

Nile Basin Initiative

Transboundary Environmental Action Project

National
Nile Basin Water Quality
Monitoring Baseline Report

for

DEMOCRATIC REPUBLIC OF CONGO

PROFESSOR KACHAKA SUDI K.
Faculty of Agronomical Sciences
Head of Natural Resources Management Department
University of Kinshasa

NILE BASIN INITIATIVE

Initiative du Bassin du Nil

List of Abbreviations

ACDI	Canadian International Development Agency
CMC	Congolese maritime company
CM-NIL	Nile Council of Ministers
CNAEA	National Water and Hygiene Action Committee
CEN-K	Regional Nuclear Study Center of Kinshasa
CRGM	Geological and Mineralogical Research Center
CTC-NIL	Nile Technical Consultative Committee
FEM	Environmental Global Fund
IBN	Nile Basin Initiative
ISTA	Higher Institute of Applied Technical Studies
LVEMP	Lake Victoria Environmental Management Project
WHO	World Health Organization
ONATRA	National Transports Office
NGO	Non-governmental Organizations
PAS	Subsidiary Action Programs
UNDP	United Nations Development Program
SVP	Shared Vision Program
DRC	Democratic Republic of Congo
REGIDESO	Water Supply Corporation
RVE	Fluvial Transport Department
RVM	Maritime Transport Department
SANRU	Rural Health
SEC-NIL	Nile basin Initiative Secretariat
SNEL	National Electricity Company
SNHR	Rural Water National Service
UNIKIN	University of Kinshasa
USAID	United States Agency for International Development

TABLE OF CONTENTS

List of Abbreviations	2
SUMMARY	5
INTRODUCTION	6
The Problems	7
The Methodology.....	8
Expected Outputs.....	8
CHAPTER ONE	
THE WATER RESOURCES OF THE DEMOCRATIC	9
REPUBLIC OF CONGO.....	9
1.1 The Geographical Situation	9
1.2. The Hydrographic Network.....	9
1.2.1 Congo River Basin.....	9
1.2.1.1. Surface Water	9
1.2.1.2. Ground Waters.....	10
1.2.3. Atmospheric Waters	11
1.2.2. Marine Waters.....	11
1.2.3. The Nile Basin	11
1.2.3.1. The Nile Hydrographic Systems.....	12
1.2.3.2. The Lakes.....	14
1.3. NILE BASIN INITAIVE.....	15
CHAPTER TWO	
WATER QUALITY DEGRADATION	17
II.1. THE ORIGINS OF WATER POLLUTION.....	17
The Congo River Basin.....	17
II.1.1. Domestic Activities	18
II.1.2. Agricultural Activities	18
Water Eutrophication.....	18
II.1.3. Industrial Activities	20
II.1.4. Mining Activities.....	20
II.1.5. Petroleum Activities	20
II.2. THE ARMED CONFLICTS AND THE ENVIRONMENTAL THREATS.....	21
II.3. WATERWEEDS INVASION.....	21
II.4. SEA WATER INTRUSION.....	21
II.5. WATER-BORNE DISEASES	21
II.6 ERROSION AND SEDIMNETAYION	22
II.7. BIODIVERSITY	22
II.8. DESERTIFICATION	23
II.9. WETLANDS	23
II.10. CLIMATE CHANGES.....	23
The Nile Basin	23
a. Source Point Pollution.....	24
b. Non Point Source Pollution	25
c. Seawater Intrusion.....	25

d. Water-borne Diseases	25
e. Sedimentation.....	26
f. Waterweed Invasion	27
CHAPTER THREE	
WATER QUALITY CONTROL AND MONITIROING MECHANISMS	28
III.1. WATER RESOURCES MANAGEMENT LEGISLATION.....	29
III.2. WATER RSOURCES MANAGEMENT INSTITUTIONS	29
III.2.1. Ministry of Environment, Nature Conservation, Water & Forests.....	30
III.2.2. Ministry of Energy.....	30
III.2.2.1. Energy Potential	30
III.2.2.3. Water Supply	31
III.2.3. Ministry of Agriculture & Livestock.....	31
III.2.4 Ministry of Planning.....	33
III.2.5. Ministry of Transport.....	33
III.2.6. The Ministry of Public Health.....	34
III.2.7. Others.....	34
III.2.8. Inter-ministerial Coordination	34
III.3. WATER ANALYSES LABORATORIES AND THEIR CAPCITIES	35
III. 4. THE HUNMAN CAPCITIES	36
III. 5. THE CONSTRAINTS	36
III.5.1. The Institutional and Legal Constraints.....	37
III.5.2. Technical, Material and Financial Constraints	37
III.5.3. Professional Constraints	37
III.6. THE RECOMMENDATIONS.....	38
CONCLUSION.....	39
BIBLIOGRAPHY	40
ANNEXES.....	42

SUMMARY

The mechanisms of water quality control and monitoring in the Democratic Republic of Congo are deficient from the institutional, technical, financial and professional point of view.

The following constraints have been established by observers: (i) water resources management regulations are obsolete and out of date, (ii) lack of standard norms on the national level for the measurement of water quality (iii) lack of advanced research studies and knowledge on water quality management, (iv) deficiency of laboratories and adequate equipment for water analysis, (v) the data on water resources is sectorial and scattered in different uncoordinated organs , (vi) the majority of stations which are in place are out of function for lack of finance and lack of staff motivation who are underpaid, (vii) deficiency in water resources management specialized human resources.

The RDC has adhered to the Nile Basin Initiative, a regional grouping of ten countries which are Burundi, RDC, Egypt, Ethiopia, Kenya, Rwanda Sudan Tanzania, and Uganda, as active members and Eritrea as observer member.

The present study lays out the water resources potential of the DRC in both the Congo River basin and Nile basin areas, the causes of water quality decline, the management constraints, control and monitoring mechanisms for water quality and the proposed remedies to this situation.

The main objectives targeted in this work are (i) national capacity building in planning water quality control and monitoring (ii) data and information collection and the establishment of related gaps in all the Nile riparian countries

In face, this project is supposed to provide an ideal framework for the exchange of experiences on water quality and priority needs for a good transboundary cooperation between the countries amongst the countries of the Nile basin. This will enable the governments and water users to easily take decisions for the management and control of water quality.

INTRODUCTION

The Democratic Republic of Congo possesses immense water resources, the components of which are the following:

- A dense hydrographic network well distributed with the Congo River, the strongest river in Africa with an average rate of flow reaching 50,000 m³/second
- A large number of lakes (around 90) the largest of which is Lake Tanganyika
- Wetlands, the main of which are the central basin, the marine mangrove park situated in the estuary of the Congo River, the wetlands of the Virunga national park and the Lufira swamps
- Ground waters, of which the most accessible level for exploitation is to be found in the alluviums as well as in the sandstone and calcium build-ups
- Atmospheric waters which are abundant all around the year, thanks to the geographical position of DRC
- Territorial waters, as DRC also possesses 40 km on the Atlantic ocean coastline

In addition to the Congo River basin, the Nile basin in the Congolese territory represents less than 2% of the total area of the country.

The Nile is the longest river in Africa. It travels more than 6.600 km, crosses more than 35 degree of latitude and drains an area of around 3.1 million of km², the equivalent of the 10th of the total area of the African continent. The Nile basin spreads through the territory of ten countries, namely, Burundi, DRC, Egypt, Ethiopia, Eritrea, Kenya, Uganda, Rwanda Sudan and Tanzania, and its influence on the livelihoods of the populations is evident in terms of the exploitation of natural resources. The decline in environment in the Nile basin will bring about considerable prejudice in the areas down-stream.

The demographic explosion, coupled with intense human activity and environmental degradation, essentially contribute to decline of water quality which becomes improper for domestic consumption, industrial or agricultural purposes, requiring diverse forms of treatment which are costly.

Lack of efficient hygiene services in the large urban clusters in particular, leaves the populations with no other options but to dump their agricultural,, industrial, and domestic waste into water courses, in the streets, in the markets, in the school,...etc. This, in consequence, favors the multiplication disease agents and the propagation of pathogenic germs.

This situation requires continuous water quality monitoring to secure a healthy water supply and a good quality of life to the population.

The goal of this study is to establish the status of water resources in the DRC and essentially the status of water quality degradation. In addition to the Congo river basin, a particular emphasis will be given to the Nile basin in view of the importance of this last one in the status of transboundary environment..

The Problems

In DRC, the mismanagement of natural resources brings about serious threats to environment which are:

- land degradation caused by deforestation of forest reserves , erosion and mining
- Water quality degradation resulting from domestic activities, agricultural and industrial activities, lack of hygiene infrastructure, eutrophication and water weed invasion.
- Catastrophes provoked by the presence of massive war refugees in the east of the country, by climate changes or floods and drought
- The loss of biodiversity and wetlands degradation

The water quality control and monitoring mechanisms in the DRC are constrained by the following handicaps:

- lack of advance studies and knowledge on water resources management
- lack of standard norms and legislation on the national level in matters of water quality management
- deficiency in terms of laboratory, appropriate equipment and human resources
- lack of financial resources of the said fields

The goal of this study is to establish the status of water resources in the DRC, the root causes of water quality degradation, the constraints in the mechanisms of management, control, and oversight of water quality, in the collection of data and information. The present study also seeks to identify the information gaps in each country of the Nile basin with and consequently establish an ideal framework for transboundary exchange and cooperation.

The Methodology

The methodology adopted in this work is based on the collection data and information on water resources management from the following sources:

- Universities, ministries of environment, water resources, energy of agriculture,.. etc
- Workshop and seminar reports, conferences and project closure reports, theses and articles on water resources management
- Visits and interviews with resources persons in the field

Expected Outputs

The report on the national water resources must reflect the following points:

- An outline of the water resources management practices as well as the institutional and legal frameworks
- A list of the institutions or organizations involved in the management of water quality as well as their capacity
- An inventory of the important rivers, lakes and wetlands and their status
- Data on key water quality stations parameters for the main rivers and lakes
- An inventory of point-source and non point-source water pollutions
- An inventory of existing laboratories and their physical and technical capacities
- Identification of gaps in the management of water resources and recommendations for the improvement of these practices

CHAPTER ONE

THE WATER RESOURCES OF THE DEMOCRATIC REPUBLIC OF CONGO

I.1 The Geographical Situation

The Democratic Republic of Congo is the third largest country in Africa after Sudan and Algeria, with an area of 2,345,000 km². The DRC is situated in Central Africa between the North latitude of 520 degree and the South latitude of 1327 degree, between 12 and 31 East longitudes. It shares borders with nine countries: The Central African Republic, Sudan, Uganda, Rwanda, Burundi, Tanzania, Zambia, Africa and The Republic of Congo

DRC , therefore, shares the following water bodies with the neighboring countries: lake Albert with Uganda, Lake Kivu with Rwanda, Lake Tanganyika with Burundi in the North and Tanzania in the South, the lakes Moero and Bangwelo with Zambia the Congo River with the Congo-Brazzaville and river Ubangi with The Central African Republic.

I.2. The Hydrographic Network

I.2.1 Congo River Basin

The Democratic Republic of Congo (DRC) is immensely rich in water resources. The water map represented by the immense fluvial network, the flooded plains and the lakes covers almost 86.080 km² (3.5% of the area of the country).

The Congo basin includes five countries which are DRC, Congo-Brazzaville, The Central African Republic, Cameroon, and Angola. Only the North-east region (Nile basin) and coastline are excluded from the Congo basin.

The water bodies in the DRC can be subdivided into three types of natural ecosystems: surface waters (rivers, lakes, and streams), ground waters and atmospheric waters.

I.2.1.1. Surface Water

(a) The Congo River and its tributaries

With the exception of the small coastline river Shiloango and the Nile basin area consisting of lake Albert and lake Edward, two thirds of the DRC territory are washed by the river Congo and its tributaries.

The tributaries of this river are of three categories:

- The North System Tributaries which drain these regions where dry season starts in January. This is the case of Ubangi river with an average rate of flow reaching $4.024 \text{ km}^3/\text{second}$ in Bangui
- The tributaries of the Southern System, which drain these regions where the dry season starts in July. The river Kasai has an average rate of flow that reaches $11.318 \text{ m}^3/\text{second}$ at Lediba and river Lualaba with an average rate of flow reaching 2.213 m^3 in Kivu
- The tributaries of the system composed of the regions spread out across the equator, with a rate of flow reaching $21.289 \text{ m}^3/\text{second}$

(b) The Lakes

The lake ecosystems include almost 90 lakes of which the DRC shares the largest portion with the neighboring countries in the east (Lake Albert, Edward, Kivu and Tanganyika), This explains why these countries are referred to as the Great Lakes countries.

The periphery great lakes in the East cover an area of almost $48,00 \text{ km}^2$, 47% of which falls within the Congolese jurisdiction Lake Tanganyika area in the DRC is $14,800 \text{ km}^2$ Lake Albert $2,420 \text{ km}^2$, Lake Kivu $1,700 \text{ km}^2$, Lake Edward 1.630 km^2 and Lake Moero $1,950 \text{ km}^2$.

The Congolese lake system also includes two important internal lakes, lake Tumba (2.300 km^2) and lake Mai-Ndombe (7.000 km^2). There also exist other lakes in the depression areas.

I.2.1.2. Ground Waters

Ground water zones are numerous. There are six large morph-structural units having identified potentials. The most exploitable reserves are to be found in the alluviums and also in the sandstones and calcium formations

The depth of the catchment area is around 40 to 60 m in general, but can reach 80 m or even 200 m particularly in the provinces of Kivu, Bandundu and The Equator.

No assessment of these reserves has so far been conducted due ignorance resulting from insufficiency of information

I.2.3. Atmospheric Waters

The general climate being tropical, the annual precipitation varies between 840 mm in the coast area, up to more than 2,000 mm in the central basin. The average rate of rainfall in the country is approximately 1,200 mm. The DRC is partially situated in the equatorial region where it rains all around the year. The maximum level of rainfall is observed towards December-January and the minimum towards June-July. The average temperature is 24 to 25° C and can fall up to 18-20° C in the high altitudes. Relative humidity varies between 70 and 85%.

In the flooding period (November and April of each year) one observes heavy precipitations which causes huge damage to community social infrastructures such as bridges, roads, shelters, etc.

I.2.2. Marine Waters

The Democratic Republic of Congo has a maritime portion in southwest of 40 km in the Atlantic ocean coastline, covering an area of 2,000 km² of the water map where intense petroleum activities take place. The coastline has greatly declined today due to the physical damages its ecosystems have undergone through diverse human actions and beach pollution resulting from hydrocarbon spills in the ocean.

There exists a small coast river, Shiloango which is of very little importance.

I.2.3. The Nile Basin

The Nile basin in the Congolese territory occupies less than 2% of the total area of the country. The dividing line between the Congo River and the Nile River is equal in length to the crest line of Blue Mounts.

In spite of its tiny size, the Nile basin area in the DRC exercises a marked influence in the livelihoods of the populations of the area in terms of natural resources exploitation. The degradation of the environment in this basin brings considerable damages in the regions downstream. The Nile basin in DRC is represented in figure 2.

The Nile stems from several sources the remotest of which is situated in Burundi. The Nile course can be divided into three parts:

- The White Nile: This river, from its origin in Equatorial Africa, receives waters from Lake Victoria and carries the name White Nile
- Upper Nile: It is situated in the Sudanese basin and swelled by several rivers and down stream in Khartoum by the Blue Nile flowing from the Ethiopian massif

- The Nile: along 2,000 km, the river stops receiving tributaries and runs across a desert. At last it splits into several branches and forms a delta before reaching the Mediterranean

Lake Albert and Lake Edward, situated in the east of DRC in the border with Uganda are part of the Nile basin and the two lakes are linked to one another by river Semiliki which, in turn, has several tributaries.

The water course of the Nile basin in the DRC flow from the west towards the east, pouring into Lake Edward and river Semiliki. The most important wetlands being the shores of lake Edward, of river Semiliki and the of Rutshuru and Lubilia rivers.

River Semiliki is shallow in depth (25 m deep) and extends up to the extreme North across a vast flat lands where lake Victoria with a slow current, spreads out to form a swampy delta. All these lakes and their surroundings are rich in fish and wild Fauna and Flores.

River Semiliki has formed a vast river valley populated by elephants, hippopotamus, crocodiles, and diverse species of antelope. The delta area is invaded by *ambacth*, a thorny tree characterized by rapid growth and papyrus which encroaches more and more into Lake Albert.

The area down-stream is situated in the North Kivu province with Lake Edward as the main water deposit, followed by river Semiliki. The area down-stream is situated in the east of the Eastern Province, in the Lтури district and lake Albert makes up the biggest water expanse. The main outlet of Lake Albert is Albert Nile which runs northwards into the Sudan through Nimule.

It is worth noting that the basins of Lake Victoria and the other three lakes situated in the west, Lake George, Lake Edward and Lake Albert are rich in inundated plains, in wetlands and small satellite lakes which are pregnant with animal and plant biodiversity, and a number of ecosystems. The sub-basin is one of the most important regions in the continent in terms of biodiversity and food production.

I.2.3.1. The Nile Hydrographic Systems

Kagera, considered to be the remotest source of the Nile, is in Burundi. It is a long water course formed by the confluence of two rivers, Ruvubu and Nyawarongo, fed by other water course coming from other areas in the east of Lake Kivu and Lake Tanganyika. Ruvizora alone, the longest tributary of river Ruvubu, 480 km long, can be considered as the remotest river source for the Nile delta.

River Kagera forms part of the border with Tanzania, Rwanda and Uganda before reaching the western shore of lake Victoria where its journey ends.

Lake Victoria, the biggest lake in Africa, is also fed by river Mara, Nzoia, Sondu-Miriu and Kuja, as well as by other rivers from Kenya and Tanzania. The only outlet, Victoria Nile, runs from Uganda through Owen Falls dam, then across Lake Kyoga and Lake Albert.

Lake Albert also receives water from Semliki which stems from the Mufimbira mountains in DRC and first flows across Lake Edward in the continental rift valley, making a part of the border with Uganda.

River Albert then follows its course towards the North and enters the Sudan from the South in Nimul where it is known as Bahr El-Djebel (Mountain Nile) till it joins Bahr El-Ghazal and Sobat Near malakal.

Before reaching Malakal, Bahre El-Dgebel and Bahr El-Ghazal pass through the immense wetlands of the south. After joining Sobat (known as Baro in Ethiopia), the water course becomes the White Nile.

The Blue Nile (Abbai in Ethiopia) and its principal tributaries, Dinder and Rahad, descend for the Ethiopian mountains. The Blue Nile passes through Lake Tana in Ethiopia and a series of spectacular canyons and large irrigation dams in Roseris and Sennar before joining the White Nile in Khartoum.

After Khartoum, the Nile receives the waters of River Atabara, the last big tributary which descends from the Ethiopian plateau in the north-east of Lake Tana and forms a portion of the Ethiopian- Eritrean border, before entering Sudan.

After Atbara, the Nile traces a long meander and runs through three cataracts it reaches Lake Nasser (known as Nubia in Sudan). Down stream the High Dam of Aswan in the Egyptian territory, the Nile follows its course northwards up to the delta in Cairo where it splits into two braches which flow into the Mediterranean.

In the south of Aswan Dam, the Nile is characterized by annual flood caused by a rise in the rate of water flow from May and reaching its maximum level in August. This rise results from the increase in the quantity of water in Blue Nile and Atbara in the rainy season, reaching almost 90% of the total volume of the river. Other inputs come from the lakes of the east Africa which are washed by The White Nile in a regular manner during the whole year. These inputs are of vital importance when the Blue Nile and River Atbara are at their lowest level. These variations are attributable to climate influences and physical influences as well. The white Nile starts off from the south and is fed by tropical rains of Central and Eastern Africa, while the Blue Nile, coming from the eastern regions, exposed to the Indian Ocean typhoons, and on the other hand, is almost nil in North Sudan and Egypt.

1.2.3.2. The Lakes

The area covered by surface water in the Nile basin is almost 90,000 km², a considerable area, representing 3% of the total area of the basin.

Lake Victoria is by far the biggest lake, with a total area of 69,000 km², followed by the other three great lakes of the continental rift valley, Lake Albert (5,660 km²), Lake Kyoga (5,600 km²) and Lake Edwards (2,340 km²).

Lake Victoria and the other three lakes situated in the west, Lake George, Lake Edward and Lake Albert are rich in inundated plains, in wetlands and small satellite lakes which are pregnant with animal and plant biodiversity, and a number of ecosystems. The sub-basin is one of the most important regions in the continent in terms of biodiversity and food production.

Lake Tana situated down-stream the source of the Blue Nile covers 3,200 km² while the lakes of the Nile delta cover 2,400 km².

The artificial lakes are numerous in the internal course of the Nile. The maximum area of Lake Nasser (Nubia) is 4200 km² which makes it the second artificial lake in the world. Lake Victoria, the second fresh water lake in the world, hosts more than 300 species of endemic fish. It constitutes a natural reservoir for the White Nile and possesses an outlet which passes through the hydropower dam of Owen Falls.

The water level of the lake is extremely sensitive to the variations in the rate of rainfall.

The fluctuations in the level of water, even if minimum, bring about grave consequences to the ports, the farms and the towns where millions of inhabitants live near the lake shores.

Lake Victoria, by its vast area and its isolation, play the role of *purifier and oxygenator* of the waters of the Nile. Down-stream, the vast swampy areas at the banks of lake Kyoga come to improve further the quality of the waters of Victoria Nile and continue the storage work of the principal lake.

Lake George in Uganda is linked to Lake Edward, bigger and shared between Uganda and DRC. Lake Edward pours through river Semliki, into lake Albert, a shallow water mass not exceeding 25 meters deep and spreads northwards over low lands and forms a marshy delta with Victoria Nile. All these lakes and their surroundings are rich abundant fish, plant and wildlife.

River Semliki has formed a vast river valley populated by elephants, hippopotamus, crocodiles, and diverse species of antelope. The delta area is invaded by *ambactch*, a thorny tree characterized by rapid growth and papyrus which encroaches more and more into Lake Albert.

Lake Tana is situated at the top of the water basin of the Blue Nile at 1800 meters above the sea level.. With a level of rainwater reaching 300 mm and evaporation reaching 1800 mm, this lake maintains its level of water thanks to contributions from the basin draining an area of 16.500 km² in which 60 seasonal small water courses are involved, the lake is surrounded by wetlands, reed bed and possesses commercial fisheries exploiting tilapia and cat-fish . The falls of Tis-Abays blocks the endemic fishes of Lake Tana from propagation up-stream. The water birds are abundant and the presence of **otters** has been observed in the lake.

I.3. NILE BASIN INITIATIVE

The Nile basin hosts and feeds almost 160 millions of inhabitants, mostly amongst the poorest in the world. The extreme poverty of a large number of inhabitants is closely linked to the status of the environmental resources on which they depend for their daily livelihoods.

These resources, the importance of which is recognized world-wide, are threatened by multiple factors, some of which are evident and some of which are of high complexity due to adverse environmental trends that block the efforts of riparian countries to move towards sustainable socio-economic development.

In 1999, by a historic decision, the riparian countries launched the Nile Basin Initiative, a regional partnership aimed at promoting economic development and poverty eradication

The NBI has three organs:

- A council of ministers in charge of issues of water in the basin countries (Nile-COM)
- A technical consultative committee (Nile-Tech)
- A secretariat (Nile-Sec)

The Nile Basin Initiative is guided by a shared vision: (the realization of a sustainable and shared socio-economic development through the equitable utilization of the common Nile water resources and the benefits.

The consensus between the riparian countries was strengthened by the international recognition of the importance of environment and development.

To put this vision into action, the NBI has formulated a strategic Action programs composed of two components:

The Shared Vision Program (SVP)

The Subsidiary Action Programs (SAP)

These programs are in the process of formulation by the riparian countries in the framework of NBI, in cooperation with the World bank, the UNDP, and other partners (GEF, USAID, CIDA).

The waters of the Nile, thanks to their constant availability throughout the year and transforming large areas of the desert into fertile lands, have favored agricultural implantations in the first agricultural land in the history of the planet.

A transboundary environmental analysis had been carried out by the Nile basin countries in order to guide the preparation of the Nil transboundary environmental action project of the Shared Vision Program. The process of the analysis involved consultations on the national and the international level aimed at determining the national commitments in the field of environment, in order to formulate the frameworks for the regional analysis on the level of the basin, and eventually take actions basin-wide.

A group of experts composed of a three-member team of each country prepared a provisional project for cooperation framework which will allow the initiation of dialogue on the establishment of a legal and institutional framework.

CHAPTER TWO

WATER QUALITY DEGRADATION

The uses and needs for water are numerous which one can summarize as follows:

- Domestic uses (drinking, washing, kitchen, bathing, swimming, etc)
- Agricultural uses (irrigation)
- Industry
- Collective uses (schools, hospitals, shops, etc)

In general, ground and surface waters are improper for drinking because they are exposed to all sorts of contamination. By definition, we name pollutant any substance capable of degrading water quality, of preventing or disturbing its subsequent use.

The origins of water pollution are multiple and are related to agricultural activities, industrial, domestic and biological activities. Therefore, there is a need to first treat these waters before being distributed for consumption.

The data on water quality in DRC is insufficient for the fact that it is not being collected regularly and it does not undergo permanent monitoring. It is dispersed in different structures such as REGIDESO, SNHR, National Committee on Water and Sanitation Action (CNAEA), Research Centers, University Laboratories, Research Institutions, NGO and some private sector actors. It is clear that there is a need to assemble all this data in a data bank, process and publish it.

In this chapter, we will present the origins of water quality pollution, the armed conflicts and the environmental threats, water weed invasion, sea water encroachment, water- borne diseases, erosion and sedimentation, biodiversity, desertification, wetlands and climate changes.

II.1. THE ORIGINS OF WATER POLLUTION

The Congo River Basin

In general, water pollution results from domestic, agricultural, industrial, mining and petroleum activities, water weed invasion and the intrusion of sea water. It is also important to mention the serious environmental threats caused by the civil war in the east of the DRC.

Concerning the surface waters of DRC, these water bodies are mostly heavy with chloride, nitrates, nitrites, ammonium, iron and manganese.

Mineralization is in general very weak, less than 100mg/l. Most rivers contain pH in the range of 5.5 – 7 but they undergo fluctuation from time to time in accordance with floods and seasons.

In the North and South Kivu, certain waters appear to be more alkaline and mineralized due to contact with thermal waters. One notes also a weak pH and a high grade of iron in the rivers of the north of the country and a heavy mineralization in magnesium and manganese in Lake Kivu.

As for ground waters, they are generally acidic and often aggressive. One notes the presence of excess elements such as iron, and manganese in the red sands. In Kinshasa, it is not rare to find ground water loaded with nitrates and sometimes with high concentration of iron.

II.1.1. Domestic Activities

These activities produce, in general, household solid and liquid wastes (cartons, boxes, solvents, etc) which are not treated before throwing into the water courses. In this context we have to mention fecal pollution arising from the elimination of human excrement by improper individual methods, or arising from the degradation of collective networks and the break down of sanitation infrastructure.

In the large clusters one observes a generalized lack of hygiene as a consequence of household trash, or the build-up of permanent cesspits, of the presence of pools or as a consequence of filth build-up.

II.1.2. Agricultural Activities

They are not yet a determinant factor in the contamination of water quality in DRC.

However, the use of chemical or biological fertilizers, and the use of pesticides in all its forms, causes water pollution by nitrates, phosphate and potassium as well as eutrophication. Nitrates are prohibited in potable waters because the high grade sometimes can increase the risk to human health.

Water Eutrophication

The quantity of nutritive elements available is a key factor for the diversity of species and the biological production of water. A greater quantity of elements leads to an increase in production, a phenomenon called eutrophication. A moderate increase in this production has beneficial effects and translates into an increase in fish production. However, too heavy production is too heavy favors the emergence of toxic waterweeds which threaten the marine environment.

Phosphate, carbon dioxide, silicon, and many other elements such as molybdenum and iron are essential factors for the growth of algae, their presence in such environment regulates this development. Certain types of waterweeds use organic matter such as waste water substance, while others accumulate nutrients for ulterior use. The phosphorus and carbon dioxide are the two main determinant factors for the growth of waterweeds, therefore eutrophication is generally linked to the excessive inputs from these two elements.

The main effect of eutrophication is the increase in the biomass of waterweeds, and the modification of the relative abundance of species. This latter also depends on the population and the efficiency of predators. Eutrophication exercises an influence on the whole food chain up to the highest level (for example, fishes). The probability of the development of waterweeds increases with the frequent emergence of new weed roots in general.

The increase in waterweeds resulting from eutrophication, leads to a decrease in oxygen which is necessary for the decomposition of organic matter. When waterweeds and their residue sediment increase, they decrease the level of oxygen concentration and this, in extreme cases, leads to the creation of an anaerobic environment.

In most cases, phosphorus is the first factor for the limitation of waterweed development. The normal carbon dioxide/phosphorus relation (in mass) for an optimal water weed growth is around 7 (with variations from 4 to 10 depending on the species). In the natural waters, this relation is around 20 or more.

When the relationship carbon dioxide/phosphorus declines below 4.5, carbon dioxide may become the limiting factor for growth. As it is easier to control the phosphate waste than that of carbon dioxide, the most efficient and economic method of fighting eutrophication will be the elimination of phosphate from waste water by well-tried techniques.

A low level of carbon dioxide/phosphorus relation in the lakes can sometimes give a competitive advantage to blue herbs which fix carbon dioxide. In this case, the carbon dioxide resulting from biological fixation becomes so abundant that the water weeds can benefit from the potential growth offered by the available quantities of phosphorus.

The relationship carbon dioxide/phosphorus which favors the development of blue water weeds is considered harmful because:

- Blue water weeds produce toxins and unpleasant smell
- Blue water weeds are not consumable by zoo-plankton. This unconsumed biomass increases the risk of oxygen deficiency at the time of its decomposition

- Blue water weeds create more esthetic problems than the other types of water weeds.

II.1.3. Industrial Activities

Industrial activities are various in DRC and create complex pollution problems, essentially in the areas where there exist the bulk of chemical, petrochemical, metallurgical industries, hospitals, printing press, paint factories, tanneries and agribusiness activities.

The effluents of these industries are directly thrown into the water courses, without prior treatment. Further more, these industries do not declare the quantities thrown into the water nor the quality of the whole effluents. It is also worthy to note that port and navigation activities are also a source of water pollution.

II.1.4. Mining Activities

Water pollution related to mining activities is essentially concentrated in the province of Katanga. Mining industry pollutes water by the emission of smokes containing toxic particles of which 20% is spread around the surrounding environment.

The smokes also contain SO₂ which, spread in the air, causes acid rains observed in the town of Lubumbashi and its outskirts.

One also observes water pollution in a vast areas of water courses in the country, particularly on the Kasai river and its tributaries, resulting from diamond and gold exploitation, notably from extractive operations and sieving.

In the Nile basin in DRC, the area which are victims of mining activities are Irumu,

Mahagi and Aru.

II.1.5. Petroleum Activities

The waters of the Congolese coastline are frequently exposed to pollution from petroleum waste spills from oil wells in Noandaa in the Low-Congo province and the neighboring countries.

Oil spills can sometimes be seen along the pipeline of Matadi-Kishasa susceptible of provoking fire and water pollutions.

II.2. THE ARMED CONFLICTS AND THE ENVIRONMENTAL THREATS

During the last seven years, the DRC has been locked in armed conflicts with its immediate neighbors in the east namely, Uganda, Rwanda and Burundi. These wars have a pernicious effect on environment which declines as a result of a huge influx of refugees and displaced persons in its eastern part.

On also notices lack of hygiene in the human settlements, gross deforestation, violation of natural reserves, water pollution through all sorts of human activities, etc. This gives rise to increased risk of the resurgence of certain epidemics, essentially due to the consumption of polluted water.

In the Nile basin in DRC, one observes and intensified deforestation in the territories of Beni, Luthero, Rutshuru, Irumu, in the National Park of Virunga and in the border with Uganda and Rwanda.

II.3. WATERWEEDS INVASION

Water hyacinth is the main plant which invades on a large scale the main water courses in Democratic Republic of Congo, in particular river Kassai and river Congo.

These plants disturb navigation and the functions of hydro-power facilities in these water courses. They could be the cause behind the fall in fish production and host certain disease carriers such as malaria.

Plant invasion is grave in Lake Albert, while it is moderate in Lake Edward. in the Nile basin are of DRC.

II.4. SEA WATER INTRUSION

During high sea level, water in the Indian Ocean rises along the river Congo up to more than 5 km and this raises the level of water and salinity in the river. Salt intrusion into the also reaches the surface water reserves being exploited in the coastline areas.

II.5. WATER-BORNE DISEASES

By its geographical location and its climate, the DRC is exposed to different types of water-related diseases. The bad health conditions the general lack of hygiene and water pollution lead to the resurgence of diarrheas, malaria, schistosomiasis and the proliferation of the vectors of these diseases river blindness and intestinal parasites.

II.6 EROSION AND SEDIMENTATION

Erosion is a phenomenon of soil displacement through the action of wind or water. Meanwhile, agriculture largely accentuates erosion. In particular, the farming practices which leave the surface without plant cover vulnerable to erosion, Soil protection is therefore an essential issue to be considered for an environment-friendly agriculture.

In the DRC, the soils mostly eroded are in the provinces with high population density, namely, Kivu and Low-Congo. In these regions, where demographic explosion is associated with pastoral activities, overgrazing and overpopulation exercise pressure on natural resources resulting in some cases in total resource depletion. We can also point to the erosion by of the town of Mbuji-Mayi in Eastern Kasai, which dates back to the colonial era.

Soil erosion is intense in the territory of Lubero and the surroundings of Kasenyi (southern bank of Lake Albert).

Forest depletion reduces water infiltration into the hydrographic basins and this results in increased flood frequency, a major source of soil erosion, and increase their power of destruction.

In the final account, the eroded materials are transported and accumulated in the basin and the estuaries. Limon build-up improves the fertility of flooded zones but in general, soil erosion and its repercussions translate into degradation of agricultural lands.

Certain techniques are used to reduce erosion. For example, building embankments to block water, mulching. Furthermore increased fertilization which will favor the growth of green cover will help in reducing erosion.

Loss of soil presents grave repercussions for the country in economic terms: sedimentation of navigable paths, increase in the level of dams, farms and land vulnerability to floods. River Congo alone carries, on average, 41 mg/l of solid load into the Atlantic Ocean, a quantity of almost 51 million tons of sediment per year. The solid load being essentially kaolin (26%), quartz (22%) organic matter (32%), iron hydroxide (10%) and a small quantity of other argillaceous minerals and feldspar.

II.7. BIODIVERSITY

By its expanse, its position in the depth of the equator, its multiple natural habitats, the DRC is one of the richest countries in biological diversity. In terms of the number of species, the fauna and flora, DRC ranks second in the world after Brazil.

However a marked disappearance of species has begun to be felt. The profound causes of this situation is to be found in poaching, the

decrease in the number of natural habitats through deforestation (agriculture , lumbering), mining, lawless exploitation of natural resources without the application of the appropriate norms.

There exists in DRC a national strategy and an action plan for the biodiversity conservation.

II.8. DESERTIFICATION

Although it is situated away from the area exposed to desertification, The Democratic Republic of Congo seeks to join the organizations concerned with desertification, to acquire the necessary arrangements for prevention, one reason why it ratified the Desertification Convention since September 1997.

II.9. WETLANDS

In addition to the multiplicity of lakes, there exist across the country a number of wetlands, three of which are considered as critical today. They are the marine Mangrove park in the Congo estuary, the wetlands of Virunga National Park on the banks of Lake Edward and the marshes of Lufra in the National Park of Upemba.

The DRC has adhered to and ratified the convention on the protection of biodiversity in 1994.

II.10. CLIMATE CHANGES

The preliminary studies on climate changes were elaborated in 1998 in DRC. It is necessary to note that two activities are behind the emission of large quantities of CO₂ and other greenhouse gases in the atmosphere. These activities include the energy sector and the industrial and agricultural sectors. Forest and land exploitation are the main absorbers of these gases. In the absence of statistics on climate data, one is tempted to correlate the recent floods in the last few years to climate changes in the Democratic Republic of Congo.

The Nile Basin

The main threats to water quality in the Nile basin are household, urban and industrial wastes insufficiently treated, non-point source pollution produced by chemical and agricultural product, silt and sedimentation, increased salinity and the loss of wetlands.

We witness the propagation of grave waterborne diseases in the whole basin. Mining toxic and dangerous wastes pose serious problems in certain regions.

It is the population down stream who usually pay the high cost of these threats.

The low quality of water has a disproportionate impact on poor households in the rural areas and the urban slums, where access to uncontaminated water is often limited. The women in the rural areas pass two hours or more per day on the search for water.

The poor populations usually live in marginal or undesirable areas, along the banks of polluted water courses, for example, in the depredated water basins and close to waste water treatment stations. In such a case they are the most exposed to pathogenic agents, with negative impacts on their work and their chances for education.

a. Source Point Pollution

This class of pollution is concentrated in the human settlements and factories, and as a whole it poses serious threat only to urban clusters such as Kampala, Khartoum, Cairo and other big cities.

The quality of water is good, most of which is in the Nile basin, but an increase in pollution resulting from tanneries, textile factories, mines and manufacturing sector, is being observed.

Other industrial and urban sectors of the basin possess sewage and waste treatment station, a large number of these equipments are faulty or out of function, leading individuals and institutions to dump their wastes into a number of water points in the Nile river system after a partial or without treatment.

For example, in certain urban centers of medium size in the outskirts of Lake Victoria, the vegetable oil factories, tanneries, soap factories and other industrial installations, throw all the wastes barely treated or not at all in the water courses already pollute through insufficiency of sanitation by the municipality.

In Sudan, the agricultural chemical products, the industrial waste, and the household waste, cause degradation in the quality of water in the irrigation canals, in particular when they are dumped during a period of low water flow.

In Egypt, the quality of water declines radically between Asswan and the delta, with a reduction in the level of dissolved oxygen and an increase suspended solid load. The drainage canal which captures the water in the agricultural areas also receive an increasing quantity of waste water, of silt, and partially treated solid industrial waste. The grade of salts, organic matter, nutrients, fecal coli forms, heavy metals and pesticides is high, in particular in the extreme north of the delta, though

there are high local variations. Some canals have become totally anaerobic.

b. Non Point Source Pollution

This type of pollution is caused by the inappropriate and excessive utilization of chemical agricultural products (fertilizers, pesticides, herbicides) during an intensive cultivation which ends in the reduction of water quality in a large number of regions. Many of these chemical products are today essential for the practice of a commercially viable agriculture, but the choice and the application of these substances are often inappropriate and dangerous.

Therefore the waters loaded with agricultural chemical substances are thrown into the water courses, the lakes and the dams in the Nile basin, in considerable quantities, generally without going through artificial or natural wetlands for possible filtering.

Such practices result in an increase of nutrients, water eutrophication, an increase of fish mortality, an increase of undesirable organisms and water quality deterioration to the detriment of all users.

These problems are particularly visible in the drainage canals that have large irrigation perimeters which introduce pesticides and fertilizers in the water course, and the wetlands in Sudan and Egypt. Also in the five countries of the Lake Victoria basin, agriculture uses a large quantity of chemicals, with the same consequences.

c. Seawater Intrusion

This phenomenon is significant only in Egypt, in the coastline region near the aquifers of the delta. The delta covers an area of about 15,000 km² and its aquifers contain some 130 milliards³ of fresh water. Water is pumped in large quantity for irrigated farming.

When the load capacity of aquifers is exceeded, sea water spills into the river. Fresh water, having density, remains at the top of salty water and forms a layer of varying density which covers the salty water.

Some aquifers near the coast are replenished directly by rainwater and runoff water and as well, excessive pumping favors seawater infiltration. A high degree of salinity in the aquifers limits the utilization of their water.

d. Water-borne Diseases

The most serious diseases are malaria, diarrhea and bilharzias. Malaria is the first cause of mortality in the countries of the Nile region and

continues to spread due to resistance of the parasite to anti malaria drugs.

In the basin, diarrhea, usually due to consumption of polluted water or lack of hygiene education, is the main cause of mortality among infants.

Progress has been made in the last few years in Egypt , through program designed specifically to remedy this problem, but in the other regions of the basin, the mortality amongst infants and old persons due to intestinal diseases remains high.

Bilharzia, the pathogenic agent of which propagates in low current waters, has become the most serious water disease in Egypt since the construction of Asswan High Dam.

It is also observed in the basin, the existence of diseases such as respiratory infections, typhoid, hepatitis, bacterial dysentery, renal problems and a variety of intestinal parasites.

Sedimentation, waterweed invasion and slow flow of water in the canals are factors that favor the propagation of water diseases.

Given the fact that 10% of the adult population in sub-Saharan Africa live with HIV/AIDS, and the fact that this disease accounts for 9% of adult mortality due to infectious diseases, the control of the threats of these infections will bring direct advantages to the victims of AIDS in the whole region, because AIDS depletes their immunity capacity and exposes them to these diseases.

e. Sedimentation

The problems of sedimentation are linked to the problems of soil erosion. One observes the presence of heavy sediments in a large number of water courses especially those which flow down from the mountains carrying away fertile soil.

Solid charges are greater in the Blue Nile and Atbara regions, in the rivers of Kagera basin, as well as in a large number of other water courses that pour into Lake Victoria. Sedimentation in the White Nile basin is also great.

The huge loads of sediments have a negative effect on canals in most of the irrigated perimeters and could degrade the small wetlands and reduce the capacity of shallow lakes.

The silting up of the major reservoirs entails direct economic costs by reducing irrigation capacity and power production, the clearance of which requires, in some cases, costly operations

The sediments and the waste carried by the Blue Nile, Atabara and their tributaries, affect water quality in the reservoirs and the irrigation canals in Sudan.

The build-up of sediments in certain parts of the Nile between Atabara and lake Nasser has formed silt islands and banks producing currents which cause river bank erosion and loss of fertile lands and fully grown trees.

Almost all the sediments carried away towards the internal course of the Nile get blocked in the Aswan High Dam, the capacity of which allows the capture of sediment inputs for almost one hundred years with hampering the production of hydropower.

f. Waterweed Invasion

The proliferation of these plants enriches water with carbon-dioxide, phosphor and other nutrients emanating from fertilizers, from waste water and agricultural sediments.

Water hyacinth, an unknown exotic species twenty years ago, has propagated in the White Nile system. It covers several lakes of Burundi and Rwanda, invades specific areas in Lake Victoria and Victoria River system as well as Lake Kyoga in Uganda, and Albert, Edward lakes in DRC. It is also widespread in the lakes and wetland of southern Sudan and in the canals and drains in Egypt.

Water hyacinth has multiple impacts. Notably it contributes to eutrophication, to evaporation, to reduction of the productivity of fisheries, the disturbance of navigation, to the acceleration of water diseases propagation, to the obstruction of hydro-power facilities and to the reduction of access to water for households, industries and agriculture.

Four types of control measures are being tested: water management (including inputs from nutrients), mechanic and manual clearance, chemical and biological elimination. Each method has advantages and disadvantages and none of them has revealed perfect efficiency.

Considerable progresses have been accomplished in the last few years in the fight against water hyacinth, notably in certain parts of lake Victoria within the framework of Lake Victoria Environmental Management Project (LVEMP), and in Egypt where there is a constant mechanic clearance..

CHAPTER THREE

WATER QUALITY CONTROL AND MONITORING MECHANISMS

The mechanisms of water quality control and monitoring in DRC are deficient from the institutional, financial and professional point of view.

This is the result of the absence of updated regulations for water resources management, the absence of norms and standards on the national level for the practice of water quality assessment, the absence of advanced research studies on water quality management, the absence of laboratories and adequate equipment for water quality analysis, lack of collaboration between the different organisms involved in water management, the disappearance of a large part of measurement or monitoring stations for lack of finance or for lack of staff motivation who are not well paid and also due to shortage of specialized human resources in the management of water resources.

Therefore, it is obviously necessary to elaborate in the DRC, policies and strategies which will guarantee a sustainable and profitable utilization of water resources for the populations.

Amongst the tools to be incorporated in the strategic approach for water resources management, monitoring and control are determinant for the performance of the water pollution threats alert system.

Monitoring consists of a set of means and procedures by which operates the monitoring of the water resources qualitative and quantitative status in view of ensuring an efficient and sustainable utilization.

Control, which is only a stage in the monitoring process, consists of a set of technical and legal instruments aimed at supporting water resources management.

In general, the tools supporting monitoring process are cartography with water maps laboratory analysis and monitoring stations

The analyses mostly in use to assess the quality of water are:

- Physicochemical Analyses which help determine parameters such as turbidity, conductivity, suspended materials, pH, CO₂, iron, nitrites, nitrates, phosphate and calcium
- Bacteriological Analyses: They focus on pathogenic germs, on microorganism, fecal water pollution indicators, in such case, the total coliforms and fecal coliforms
- Parasitological Analyses: They focus on parasites which threaten public health, protozoa pathogens, helminthes and free organisms which should not be in potable water

The main water resources control instruments in use in DRC are : (I) fiscal or economic instruments with taxes on the exploitation of water resources (ii) legal instruments with legal regulations and responsibility, negotiated arrangements that can be brought to justice in case of breaching

In this chapter we will present the following:

- Water resources management legislation
- Water resources management institutions
- Water quality analysis laboratories and their capacities
- The human capacities
- The constrains
- The recommendations
- The conclusion

III.1. WATER RESOURCES MANAGEMENT LEGISLATION

In respect of identifying the laws and regulations in force in the field of water, we refer to the laws and regulations published during the colonial era and to some issues of the Official Journal of the Democratic Republic of Congo.

Certain texts govern in specific way water as a resource, while others do this indirectly when they deal with activities that have impacts or incidence on water.

The majority of the texts date back to the colonial era when water and forest enjoyed a good institutional organization which placed them on the same level of importance with mines, agriculture and public health.

Today it is obviously urgent to update these texts, to elaborate and promulgate regulatory acts for water resources management, particularly the norms on water quality, as well as the rules and principles for water quality control and pollution control

III.2. WATER RSOURCES MANAGEMENT INSTITUTIONS

In addition to the Ministry of Environment, Nature Conservation, Water & Forests, which has as a main function the management of water resources, there exist other ministries and organisms intervening in this field for a specific purpose

III.2.1. Ministry of Environment, Nature Conservation, Water & Forests

This is the ministry to which falls the responsibility of water resources management. This responsibility is fixed by the act n° 75-231 of 22 July 1975 which defines the attributions according to which the ministry has the authority to coordinate all the activities relative to the environment, conservation of nature, water resources management and take all the measures that allow the full accomplishment of this mission

Within the framework of this mission, the Ministry of Environment, Nature Conservation, Water & Forests has notably the following responsibilities

- Guarantee hygiene in the urban environment by removing nuisances caused by water, soil and air pollution, capturing stations, water ecosystems and forests
- Conduct a sound reforestation and anti-erosion policy
- Express a view on industrial or development projects that could threaten the quality of life and water quality

III.2.2. Ministry of Energy

The interventions of the Ministry of Energy in the water sector focus on water as a source of energy. The National Electricity, Company one of the organisms of the ministry, carries out the construction of dams for the production of electricity. Another arm of the ministry is the Water Supply Corporation (REGIDESO) which is responsible for the treatment and distribution of potable water in the urban areas.

III.2.2.1. Energy Potential

The Congo river is the most powerful river in Africa with an average rate of flow reaching 500 m³ per second, the second in the world after Amazon (South America) and the fifth in the world in terms of length (4,374 km). River Congo maintains a regular and abundant regime during the whole year because it is situated in the equatorial zone where it rains all around the year and has tributaries in the South and the North of the equator. However, one notes a maximum level towards December-January and a minimum level towards June-July. This explains the enormous energy potential this river together with its tributaries represent (774,000 MW/h), covering an area of 34000 km² with a network of more than 33000 km. This energy potential represents 37% of the total potential of Africa and 6% of the potential of the world.

III.2.2.3. Water Supply

The needs for water (m³/day) in DRC were assessed in 1988 by the National Water Action Committee and present the following trends (see Table 1)

Table1: Assessment of Needs in the Democratic Republic of Congo (m³/day)

Needs	1988	1990	1995	2000	2005	2010
Domestic	735.100	824.600	1.129.400	1.542.600	2.108.100	2.632.500
Industrial	102.27	120.530	161.293	215.842	288.840	386.526
Total	837.37	945.130	1.290.693	1.758.442	2.396.940	3.019.026

Source: Rapport CNAEA

The needs of populations for water differ according to their level of socio-economic development. In Kinshasa (an urban area), the average daily consumption established by REGIDESO falls between 60 and 70 liters per person. In rural area, the optimal average daily consumption per person is 20 liters according to the agencies executing water supply programs in the rural areas.

Surface waters account for nearly 80% of water used for human consumption.

In the urban centers, capturing, treatment and distribution of water is the responsibility of REGIDESO, a State company. Its action extends, for the moment, only to 90 centers of at least 5000 persons each. The water requirements by industries in the urban centers are covered the domestic network of REGIDESO. Although it is the largest water distribution company, REGIDESO does not cover more than 25% of the domestic needs of populations.

III.2.3. Ministry of Agriculture & Livestock

Within this ministry, there exists the National Rural Water Service (SNHR), the main objective of which is the promotion and distribution of potable water in the rural areas. It is in the framework of the improvement of living conditions for the rural populations that the SNHR was established. Also the NGOs, confessional organizations and some private sector actors take part in capturing and distributing potable water.

In 1990 the supply of water in the rural areas was covered by 5118 sources built by the government, of which less than 2% had a rate of flow above 3.1/second, 1595 wells and 128 canals. All these facilities

served 4.1 millions of 20.3 millions of the rural populations, a supply rate of 20%.

As for water supply for agriculture, only 400 hectares received modern irrigation and 20,000 hectares received small irrigation in 1982.

The identified potential, as indicated by the same source was estimated to be 4 millions of hectare. In 1996, the 24000 irrigated hectares did not represent more than 0.4% of the cultivated areas.

- ***Fish Potential***

In addition to rivers, the DR of Congo has great lakes in the East (Tanganyika, Albert, Kivu and Edward) which cover an area of 48000 km² of which 47% falls within the Congolese jurisdiction. The Congolese lake system also includes two internal lakes, lake Tumba (2,300 km²) and lake Mai-Ndombe (7000 km²) and the lakes in the Kamalondo depression (6,256 km²), lake Tshangalele (446 km²) and lake N'Zilo (280 km²).

The national fish potential is estimated to be around 70700 tons, of which almost 63% comes from the great lakes, 28% from the rivers, 8% from the depression lakes and captured water in Katanga and 1% from sea waters in the Atlantic coast.

Lake Tanganyika is the richest in the country in fish stock, having a potential estimated at about 400,000 tons (57% of the total national stock). Lakes are poor in fish species compared to rivers. In 1992, 669 fish species were denominated in the central basin and it is estimated that this figure will exceed the 1000 of which almost 70% will be endemic. (see table 2).

Table 2: Physical Characteristics, Area and Number of Fish Species in Some Lakes in the East of Congo

Name of Lake	Altitude (m)	Average Depth (m)	Maximum Depth (m)	Area (km ²)	Number of Fish Species	pH
Albert	618	85	25	5.270	46	8.4 - 9.5
Edward	914	117	34	2.300	46	8.5 – 9.3
Kivu	1.463	489	240	2.370	25	7.0 – 9.1
Tanganyika	773	1.435	700	32.900	288	7.3 – 8.5

Source: Mungangu Tinto (1996)

Fishing mainly focuses on some species which represent an important percentage of the total catch. More than 90% of the total production comes from local fishermen. Semi-industrial fishing is practiced in lakes Albert and Tanganyika. The species that are mostly captured in the East lakes are presented as below:

Table 3: Fish Species and Weight in the Total Catch

Name of Lake	Toxins	Taxonomic Characteristics	% of Total Catch
	<i>Hydrocyanic forskali</i>	Endemic	40 – 50%
Albert	<i>Lates niloticus</i>	Endemic	20%
	<i>Oreochromis niloticus</i>	Introduced	20%
Edward	<i>Oreochromis niloticus</i>	Endemic	60 –70%
Kivu	<i>Limnothrissa miodon</i>	Introduced	85%
	<i>Stolothrissa tanganyicae</i>	Endemic	
Tanganyika	<i>Limnothrissa miodon</i>	Endemic	70 – 80%
	<i>Luciolates strapersii</i>	Endemic	5 – 15%

Source: Grevobal and Maes (1991: 8)

III.2.4 Ministry of Planning

On this level, there is a need to point out the existence of National Water & Sanitation Action Committee (CNAEA in French), functioning under the technical mandate of the said ministry, and having as a main mission, the enforcement of norms on potable water production. Furthermore, it formulates and proposes to the government the national potable water supply and sanitation policy for communities in the DRC.

III.2.5. Ministry of Transport

This ministry exercises authorities related to the use of water through the following public enterprises falling under its mandate:

- Fluvial Ways Department charged with facilitating fluvial navigation
- Maritime Ways Department which is in charge of facilitating maritime navigation
- National Transport Office which exploits commercial transports on the Congo and Kassai rivers
- The Congolese Maritime Company

III.2.6. The Ministry of Public Health

This ministry administers the public hygiene services and intervenes in the water sector to limit the public hygiene threats posed by water.

III.2.7. Others

The other organisms which intervene more or less in water management are :

- The universities(Unilu Geology & Civil Engineering Laboratory, Unikin Ecotoxicology Laboratory, Unikin Department of Land Sciences, Unikin Laboratory of The School of Public Health, etc)
- Higher Institutes
- NGOs (SANRU, Religious Associations, etc)
- Research Cabinets
- Research Centers (CRGM, CRENK-K)
- Civil engineering private companies

III.2.8. Inter-ministerial Coordination

The Inter-ministerial Committee for Environment, Nature Conservation & Tourism

Composed of the secretary generals of different ministries and top level civil servants from other public departments; this committee has as a mission the following goals:

- Study and prepare the broad policy outlines on environment, nature conservation and tourism in DRC
- Review the amendments to be made in the international treaties and conventions and treaties related to environment, nature conservation and tourism

- Study all industrial, commercial tourist or any other proposal that can have impact on environment, nature conservation and tourism
- Study ways and means for the protection of the environment, nature, water and forest conservation and tourism
- Give views on any issues raised by the government in the field of environment, nature conservation and tourism
- Provide the government with all the necessary clarifications and formulate all the proposals relative to environment, nature, water and forest conservation, and tourism

III.3. WATER ANALYSES LABORATORIES AND THEIR CAPCITIES

Water quality control laboratories are insufficient in view of the immense needs of the country. In most cases the equipment is old (CRGM) and others are no longer functioning (ISTA) because the devices are faulty and spare parts are not available.

In addition to this, there is the problem of financing which handicaps the regular procurement of reagents. There are operational laboratories in the breweries, in the School of Public Health of Kinshasa University, etc. But these organs do not conduct advanced water analyses. There are also commercial units carrying out water treatment for sale. Due to the lack of data, we are not in a position to testify with honesty the quality of these waters.

In our studies and after field visits, we have held out the laboratories of REGIDESO, CRENK-Kinshasa and Ecotoxicology of Kinshasa University as the most advanced in terms of equipment and the scope of water analysis.

After cost analysis, two solutions are envisaged to reactivate the laboratories: (i) rehabilitate the existing laboratories (ii) build new laboratories.

For the first case, there is an urgent need to enhance the human capacities, to obtain sufficient financing for the renewal of equipment and for regular supply of inputs.. The second case concerns in particular the Nile basin where it is imperative to have mobile laboratories for field analyses and 3 well-equipped laboratories have been proposed for the collection and analysis of water samples taking into account the existing infrastructures.

The areas suggested in the proposed laboratories are as follows:

- **MAHGI PORT Station in Tshomia for Lake Albert**
- **KYAVINKOGE Station for river Semliki**

- **VITSHUMBI Station for Lake Edward**

It has to be noted that the feasibility studies and security conditions are necessary for the installment of these laboratories.

The largest entity in capturing, treatment and distribution of water. REGIDESO owns laboratories in all the major places in the provinces. It has a very high capacity of sample analysis but it covers on 25% of the needs of populations.

The Central laboratory of REGIDESO is well prepared in terms of equipment and personnel and produces very viable results. The routine analyses for the constant water quality control are color, turbidity, pH, oxydizable matter, residual chloride germs search and fecal pollution tests. The respect of standards as set out by WHO is strictly observed (total absence of fecal coliforms in 100ml, a pH of 6.5 – 8.5, a turbidity not exceeding 5 units, oxydizable matter grade not exceeding 5 mg O₂ /liter, a nitrate grade of mg/l, nitrite grade of 0.1 mg/l aluminum grade of 0.2 mg/l, etc)

In view of the immense needs of the country, REGIDESO needs a regular supply of inputs (reagents, gel capsules) and spare parts which represent a thorny problem of task execution, human resources capacity building, procurement of modern equipment and finance.

Before the war, the central laboratory of REGIDESO used to conduct analysis on the hardness of water samples of the lakes flowing from Goma.

III. 4. THE HUMAN CAPACITIES

The enhancement of national capacities through training and research is obviously urgent in the light of the serious shortage of specialists in the field of aquatic ecosystem research,. In order to organize a specialized training on the management of water, resources, hydrology and hygiene schools and institutes need to be first rehabilitated.

There is also an obvious need for the equipment and rehabilitation of hydrological measurement stations which are no longer functional for lack of financing and low performance of technicians resulting from underpayment and lack of motivation

III. 5. THE CONSTRAINTS

The constraints of water resources management in the DRC spreading across the institutional capacities, technical, material, financial and professional capacities, are multiple and complex. These constraints are visible in the Congo basin and in Nile basin.

III.5.1. The Institutional and Legal Constraints

These constraints are visible in the following areas:

- Weak institutional framework in the field of water resources management in the DRC
- Very low level of coherence in the legal framework and confusion in the interpretation of existing texts
- Conflicts in the sectorial management of water resources reflecting lack of collaboration amongst the different organisms
- Lack of incentive policies on the exploitation of water resources for the national market and the external market
- Urban and industrial waste in the water course for lack of purifications stations
- Absence of defined perimeters for protection around water points
- Lack of population awareness of the water resources management policy

III.5.2. Technical, Material and Financial Constraints

- Lack of a central data bank
- Lack of means for the publication and dissemination of meetings reports
- Lack of specific financing in the field
- Laboratory deficiency and obsolescence of the few hydrological measurement stations which were in service before independence
- Lack of inventory on water points cartographic support
- Insufficient financial resources for regular treatment inputs
- A country of a vast area and lack of the means of communication
- Neglect of old hydrological measurement stations and lack of new ones

III.5.3. Professional Constraints

- Lack of knowledge on water resources and monitoring mechanisms
- Lack of specialists in the field of aquatic ecosystems research
- Under-utilization of existing technicians resulting in apathy

- Lack of encouragement for the youth for qualification in the field of water

III.6. THE RECOMMENDATIONS

The government needs to enhance water management in the Ministry of Environment, Nature Conservation, Water & Forests, by providing this ministry with the human, material, and financial resources commensurate with the immense size of the country and the existing water problems. These recommendations address both the Congo and the Nile basins. I propose the following actions:

- The formulation of specific modules for the management of environmental resources
- The provision of mobile laboratory kits for field data collection
- The establishment of a well-equipped laboratory in the Nile basin, the headquarters which should be in Beni, Butembo or Goma. This laboratory should be equipped with at least a spectrometer HACH DR/2400 capable of dosing the nitrite ions, nitrates, sulfates, silica, phosphates, manganese, iron, copper and chrome, and with an equipment titrimetric analyses (bicarbonates and chorines) and microbiological analyses
- Building and rehabilitation of schools (ex. Butembo Fishing School) and hydrology and hygiene training institutes
- Enhancement of national capacities through training and research
- The establishment of a data bank to assemble the information on water resources scattered in the various organizations
- The exploitation of existing expertise
- Organization of specialized raining on water resources management and aquatic ecosystems
- the permanent dissemination of information to stir public interest and the interest of decision-makers in hydrological sciences
- Elaboration of national standards based on WHO guidelines
- Promoting research in the field of water resources management
- Updating and enforcement of water resources regulations
- Regulating production, storage and treatment of waste by installing purification stations
- Reactivation and enforcement of legal and regulatory instruments on the protection of water resources

CONCLUSION

The main environmental threats to the Nile basin and the Congo basin are water courses and lakes pollution, deforestation, soil erosion, hunting, natural disasters, loss of biodiversity and wetlands. There is an imperative need therefore to envisage:

- Environmental planning and mitigation measures
- Public and NGO participation and consultation
- Land development
- Transboundary cooperation (eg. waterweed invasion and the necessity of cooperation with Uganda)
- Public education and awareness raising
- Updated legislation and regulation with the formulation of standard norms on the national level
- Field equipment for analysis in situ
- Enhancement of human capacities through training and research
- Laboratories with modern viable equipment and rehabilitation of hydrological measurement stations
- Specific financing in the field
- The means for the dissemination of data

BIBLIOGRAPHY

- Notes the 1st Conference on the Issue of Waste in Kinshasa (CONGO) MEDEDELINGEN – Facultiet Landbouwkundige en toegepaste biologische wetenschappen Kinshasa, August 12 – 1, 1998
- Transboundary Environmental Analysis, Nile basin Initiative, GEF, UNDP, World bank May 2001
- Ministry of Land, Environment, Nature Conservation, Fishing & Forests, National Strategy and Action Plan for Biodiversity. June 1999
- Ministry of Land, Environment, Nature Conservation, Fishing & Forests *National Forum on Fishing and Water Resources* from 29/5/200 to 1/6/2000
- Oluf, C.B. , Ola K., Ole H.L. , Ian R. Agriculture and Fertilization. Fertilizers – Their Future. Agriculture Division, Norsk Hydro a.s. Oslo, Norway. April 1990
- Transboundary Environmental Action Project. *Project Implementation Plan*. Nile Basin Initiative
- World Bank, *Project Appraisal Document on a proposed grant from the global environment facility in the amount of US\$ 8.00 million to the Nile Basin Initiative for Nile Transboundary Environmental Action Project, March 5, 2003*

DRC Water Resources Management Status

**Comments on the Types of Analysis, of
Equipment and Personnel of the Central
Laboratory of REGIDESO
(French acronym for Water Supply
Corporation)**

ANNEXES

LABORATORIES	TYPES OF ANALYSIS			EQUIPMENT	STAFF	REMARKS
	Physicochemical	Chemical	Microbiological			
The Central Laboratory of REGIDESO (Water Supply Corporation)	Color, temperature, turbidity, residual chloride after disinfection, pH, oxydizable matter, suspended material, alkalinity, hardness	Chlorides, nitrates, nitrites, iron, manganese, aluminum, heavy metals (copper, cobalt, lead)	Coli forms, fecal streptococcus, total or banal germs, Shigellosis, Salmonella	Spectrophotometer DR 2000, Spectrophotometer DREL 5, Spectrophotometer PC22 Flame Spectrophotometer (out of service), pH-meter, Comparator, Turbid meter, drying oven, autoclave, knead boxes, glassware, etc	20 persons of which 1 PhD in Organic Chemistry, 1 Bachelor of Biology, 1 Bachelor of Pharmacy, 4 Diploma of the Institute for Medical Education, 13 technicians graduate from higher institutes	- A very high analysis capacity -The largest entity in capturing, treatment and distribution of water on the national level -Problems of reagents and spare parts procurements -Shortage of qualified staff and modern equipment and financing.

The largest entity in capturing, treatment and distribution of water. REGIDESO owns laboratories in all the major places in the provinces. It has a very high capacity of sample analysis but it covers on 25% of the needs of populations.

The Central laboratory of REGIDESO is well prepared in terms of equipment and personnel and produces very viable results. The routine analyses for the constant water quality control are color, turbidity, pH, oxydizable matter, residual chloride germs search and fecal pollution tests. The respect of standards as set out by WHO is strictly observed (total absence of fecal colifroms in 100ml, a pH of 6.5 – 8.5, a turbidity not exceeding 5 units, oxydizable matter grade not exceeding 5 mg O₂ /liter, a nitrate grade of mg/l, nitrite grade of 0.1 mg/l aluminum grade of 0.2 mg/l, etc)

Given the immense needs of the country, REGIDESO requires a regular supply of inputs (reagents, gel capsules) and spare parts which constitute a thorny problem for the entity in carrying out its tasks, in enhancing human resources skills,, in the procurement of modern equipment and finance.

Before the war period, the central laboratory of REGIDESO, used conduct analysis on the solidity of samples from Goma.

LABORATORIES	TYPES OF ANALYSIS			EQUIPMENT	STAFF	REMARKS
	Physicochemical	Chemical	Microbiological	Spectrometer model HACH DR/2400	5 persons of which 1 PhD in Agronomy and 4 Bachelor degree assistants	- The Laboratory is dedicated to scientific research for teachers, researchers, assistants,
CREN-K Hydrology & Physics Laboratory (CREN-K=Kinshasa Regional Centre for Nuclear Studies)	Temperature, pH, Conductivity, Potential Hydro reduction, Dissolved Oxygen Turbidity	Ions magnesium doses calcium, sodium, potassium, bicarbonate, sulfate, chloride, nitrate, nitrite, manganese	Nil	IC 761, connected to a computer Portable Multiparameter for physicochemical		-High analysis capacity -There is a need to renew equipment and

		iron, chrome and silica		analyses		enhance capacities
--	--	-------------------------	--	----------	--	--------------------

This laboratory enjoys a great reputation regionally and internationally and collaborate closely with the International Atomic Energy.

It has a high capacity of sample analysis both in the laboratory or on site (student these and third party samples).

This laboratory requires upgrading in terms of human resources and equipment and also requires a regular supply of inputs (reagents, gel capsules) and financing.

LABORATORIES	TYPES OF ANALYSIS			EQUIPMENT	STAFF	REMARKS
	Physicochemical	Chemical	Microbiological	Spectrometer, Conductivity meter pH meter, COD Reactor, BOD mineralizer, Drying Oven, Autoclave Magnetic agitator Homogeneitizer Thermometer Digester	2 persons of which 1 PhD in Sciences and 1 Bachelor Degree Assistant	-The Laboratory is dedicated to scientific research for teachers, researchers, assistants, -Average analysis capacity -There is a need to renew equipment and enhance capacities
Ecotoxicology laboratory of the Faculty of Sciences, University of Kinshasa	pH, Temperature, Conductivity, Turbidity Potential Oxydo reduction Dissolved oxygen	Magnesium ions oligo elements Total mineralization	COD BOD Germ numeration, Germ identification Toxicity			

This laboratory has an average capacity and focuses on water quality control, in which case, water pollution and contamination. The analyses are related to researches and dedicated to teachers, assistants and students , as well as samples from third parties.

As it is the case with most of laboratories in DRC, the Toxicology laboratory is in need f upgrading in terms of equipment and human resources. There is also an acute shortage of financing and inputs.



NILE TRANSBOUNDARY ENVIRONMENTAL ACTION PROJECT

TERMS OF REFERENCE FOR NATIONAL CONSULTANTS TO ASSESS THE STATUS OF DATA MANAGEMENT IN THE NILE BASIN COUNTRIES

1.0 BACKGROUND

1.1 Nile Trans boundary Environmental Action Project (NTEAP)

The Nile Trans boundary Environmental Action Project (NTEAP) is one of the eight Projects under the Nile Basin Initiative (NBI) Shared Vision Program and runs for five years. The main objective of this Project is to provide a strategic environmental framework for the management of the trans boundary waters and environmental challenges in the Nile River Basin. The NTEAP, is expected to meet its objectives through, the provision of a forum to discuss the broad development paths for the Nile Basin with a broad range of Stakeholders; improving the understanding of the relationship between water resources development and the environment; enhancement of basin wide cooperation and enhancement of environmental management capacities of basin wide institutions and the NBI.

The NTEAP's overall key outputs/ impacts are expected to be:

- Increased regional cooperation in environmental and water management fields,
- Increased basin-wide community action and cooperation in land and water management,
- Increased number of basin-wide networks of environmental and water professionals and increased number of experts knowledgeable on the environment,
- Greater appreciation of river hydrology and more informed discussion of development paths,
- Expanded information, knowledge base and know how on land and water resources available to professionals and NGOs,
- Greater awareness of the linkages between macro/sectoral policies and the environment,

- Greater awareness and increased capacity on trans boundary water quality threats.

1.2 The Basin Wide Water Quality Monitoring Component

The Basin wide Water Quality Monitoring Component is one of the six Components of the NTEAP. This Component will initiate a basin-wide dialogue on water quality and improve understanding of trans boundary water quality issues, improve capacities for monitoring and management of water quality and initiate exchange and dissemination of information on key-parameters.

It will also promote trans boundary cooperation on water quality management which will be increasingly important to maintain appropriate water quality for drinking water, irrigation, and industry and to support human health and livelihoods and ecosystem functions in the Nile Basin. This project component will increase the understanding of the current state of water quality and priority needs for trans boundary cooperation between the Nile countries and will contribute to building greater capacity for water quality monitoring and management. Exchange of experiences on regulatory issues and on water quality information between countries will also facilitate improved decision making by governments and other resource users.

This Component further aims to create a starting point for increased regional trans boundary water quality assessment and collaborative action. Basin-wide dialogue among relevant stakeholders will help develop a common vision and goal for water quality management for the Nile Basin.

In conclusion, this Component aims to enhance the technical capacities for water quality monitoring at the national levels and to raise awareness and information sharing on water quality management issues. It is therefore expected to develop uniform and compatible data reporting and database formats to be adopted and used by all the Nile Basin countries.

2.0 OBJECTIVES OF THE STUDY

The main objective of this study is to carry out a detailed assessment of the existing water quality data management practices in each country and to identify the data management practices which may be emulated by other countries. Any weaknesses in data management should be mentioned as well as

any information gaps and needs, and the Consultant should propose recommendations on how and which effective water quality data management practices should be adopted.

3.0 STUDY LOCATION

This Data Management Study will be carried out concurrently in the nine riparian countries of the Nile basin; i.e. in Burundi, D. R. Congo, Egypt, Ethiopia, Kenya, Rwanda, Tanzania, Sudan and Uganda.

4.0 STUDY DURATION

The study will be carried over a period of three weeks (21 working days).

5.0 SCOPE OF WORK

Task: To critically examine and assess the status of water quality data management in the country and give recommendations on improvements.

The Consultant will be expected to:

- 1) Examine and outline what information management systems are in place
- 2) Examine the current practice and methods used for data collection, storage, analysis and retrieval,
- 3) Indicate the type of water resources management data collected and stored,
- 4) Indicate the level of computerization and the software packages or any other tools being used for water quality data management,
- 5) Indicate if there exists any specific capacity to undertake water quality data management and recommend what type of training should be provided to staff, at what levels and for which packages,
- 6) Document if any data and information management techniques have been adopted by other programs and if they are worth emulating,
- 7) Examine and indicate whether any attempts have been made at water quality modeling and if so indicate the type of models used,

- 8) Study and evaluate the existing capacity for general data management, at the national level, and at the River Basin or Project level and recommend how cross border and trans boundary networks for data management and information sharing can be initiated,
- 9) Recommend the modalities required for data sharing and information exchange at the national and regional levels, indicating the types of data that should be exchanged,
- 10) Make suggestions on how agreed upon, uniform data reporting and data formats for the Nile Basin can be established.

6.0 METHODOLOGY

The Consultant will be expected to consult widely with Government Ministries and departments, institutions and sector actors involved in water resources management, mainly in the Ministries of Water and Environment. The Consultant will need to examine the existing databases therein, for their capacity and effectiveness.

The Consultant should examine recent and ongoing work, or projects in the Nile Basin portion within those countries, especially water quality related studies; that may have focused on data management practices or that may have generated some water quality data and information.

Although the main focus of this study is water quality data management, the Consultant will be expected to give a general broad overview of the water resources management data and database management practices in the country. Where available, related data such as river flow measurements, and any correlation between data sets should be indicated.

The Consultant will also be required to collect and summarize all available water quality data especially on key parameters of trans boundary importance. Such parameters include, sediment load, TSS, Conductivity, Heavy metals, Pesticide residues, Nutrients, Color, Turbidity and PH. He should indicate the methods being used for water testing and the integrity of the collected data.

The Consultant will be expected to employ the most effective methodology to achieve results. Such methods may include but not limited to the use of questionnaires. The Consultant should prepare clear and concise reports, which should be delivered on the specified or agreed dates.

7.0 EXPECTED OUTPUTS

A comprehensive Report on the status of water quality data management and information sharing at the national, basin and project levels, comprising of:

- i. Status of water quality data management practices in the country,
- ii. Type of data collected, and the institutional set up for water quality data management,
- iii. The existing capacity for data management with recommendations on desirable computer packages and software,
- iv. Identified gaps and strengths and recommendations on required training to enhance capacity,
- v. Recommendations on modalities for data sharing and the development of uniform data reporting and database formats.

8.0 DISTRIBUTION OF REPORTS

The Consultant will be expected to produce an Interim Report after two weeks for review and comments (**6 copies**) to be distributed as follows:

NPC – 1, PMU – 1, PSC -1, TAC – 1, WQWG – 2.

The Final Draft Water Quality Data Management Report will be submitted immediately after the Consultant presents his revised report in a meeting attended by the main stakeholders. The Final Report shall be submitted in **6 copies**. The Reports will also be submitted in a word format in a floppy diskette, or CD.

9.0 MONITORING AND SUPERVISION

The Consultant will be supervised by the PMU at the regional level and by the NPC at the national level. The Regional Water Quality Working Group members being the national technical experts on water issues in their countries, will be also be expected to provide guidance to the Consultant, to ensure compliance with the TORs.

10.0 REFERENCE DOCUMENTS

The following documents would be availed as reference background material about the NTEAP Project:

- i. Trans boundary Environmental Analysis(TEA)
- ii. Project Appraisal Document(PAD)
- iii. Project Implementation Plan(PIP)
- iv. Country level documents available at the PMU and NPC's offices.

11.0 TIME FRAME

It is envisaged that this work will start in mid July and be accomplished by early August, 2005(21 working days).

12.0 RENUMERATION

The Consultant will be remunerated in accordance with the standard official UNDP rates for National Consultants. Reimbursable expenses will be made according to an agreed and approved plan.

13.0 QUALIFICATIONS OF THE CONSULTANT

- Advanced degree in either water quality management, water and environmental resources management, or environmental sciences.
- Extensive experience in water quality control and management
- At least ten years of experience in water or environmental resources management.
- Excellent knowledge on water and environmental resources issues
- Expertise on database design, organization and management, and on information exchange and management.
- Fluency in spoken and written English, or French.
- Excellent presentation skills and communication techniques
- Expertise in research methodology, data processing, technical report production and information dissemination.
- Good computer skills and knowledge of statistical software packages applications.
- Experience having worked with/for an international or donor organization an advantage.