and vulnerable resource.

The principle (pay-as-you-pollute) which is new in the vocabulary of environmentalists should be adopted in Burundi and in the Basin at large. In the same manner, all should be required to adopt

environmental impact study in their activities. This last obligation is both coercive and preventive.

Conclusion

The Nile Basin is a vast sub-regional entity. In fact, ten countries belong to this region. Burundi hosts the southernmost source of the Rive Nile. Within the framework of the Nile Transboundary Environmental Action Project, different concerns relative to water quality have been brought to light in Burundi. Burundi is endowed with water resources, but this situation should be addressed in the light of the demographic trends in order to arrive at an objective judgement.

On the level of quality, different threats are hanging on the water resources of Burundi. The physicochemical characteristics are good as a whole. Key standard indicators for water quality control have been proposed. It is now the duty of stakeholders to act in synergy in order to restore water quality, those indicators serving as guidelines

A Summary of the Proposed Recommendations in View of Filling Identified Gaps

Result Indicators by Activity	Value of Targeted Indicators					Measurement Methods
	Year 1	Year 2	Year 3	Year 4	Year 5	
1. Decision makers are aware of the water quality issue	-	50%	80%	80%	80%	<ul style="list-style-type: none"> - Analysis of the budget allocated to environment sector - Analysis of the involvement of Burundi in the NBI activities
2. A permanent water management organ on the national level is in place	-	-	100%	100%	100%	The texts establishing this organ are signed and can be reviewed
3. Two departments for the sub-basins are in place	50%	100%	100%	100%	100%	The offices of the two department built or rented
4. A mechanism of alert and information exchange is in place in the basin	-	-	100%	100%	100%	Accessibility of information on water in whatever State of the Nile
5. 80% of staff and agents in the water quality sector are trained	-	20%	40%	60%	80%	<ul style="list-style-type: none"> - Trainers for on-the-job-training recruited - Or the beneficiaries sent abroad for training
6. A data bank on the national hydrological wealth is in place	-	40%	60%	80%	100%	The permanent water management organ runs a data bank
7. Two sampling stations installed in Rivubu and Kanyaru rivers	-	-	50%	100%	100%	Regular supply of sampling from these stations for testing in the laboratories
8. Five Testing Laboratories, two of which are private sector, fully equipped	-	50%	100%	100%	100%	The equipment in place in the selected laboratories
9. The water potentials of Burundi identified and updated	-	-	100%	100%	100%	At the third year, the reports of the water potentials of Burundi available
10. All the texts governing water	-	-	100%	100%	100%	By the third year, the stakeholders in the

quality in Burundi completed and harmonized						water quality sector expected in have at their disposal applicable texts
11. The national standards for water quality identified	-	40%	60%	80%	80%	Analysis laboratories refer from now on to national standards
12. The different causes of point-source and non-point source pollution documented and reduced to 80%	-	40%	60%	80%	80%	<ul style="list-style-type: none"> - Census of households possessing latrines - Analysis of the level of livestock in stables - Water quality analysis in the stations install on Ruvubu and Kanyaru

ANNEX 1 LIST OF PERSONS CONTACTED

1. Mr. Audace NDAYIZEYE, National Coordinator for Nile Transboundary Environmental Action Project of the Nile Basin Initiative.
2. Mr. Boniface NYAKAGENI, Cabinet Adviser at MINATET and member of National Water Quality Working Group
3. Mr. Fulgence NDAYITWAYEKO, Director General of Rural Water & Energy Department
4. Mr. Joseph NDAYEGSMIYE, Head of REGIDESO laboratory and member of National Water Quality Working Group
5. Mr. Evariste NDABANIWE, staff member of Gitega Brewery (BRAGITA)
6. Mr. Gabriel HAKIZIMANA, Director of Environment at INECN
7. Mr. Prosper KIYUKU, Chief Research Assistant in Microbiology and Cultivation of Edible Mushrooms
8. Mr. Tharcisse GAHUNGU, ISABU and SAC Ltd
9. Madam Intisar Sakeh, NTEAP
10. Mr. John Omwenga, NTEAP
11. Madam Beatrice SINDAYIRWANYA, Director of LACA
12. Mr. Ladislav KAZIRUKANYO, ISABU Laboratory Staff Member
13. Madam Spes HAKIZA, BRARUDI Laboratory
14. Mr. Francois NGENDABANKA, Human Resources Manager at REGIDESO

**ANNEX 2. DISTRIBUTION OF WETLANDS PER PROVINCE
IN 1979**

Province	Area Per Province (in Km³)	Area of Wetlands (in Hectares)	Cultivated Proportion (in %)
Bubanza	1165	165	72
Bujumbura	1319	558	0
Bururi	2456	3009	41
Kankuzu	1948	11378	35
Cibitoke	1634	1114	62
Citega	1972	8084	89
Karuzi	1457	9347	38
Kayamza	1232	11026	73
Kirundo	1700	13810	11
Makamba	1957	1626	70
Muramuya	1534	6960	92
Muyinga	1836	10700	37
Nogzi	1471	14662	48
Rutana	1941	8018	20
Ruigi	2331	10571	47
Burundi	25874	112028	47

Source: SNEB

ANNEX 4: THE RESULTS OF ANALYSES CONDUCTED BY SAC
SAC Ltd/Water Analysis Matrix

Province: KANYANZA

Locality: KANYANZA

Hill:

Source: MURIMA3 (AEP)

Chemical and Bacteriological Analysis

Analyses	Unites	Results	Guiding Values
<u>Chemical Analyses:</u>			
Organoleptic parameter Optical Aspect Turbidity	NTU	Clear 0.2	5
<i>Physicochemical parameters</i>			
Hydrogen Concentration	pH	6.43	6.5 to 9.2
Conductivity	µS/cm	40.1	400
Suspended materials	mg/l	3	none
Total solidity (Ca CO ₃)	mg/	12	500
<i>Parameters Indicating Pollution</i>			
Nitrate (NO ₃)	mg/l	9.9	50
Nitrites (NO ₂ ⁻)	mg/l	0	1.1
Ammonium (NH ₄ ⁺)	mg/l	0	0.5
Dissolved Oxygen (O ₂)	mg/l	7.9	<75% of saturation
<i>Mineralization Parameters</i>			
Carbonic Gas (CO ₂)	mg/l	27	
Phosphates (PO ₄ ³⁺)	mg/l	0.2	
Total Iron (Fe)	mg/l	015	
Chloride (C1)	mg/l	13.01	
<u>2. Bacteriological Analyses</u>			
Total germs	UFC/100ml	80	100
Total coliformes	UFC/100ml	2	3
Escherichia coli	UFC100ml	0	0
1. Interpretation and recommendations	The water is potable and of good quality		

SAC Ltd/Water Analysis Matrix

Province: KARUZI

Locality: MUTUMBA

Hill: BIBARA

Source: KIGARAMA

Chemical and Bacteriological Analysis

Analyses	Unites	Results	Guiding Values
<u>Chemical Analyses:</u>			
Organoleptic parameter			
Optical Aspect		Clear	
Turbidity	NTU	1.0	5
<i>Physicochemical parameters</i>			
Hydrogen Concentration	pH	5.53	400
Conductivity	μS/cm	9.8	none
Suspended materials	mg/l	6	500
Total solidity (Ca CO ₃)	mg/l	11	
<i>Parameters Indicating Pollution</i>			
Nitrate (NO ₃)	mg/l	23	50
Nitrites (NO ₂ ⁻)	mg/l	0	1.1
Ammonium (NH ₄ ⁺)	mg/l	0	0.5
Dissolved Oxygen (O ₂)	mg/l	8.0	<75% of saturation
<i>Mineralization Parameters</i>			
Carbonic Gas (CO ₂)	mg/l	48	equilibrating
Phosphates (PO ₄ ³⁺)	mg/l	0.2	5
Total Iron (Fe)	mg/l	0.07	0.3
Chloride (Cl)	mg/l	11.75	250
<u>2. Bacteriological Analyses</u>			
Total germs	UFC/100ml	80	100
Total coliformes	UFC/100ml	2	3

Escherichia coli	UFC100ml	0	0
2. Interpretation and recommendations	The water is potable and of good quality		

SAC Ltd/Water Analysis Matrix

Province: MUYINGA Locality: GASORWE
Hill: KARIRA Source GAHOGO

Chemical and Bacteriological Analysis

Analyses	Unites	Results	Guiding Values
<u>Chemical Analyses:</u>			
Organoleptic parameter Optical Aspect Turbidity	NTU	Clear 0.8	5
<i>Physicochemical parameters</i>			
Hydrogen Concentration	pH	4.99	
Conductivity		54.7	400
Suspended materials		7	none
Total solidity (Ca CO ₃)		18	500
<i>Parameters Indicating Pollution</i>			
Nitrate (NO ₃)	mg/l	6.1	50
Nitrites (NO ₂ ⁻)	mg/l	0	1.1
Ammonium (NH ₄ ⁺)	mg/l	0	0.5
Dissolved Oxygen (O ₂)	mg/l	7.7	<75% of saturation
<i>Mineralization Parameters</i>			
Carbonic Gas (CO ₂)	mg/l	9.4	equilibrating
Phosphates (PO ₄ ³⁺)	mg/l	0.3	5
Total Iron (Fe)	mg/l	0.08	0.3
Chloride (C1)	mg/l	11	250

<u>2. Bacteriological Analyses</u>			
Total germs	UFC/100ml	80	100
Total coliformes	UFC/100ml	2	3
Escherichia coli	UFC100ml	0	0
<u>3. Interpretation and recommendations</u>	The water is potable and of good quality		

SAC Ltd/Water Analysis Matrix

Province: KARUZI
Hill: KABWIRA

Locality: BUGENYUZI
Source MUKAGOGO

Chemical and Bacteriological Analysis

Analyses	Unites	Results	Guiding Values
<u>Chemical Analyses:</u>			
Organoleptic parameter			
Optical Aspect		Clear	
Turbidity	NTU	0.5	5
<i>Physicochemical parameters</i>			
Hydrogen Concentration	pH	5.19	56.5 to 9.2
Conductivity	µS/cm	20.3	400
Suspended materials	mg/l	2	none
Total solidity (Ca CO ₃)	mg/l	8.1	500
<i>Parameters Indicating Pollution</i>			
Nitrate (NO ₃)	mg/l	0.2	50
Nitrites (NO ₂ ⁻)	mg/l	0	1.1
Ammonium (NH ₄ ⁺)	mg/l	0	0.5
Dissolved Oxygen (O ₂)	mg/l	8.1	<75% of saturation

Mineralization Parameters			
Carbonic Gas (CO ₂)	mg/l	62	equilibrating
Phosphates (PO ₄ ³⁺)	mg/l	0.4	5
Total Iron (Fe)	mg/l	0.23	0.3
Chloride (C1)	mg/l	9.75	250
<u>2. Bacteriological Analyses</u>			
Total germs	UFC/100ml	150	100
Total coliformes	UFC/100ml	3	3
Escherichia coli	UFC100ml	0	0
<u>4. Interpretation and recommendations</u>			
The water in this source is of sufficiently good quality			

SAC Ltd/Water Analysis Matrix

Province: KARUZI
Hill: KABWIRA

Locality: BUGENYUZI
Source MUKAGOGO

Chemical and Bacteriological Analysis

Analyses	Unites	Results	Guiding Values
<u>Chemical Analyses:</u>			
Organoleptic parameter			
Optical Aspect		Clear	
Turbidity	NTU	1.0	5
<i>Physicochemical parameters</i>			
Hydrogen Concentration	pH	5.59	56.5 to 9.2
Conductivity	µS/cm	42.3	400
Suspended materials	mg/l	5	none
Total solidity (Ca CO ₃)	mg/l	17	500
<i>Parameters Indicating Pollution</i>			
Nitrate (NO ₃)	mg/l	0.2	50

Nitrites (NO ₂ ⁻)	mg/l	0	1.1
Ammonium (NH ₄ ⁺)	mg/l	0	0.5
Dissolved Oxygen (O ₂)	mg/l	8.0	<75% of saturation
Mineralization Parameters			
Carbonic Gas (CO ₂)	mg/l	62.8	equilibrating
Phosphates (PO ₄ ³⁺)	mg/l	0.4	5
Total Iron (Fe)	mg/l	0.13	0.3
Chloride (Cl)	mg/l	875	250
<u>2. Bacteriological Analyses</u>			
Total germs	UFC/100ml	300	100
Total coliformes	UFC/100ml	11	3
Escherichia coli	UFC/100ml	0	0
<u>5. Interpretation and recommendations</u>	The water in this source is of poor quality		

BIBLIOGRAPHY

1. Transboundary Environmental Analysis
2. Project Appraisal Document
3. Project Implementation Plan
4. Social & Economic Council of Burundi
5. MINATET, National Environmental Strategy and Action Plan, 1993
6. MINATET 2001, National Strategy and Biodiversity Action Plan
7. MINATE 2000, Environment Code of the Republic of Burundi
8. MINATET 2001, National Water Resources Management Policy and Action Plan
9. MINATET 2005, Annual Report on the Status of Environment, 2004 Edition
10. Bidu J.E. NDAYIRUNKIYE, NDAYISHIMIYE, J.P. Sirven, p. Geography of Burundi, Hatier, Paris, October, 1991
11. Ethics and Society, Moral Thought Review, Vol. 1 N° 1, January 2004
12. Michael Keating, A Program of Action, Agenda 21 Version for the Public and other Rio accords, 1992
13. Taking Action, An Environmental Guide for you and your community, UNEP
14. Margaret MUTHOKA, Assumpta REGO, Zipporah Rimbu, environmental education, essential knowledge for Sustainable.
15. SINARINZI Evariste, Data and information on water resources of Burundi, UNDP, February 1999
16. KINEZERO Mathias, Population Growth impacts on water resources, 2002
17. KINERZER Mathias, Socio-economic values of wetlands in Burundi, 2001
18. Pollution Control and other measures for Lake Tanganyika biodiversity protection, revised and corrected- 1997. Project start-up Report
19. Water resource development in Great Lakes Africa. Bujumbura Conference 14 – 18 1991, GRET collection (Land-locked countries) n° 5
20. BIKWEMU G. BIMENYUMUREYIL RUFIKIRI E. RUSHEMEZA J. Burundi Report on Fragile Ecosystems Management: durable mountain exploitation, March 1996
21. KOICHIRO Matsuura, Water no longer flows from the source, Article run in daily
22. ***Le Renouveau du Burundi*** issue n° 5935 of January 10,2003

23. NBI, Legal Framework for Shared Water Resources Management: Field action of Shared Vision
24. GAKIMA C. NZIGIDAHERA B., NDABAHAGAMYE F., NZOHABONIMANA F. Population-Environment Interdependence Study, Gitega December, 1997
25. Law n° 1/008 of the 1st of September 1986 carrying the Burundi Land Code
26. MINATET, The First National Report on the UN Framework Convention on Climate Change, August 2001
27. Technical water Bulletin, fiftieth anniversary edition 1989, 9th edition, volume 1, Degremont
28. SAC 2005, Draft Report on water quality analyses conducted in the provinces of Bururi, Ngozi, Kayanza and Kanzi on behalf of ASBL Twitezimbere