

# Analysis of the Nature of the Sediments Load in the Nile Basin, Burundi Case





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#### **Project Title**

#### **Knowledge Networks for the Nile Basin**

"Using the innovative potential of Knowledge Networks and CoP's in strengthening human and institutional research capacity in the Nile region"

#### **Implementing Leading Institute**

UNESCO-IHE Institute for Water Education, Delft, The Netherlands (UNESCO-IHE)

#### **Partner Institutes**

Nine selected Universities and Institutions from Nile Basin Countries.

#### **Project Secretariat Office**

NBCBN-SEC office, Hydraulics Research Institute – Cairo - Egypt

#### **Beneficiaries**

Water Sector Professionals and Institutions in the Nile Basin Countries

#### **Short Description**

The idea of establishing a Knowledge Network in the Nile region emerged after encouraging experiences with the first Regional Training Centre on River Engineering in Cairo since 1996. In January 2002 more than 50 representatives from all ten Nile basin countries signed the Cairo Declaration at the end of a kick-off workshop was held in Cairo. This declaration in which the main principles of the network were laid down marked the official start of the Nile Basin Capacity Building Network in River Engineering (NBCBN-RE) as an open network of national and regional capacity building institutions and professional sector organizations.

NBCBN is represented in the Nile basin countries through its nine nodes existing in Egypt, Sudan, Ethiopia, Tanzania, Uganda, Kenya, Rwanda, Burundi and D. R. Congo. The network includes six research clusters working on different research themes namely: Hydropower, Environmental Aspects, GIS and Modelling, River Morphology, flood Management, and River structures.

The remarkable contribution and impact of the network on both local and regional levels in the basin countries created the opportunity for the network to continue its mission for a second phase. The second phase was launched in Cairo in 2007 under the initiative of; Knowledge Networks for the Nile Basin. New capacity building activities including knowledge sharing and dissemination tools, specialised training courses and new collaborative research activities were initiated. The different new research modalities adopted by the network in its second phase include; (i) regional cluster research, (ii) integrated research, (iii) local action research and (iv) Multidisciplinary research.

By involving professionals, knowledge institutes and sector organisations from all Nile Basin countries, the network succeeded to create a solid passage from potential conflict to co-operation potential and confidence building between riparian states. More than 500 water professionals representing different disciplines of the water sector and coming from various governmental and private sector institutions selected to join NBCBN to enhance and build their capacities in order to be linked to the available career opportunities. In the last ten years the network succeeded to have both regional and international recognition, and to be the most successful and sustainable capacity building provider in the Nile Basin.

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FOREWORD

This report is one of the final outputs of the research activities under the second phase of the Nile Basin

Capacity Building Network (NBCBN). The network was established with a main objective to build and

strengthen the capacities of the Nile basin water professionals in the field of River Engineering. The first phase

was officially launched in 2002. After this launch the network has become one of the most active groupings in

generating and disseminating water related knowledge within the Nile region. At the moment it involves more

than 500 water professionals who have teamed up in nine national networks (In-country network nodes)

under the theme of "Knowledge Networks for the Nile Basin". The main platform for capacity building

adopted by NBCBN is "Collaborative Research" on both regional and local levels. The main aim of collaborative

research is to strengthen the individual research capabilities of water professionals through collaboration at

cluster/group level on a well-defined specialized research theme within the field of River and Hydraulic

Engineering.

This research project was developed under the "Local Action Research Modality" which has a main objective to

contribute to the capacity building process at local level and enhance the collaboration among the researchers

and institutions in the same country. This activity is the core activity of all NBCBN nodes and is contributing

to the establishment of the in-country network.

This report is considered a joint achievement through collaboration and sincere commitment of all the

research teams involved with participation of water professionals from all the Nile Basin countries, the

Research Coordinators and the Scientific Advisors. Consequently the NBCBN Network Secretariat and

Management Team would like to thank all members who contributed to the implementation of these research

projects and the development of these valuable outputs.

Special thanks are due to UNESCO-IHE Project Team and NBCBN-Secretariat office staff for their

contribution and effort done in the follow up and development of the different research projects activities.

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This research fills a pressing need to increase knowledge on the hydrology of the Nile Basin Burundi. In the context of this research, 11 rivers have been targeted in sub-basins with different lithology, vegetation and various population density.

After analyses, it emerges that the rivers from upstream to downstream, given the factor of vegetation coverage and stand, undergo changes in their physico-chemical properties. Indeed, the rivers flowing into areas with dense vegetation experiencing low turbidity vis-à-vis those passing through populated areas and reduced vegetation coverage. On a river whose waters are gray upstream, we pass a water color in red and heavily laden with sediment.

The study revealed that the chemical composition of water varies in relation to the rainy seasons related to the dry season. Organic materials such as nitrites, nitrates, phosphates are present in the water of rivers more in the rainy season than dry season. Dissolved oxygen is more important in periods of dry seasons because of the reduce of solids suspensions.

Another observation is that regions with high density and using chemical fertilizers have an impact on water pollution especially organic materials such as phosphates and nitrogenous matter.

The lithology of the sub-watershed is reflected in the chemical composition of river water. Thus, the river crossing basic- and ultrabasic rocks are rich in base cations Ca<sup>2+</sup> and Mg<sup>2+</sup> while acidic lithologies have a low rate in these elements. The grain sizes of sediments show also different spreads from these lithologies.

GIS Geographical Information System IGEBU Institut Géographique du Burundi.

ISABU Institut des Sciences Agronomiques duBurundi.

MES Suspended solids

NBCBN-RE: Nile Basin Capacity Building Network for River Engeneering.

NBI Nile Basin Initiative.TAC Alcalinity TitrationTDS Total dissolved solids.

#### 1 INTRODUCTION

The study of the hydrological basin of the Nile Basin is now an urgent necessity. Indeed, under the initiative of the Nile, the Nile countries have developed several frameworks including the project "Nile Basin Capacity Building Network River Engineering (NBCBN-RE). The latter is responsible for strengthening the capacity of researchers from the Nile Basin Countries.

This study falls within this framework and focuses on the physico-chemical and grain size analysis of rivers, the lithology and geology study of watersheds in which these rivers flow.

An analysis of the impact of the degree of vegetal coverage, density of population of these watersheds on the various properties mentioned above, is an objective of this study. Also, it is to see to what extent the lithology may be reflected in the chemical composition and physical properties of these rivers. After discussing the objectives and methodology adopted in this study, the analysis results will be presented and subsequently interpreted. Finally, a conclusion and recommendations will be delivered to the reader.

#### 2 OBJECTIVES OF THE STUDY

The main objectives of the study were to:

- Analyze of the turbidity, chemistry, mineralogy and grain size of some Nile rivers from some target sub-catchments;
- Analyze the lithology of the identified catchments areas;
- Analyze the interrelation between the data related to the vegetal coverage and the density of the population.

#### 3 METHODOLOGY

- First, sub-catchments with homogenous lithology have been identified.
- Second, water and suspended matters have been sampled using 5liters plastic bottles for the chemical analysis and also the turbidity. Likewise, sediments in 1.15 m deep along the rivers have been also sampled. The physico-chemical parameters that vary greatly with time were measured on site immediately after water sampling. These parameters are: temperature, conductivity, pH, salinity and TDS (total dissolved solids).
- The alkalinity (TAC), the dissolved oxygen and oxidizability of potassium permanganate have been done at the University of Burundi, Chemistry Department, whereas the grain size analysis using sieving, washing and sedimentation methods were carried out at the Applied Sciences Faculty, Soil Mechanics Department.
- The measurement of chlorides, sulfates, lead, manganese, iron, zinc and ammonium ions, nitrate, nitrite and phosphate has been done by the ISABU (Institute des Sciences Agronomiques du Burundi).
- The coordinates of all sampled-positions have been fixed using GPS methods. Also, the geological mapping of the target sub-catchments have been supported by the same GPS method. The coordinates have been transformed in Maps using GIS-Arcview.
- Two sampling periods, rain and dry seasons, have been considered so that we can appreciate the effect of the erosion through turbidity.
- An interpretation of the results will be the output of the research and some recommendations will be delivered.

#### 4 GEOGRAPHICAL POSITION OF BURUNDI

The Republic of Burundi is located in Central Africa in the East of the Democratic Republic of Congo, in the South of Rwanda, and in the West of the United Republic of Tanzania. Its area is 27834km2 with about 8 million inhabitants (Population statistics, 2008). Burundi is a land locked country lying between 29°0' as shown in figure (4.1) below.

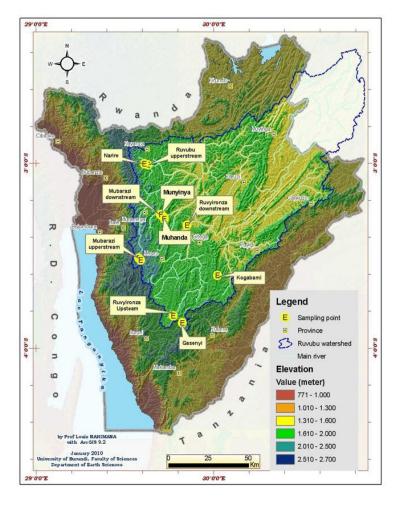


Figure 4.1: Geographical location of Burundi and sampling areas

The waters of Burundi are distributed in two major catchments area: The Congo Basin and the Nile Basin. The line sharing of these waters is called "Crête Congo-Nil" or "Congo-Nil". It is so called because all the waters are at its western part flows to Lake Tanganyika, which belongs to the Congo Basin, whereas, opposed to those, at its eastern part, they drained to Nile Basin system.

Burundi is in the upland region of Eastern Africa. Its terrain consists of large morphological compounds:

- Areas with low altitude, the Imbo plain along the western border of the country, Moso
  Mosodepression along the Rumpungwe river and the Maragarazi depressions of the south
  and south-east.
- The Mirwa highlands area with an overlook on the plain Imbo (altitude higher than 2000m).
- The central plateaus are a set of hills where the average altitude is 1800m.

### 5 PHYSICAL, GEOLOGICAL AND HYDROLOGICAL DESCRIPTION OF THE STUDIED AREAS

Eleven rivers in the following 4 sub-catchments were analyzed: Munyinya, Mubarazi upstream, Mubarazi downstream, Ruvubu upstream, Narire, Kogabami, Ruvyironza upstream, Ruvyironza downstream, Muhanda and Gasenyi rivers.

#### a. Mubarazi upstream sub-catchment area

It is located in Mugamba-Bututsi natural region. This encompass Mubarazi upstream with many tributaries as Karuyenzi and Kigezi river. Ruvyironza upstream and its affluents Gasenyi and Kigira are located further in the south, figure (5.1). The lithology is mainly composed of basic rocks and randomly some shale. The valleys are occupied by recent organic sediments. The ultra-basic rocks are found around the Kigira river. However, the latter has its source in the quartzites.

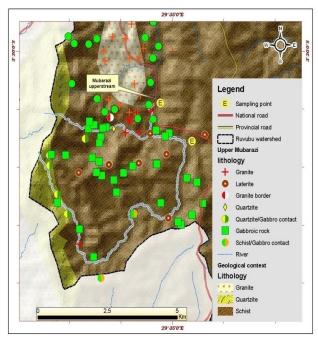
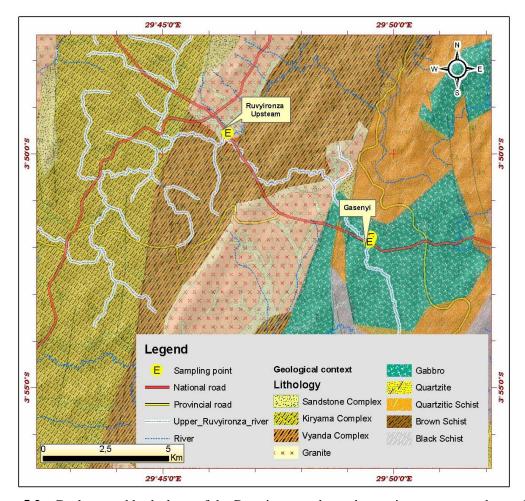


Figure 5.1: Geology and hydrology of the Mubarazi sub-catchment in uperstream area.

The western part which is directly linked to the Congo-Nile ridge (including the mountain range Mukike) is strongly steep. From Mubarazi upstream to Kigezi, the altitude slow down when it undergoes the central plateaux. The Mubarazi river is also a tributary to Ruvubu river.



**Figure 5.2:** Geology and hydrology of the Ruvyironza sub-catchment in upstream and sampling area

This area is low populated and the landscape is endowed of very rich and different natural vegetations which consist of grasses, bushes dotted with shrubs, and some bamboussaies eucalyptus, etc... We find also food crops (maize, wheat ...) and industrial crops such as thee.

#### b. Kogabami sub-catchment area

This area is located in the center of the natural region Kirimiro. Lithologicaly, it is largely made up of basic rock outcrops which are in the upper bed of the Kogabami sub-catchment. These outcrops are also in contact with metasediments which are highly altered and provide a soil with a reddish colour. The East part is formed by a large gently sloping hill whereas the right one more or less fresh ist. The western part has relatively higher slopes.

The Kogabami river flows into the Nyakijanda river and the latter is a tributary of the Ruvubu river. In Kirimiro natural region, the vegetation is almost inexistent. Apart the west and south parts which are occupied by pine, eucalyptus and natural herbs, the rest is widely cultivated. Many sorts of culture are practised because of a high density of the population in this region and fertilizers are used in agriculture.

#### c. The Munyinya Sub-catchment, Gatabo area

Like the previous sub-basin, this area is in the Kirimiro natural region. The rocks encountered along the Mubarazi downstream and the Munyinya rivers are basic, as in figure (5.3). There are also enclaves of meta-

sediments (shale), sandstone mixed with locally shale rich in quartzite (the west part); shales (especially in the north-west part, eastern and south-eastern part). Moreover, there are sediment deposits in the valley. Furthermore, in the south side of the Muhanda River, we find granite.

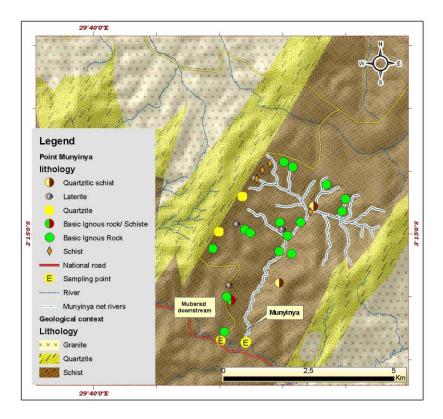
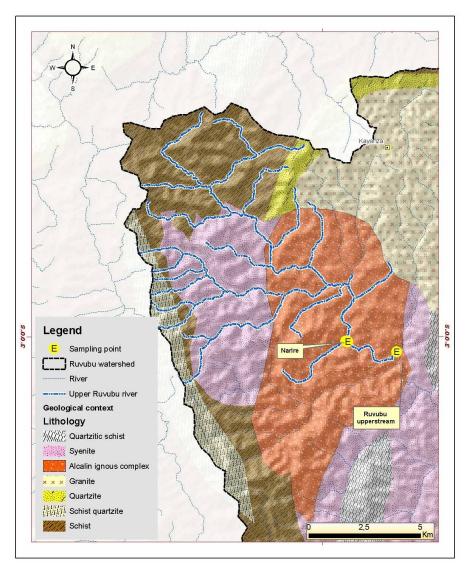


Figure 5.3: Geology, hydrology and sampling area of the Munyinya sub-catchment

The landscape of the Munyinya sub-catchment shows in general rounded hills which are separated by talwegs. As well as the sides around Munyinya river, the upstream area shows a steep topography which is interspersed with valleys. The area is drained by the Munyinya river with its tributarie. The Munyinya river flows into the Mubarazi which equally flows to the Ruvubu river. The natural vegetation is absent. Very rarely we find grass, eucalyptus and cedar. Food crops are uninterrupted cultivated by the population because of the high density and fertilizers are in use by agriculture.

#### d. Ruvubu upstream sub-catchment area

It lies north of the country in the Buyenzi natural region, but closer to Mugamba natural region. We can distinguish syenites rocks (along the Ruvubu and Narire river (figure (5.4)) and metasedimentary formations: schisto-quartzites. We can quote the presence of granitic-gneiss formations in the upper reaches of the Ruvubu and recent deposits in the marshes situated between 1400 and 1900 m altitude; this area is part of the north Congo-Nile watershed. From the crest to the east, there is a stepwise gradually decreasing of the relief. In the central highlands, we have hills formations.



**Figure 5.4:** Geology, hydrology and sampling downstream area of the Ruvubu sub-catchment by Buyenzi natural region.

The Ruvubu sub-catchment is high populated and therefore the human occupation is high and the terrain is 100 % exploited with diverse cultures. Ruvubu is the main river in Burundi and Mubarazi and Narire are their tributaries.

#### 6 PHYSICO-CHEMICAL ANALYSIS RESULTS

The results of the chemical analysis are illustrated with graphs (Fig. 6.1 to 6.18).

- **6.1.** Interpretation and Discussion of the Results.
- Physical parameters
- The temperature

Regarding the change in temperature, we have low values of temperature for the areas near the Congo-Nile high altitude, oscillating around 17 and 18  $^{\circ}$ C while the remaining areas in the central plateau regions where the temperature varies from 21 to 25  $^{\circ}$  C.

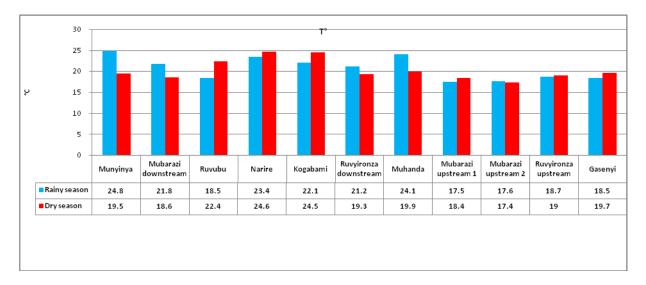


Figure 6.1: Temperature variation in rainy and dry season

#### • Suspended solids (M.E.S)

Comparing the turbidity, we can observe that the latter is lower in the south region: (Mubarazi upstream subcatchment, Kigira and Karuyenzi than in the north (Buyenzi and Kirimiro region): Narire sub-catchment, Mubarazi downstream and Muhanda. This is related to the low density of the population and the high rate of the vegetal coverage in the south part of our studied area. In contrary, the north region is very densely populated and almost the all surface is cultivated. The consequence is a high rate of soils erosion which are conducted in the valleys and ins rivers increasing their turbidity. This turbidity can be appreciate only on the waters colour, so for example, considering the Mubarazi river, it is grey in south (Mubarazi upstream) and reddish in the north part (Mubarazi downstream), indicating the transport of altered soils rich in iron.

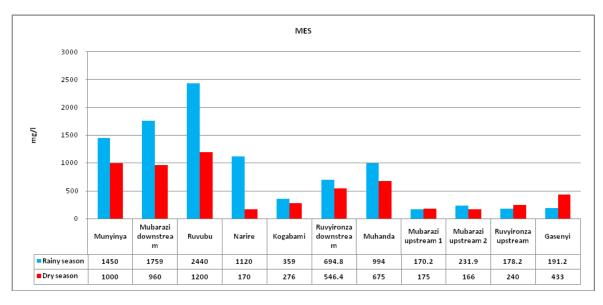


Figure 6.2: MES variation by rainy and dry season

#### • Total dissolved solids (TDS)

The rivers situated in the upstream part of the main rivers, Ruvubu and Mubarazi, are poor in TDS. This is linked to the high vegetal coverage rate and the low density of the population in the south region, Mugamba and Bututsi. In contrary, the downstream of those rivers are more loaded in dissolved salts (Fig. 4). Another consideration is that the TDS in dry season in very high compare to the rainy season. This is due to the high temperature in dry season which produce a high water evaporation and consequently a concentration of salts whereas in rainy season, we have a dilution effect on the salts.

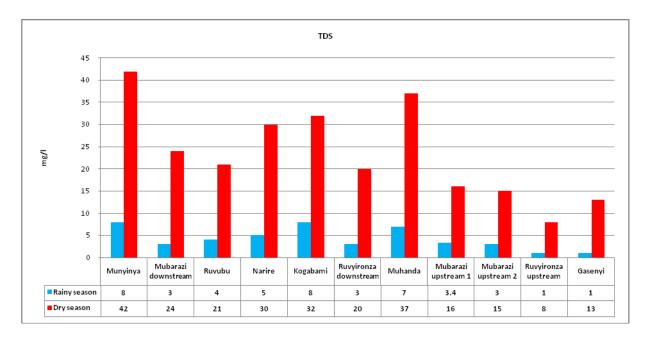


Figure 6.3: TDS variation by rainy and dry season

#### Conductivity

The conductivity of water is a physico-chemical capacity of the water to carry the electricity. This latter depend on the presence of ions in water. High rate in ions produced a high conductivity. In our eleven sampling sites, differences were observed. These differences are due to the mineralogical composition of rocks in their sources and possibly the quality and quantity of discharges.

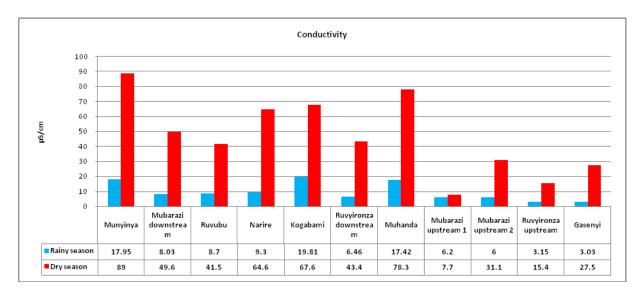


Figure 6.4: Conductivity variation by rainy season and dry season

Also, in dry season, related to the high TDS (Fig.4), the conductivity is comparatively high than in rainy season. There is a positive correlation between TDS and conductivity because of the presence of more concentration in salt.

#### pH

The pH varied from river to river. It varies between 5,7 to 8,2. In our case study, a high value of pH indicated the presence of basic rocks. The average of the results shows a pH value larger indicate a acidic rock.

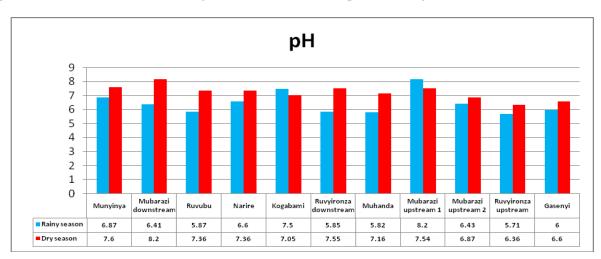


Figure 6.5: pH variation by rainy and dry season

#### CHEMICAL ANALYSIS

#### $\bullet$ N-NO<sub>3</sub> and N-NO<sub>2</sub>

The results show that we have higher levels for nitrites compare to nitrate and ammonium nitrate in the various rivers concerned by our study. These ions are unstable and toxic (nitrite) to aquatic organisms and especially for fish. Their high rate lead to pollution.

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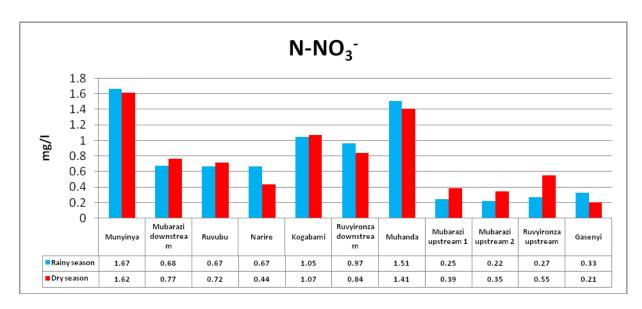


Figure 6.6: N- NO3 variation by rainy and dry season

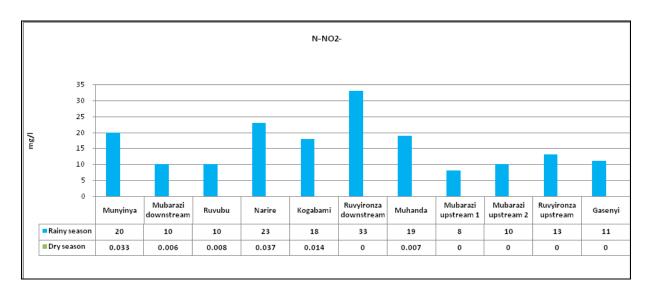


Figure 6.7: N- NO2 variation by rainy and dry season

#### • The $PO_4^{3}$

The rivers of the south part of our investigations, Mugamba and Bututsi natural regions, contain any PO<sub>4</sub> <sup>3-</sup> (Mubarazi upstream1 and 2, Kigira). This situation is related to the high vegetal coverage and to the agricultural practice which do not use chemical fertilizer. At contrary, PO<sub>4</sub> <sup>3-</sup> is present by the rivers flowing in the north part of our study area because of the low vegetal coverage, the high population and the use of chemical fertilizer even in low rate (illustrated by the photos 2 to 5).

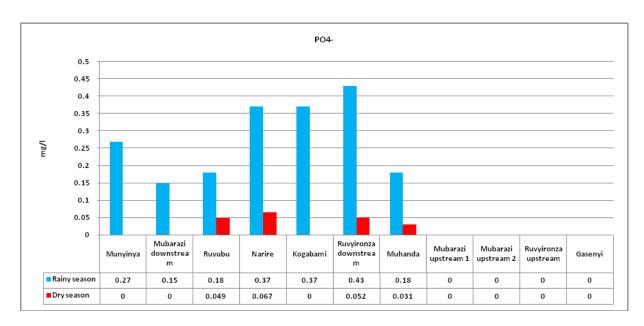


Figure 6.8: PO4 variation by Rainy and dry season

#### Chlorides

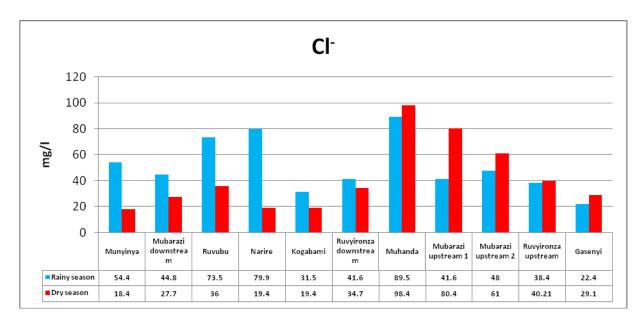


Figure 6.9: Cl variation by RS and DS of the rivers

All sites we sampled showed chloride ranging from 22.4 to 89.5 mg / 1.

#### **❖** Lead (Pb)

The results show a total absence of lead all samples. The Knowing that the main sources of lead are cars or industrial rejections confirm that Burundi belongs to none industrial countries.

#### ❖ Zinc (Zn)

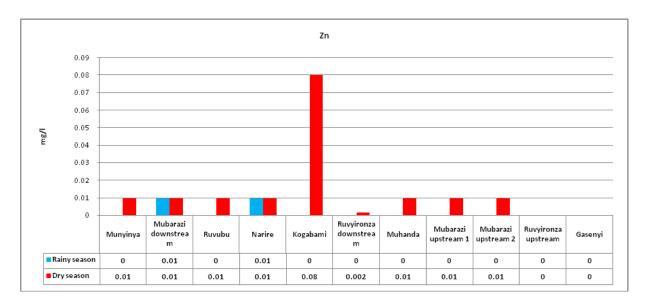


Figure 6.10: Zinc variation in rainy and dry season

The rate of Zinc is very low and is almost inexistent in rainy season. But, the river Kogabami has a relatively high rate compare to the other rivers. This exceptional Zn content in this river has to be further analyzed.

#### Sulphates

The values found in our analysis show that there is a marked difference depending on the rivers. They vary from 0.4 to 12.1mg / l. Further investigations in the second phase of our study will probably reveal the origin of this. The rivers situated in south, upstream of the main rivers, Ruvubu, Mubarazi and Ruvyironsa, are very poor in sulfates. This can be interpreted as due to lithology or the not use of fertilizer.

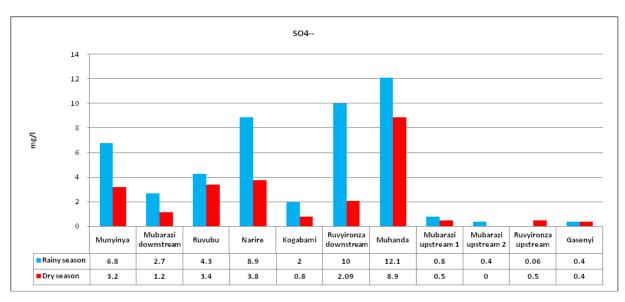


Figure 6.11: SO4 variation by rainy and dry season

#### The Iron

According to the results obtained, iron is to correlate with a high turbidity. Another observation is that presence of high rate in sulphate can refer also to a high turbidity. This sulphates are associated with ferric and ferrous ions which are also to connect with a high turbidity.

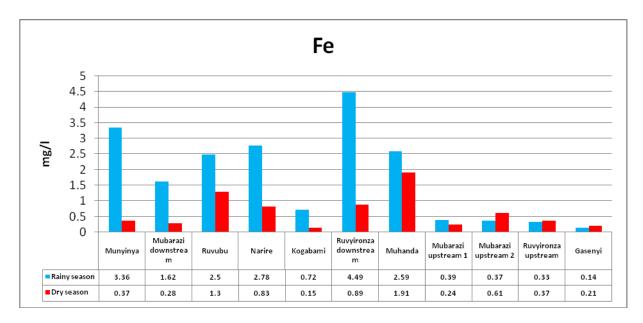


Figure 6.12: Fe<sup>-</sup> variation by rainy and dry season

#### Manganese

Manganese is present in all rivers concerned in few amount (0.37 mg / 1 maximal). This is due to the nature of the terrain crossed, where dissolved salts contain some Mn.

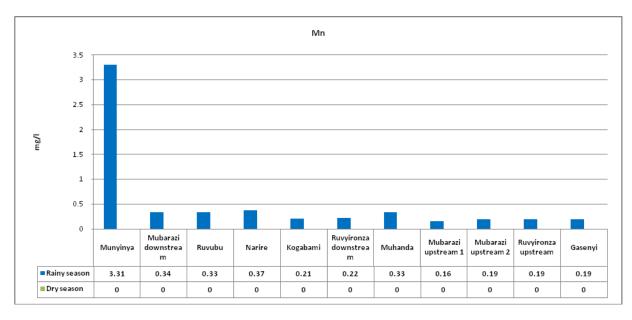


Figure 6.13: Mn variation by rainy and dry season

#### Calcium and Magnesium

We have levels of  $Ca_2^+$  and  $Mg_2^+$  ranging from 1.47 to 8.92 mg/l for  $Ca_2^+$  + and 0.31 to 4.61 mg/l for  $Mg_2^+$ . The content of  $Ca_2^+$  greater than  $Mg_2^+$ . Normally, calcium and magnesium are to refer to the presence of basic rocks.

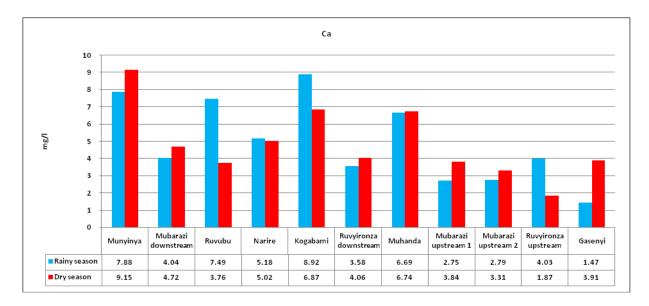


Figure 6.14: Ca variation by rainy and dry season

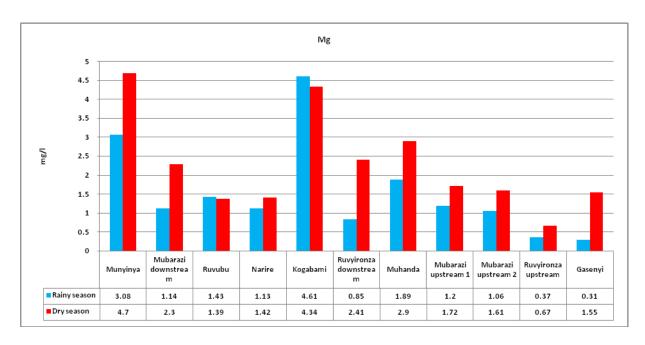
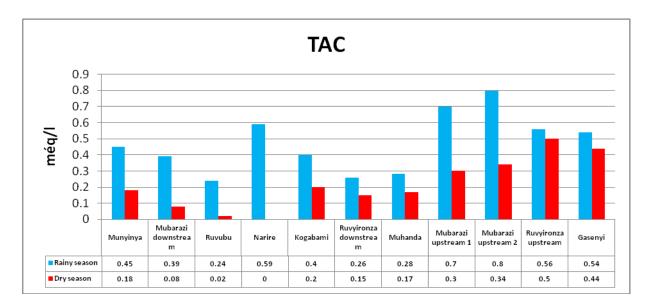


Figure 6.15: Mg variation by rainy and dry season

#### The TAC (alcalimétrique complete title)

The results show that there is a little amount of  $CO_3^{2-}$ ,  $OH^-$  and  $HCO_3^-$  in all rivers (1 meq / 1). It means that the alkalinity for those rivers is very low and this is to correlate with the pH which is around 7.



**Figure 6.16**: TAC<sup>-</sup> variation by rainy and dry season.

#### Dissolved oxygen

There is no relevant variation of dissolved oxygen along the time. However in all rivers sampled the dissolved oxygen levels are still lower than that of dissolved oxygen saturation (8.11 to 8.84 mg oxygen / l). If the temperature varies between 20 and 25  $^{\circ}$  C this indicates that despite the constant renewal of dissolved oxygen due to contact of water with the atmosphere, part of the oxygen is consumed by the substances present in water.

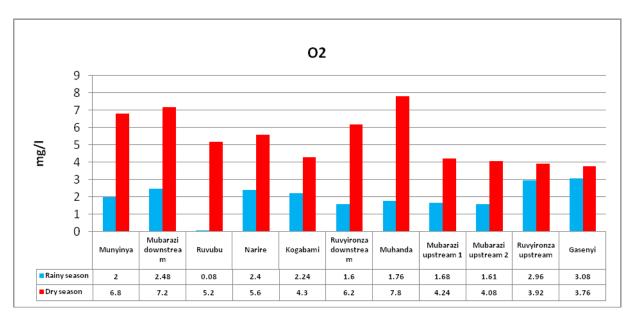
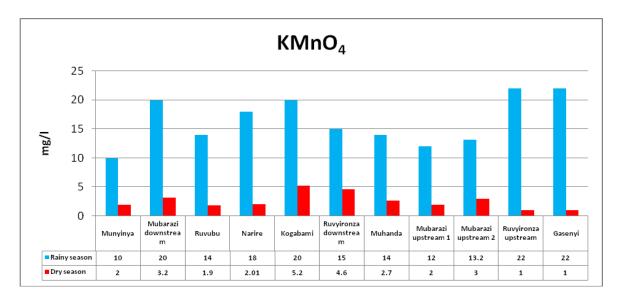


Figure 6.17: O2 variation by rainy and dry season

We can quote also that the amount of dissolved oxygen is higher in dry season than in rainy season. The raison is that in dry season, there is an effect of ions-concentration related to the evaporation and also, there are ions-flow from the groundwater into the rivers coming from the leaching of superficial rocks.

#### Oxidizability in KMnO4

An increase in discharges of organic matter in rivers logically translates an increase in oxidizability of KMnO4. The values ranges are from 12 to 22 mg of oxygen/l. It shows indeed that in these rivers there are high quantities of oxidizable organic substances.



**Figure 6.18:** KMnO4 variation by rainy and dry season.

#### 7 GRAIN SIZE ANALYSIS

The size analysis is the easiest way to characterize the soil and to classify the various particles by size. It can be done by:

- Screening for items above 0.63 mm in diameter
- Sedimentation for fine particles

Considering the results given by the size analysis, we find out that:

- For the sample of area 1 (Karuyenzi), the soil is composed mainly of silt (70%), sand (20%) and some clay (10%). In this soil there was no gravel.
- For the sample of area 2 (Kigira-Rutovu), the soil consists of a large portion of sand (65%), silt (34%) and just 1% gravel)
- For the sample from zone 3 (Coga ca Taba), the soil is dominated by the silt fraction (52%), sand average of 43% and a small fraction of gravel (5%). The clay fraction does not exist in this area.
- Regarding the sample area 4a (Muhanda), the sand fraction dominates with 55%. The silt fraction is in the proportions of 45%. The gravelly and clay fraction in the sample do not exist.
- For the sampling area 4a (Munyinya), the results show that the soil is composed largely of silt (78%) and sand (22%).
- For the sample of zone 5 (Narire), the results show that the soil is composed largely of silt (66%), sand (32.5%) and a bit of gravel (1.5 %).

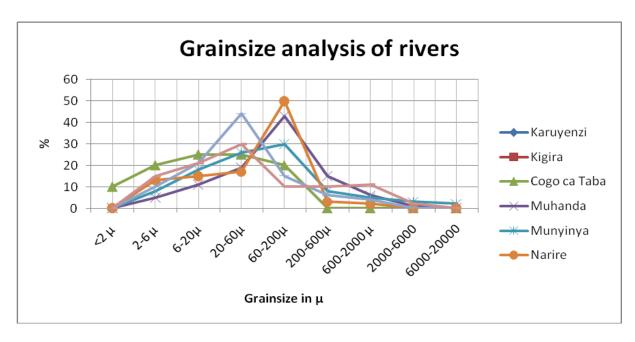


Figure 7.1: Grainsize analysis of rivers

The analysis of granulometric curves shows that Karuyenzi is a sandy silt with little clay while Rutovu - Kigira is a silty sand with little gravel. As for curves Narire and Muhanda, respectively, we have a sandy loam and very gravelly loamy sand or gravel without clay. In contrary, the soil of Munyinya is a sandy-silt whereas that of Narire is a silt-sand but with very few gravel.

#### 8 CONCLUSIONS AND RECOMMENDATIONS

#### Chemical analysis

Considering the nitrogen content in the rivers, we find out that it is more present in the Kirimiro natural region area. It represents a pollution factor which is related to the use of chemical fertilizers in this region because of its high population. Each peasant try to maximize the agricultural production on very limited field (less than half hectare for one family of an average of 5 persons).

The low dissolved oxygen content in almost all rivers indicates the presence of biodegradable materials, while the high oxidizability of KMnO4 indicate a high rate of organic materials and inorganic oxides. There is some discrepancy regarding the rate of solid suspended matters in the different rivers. This is due to the different lithological composition of the rocks in the considered sub-catchment and also on the stage of the rocks weathering and finally the steep of the slope.

#### Grain Size analysis

The high rate of silt composition by Karuyenzi in Mugamba natural region is due to the presence of a basic rock in this sub-catchment. However, we find also some sand due to the fact that these rivers originate in Mukike which is composed of quartzites and pelitic metasediments. The predominance of sand in the river Kigira is due to the presence of quartzite in an basic rocks environment which altered in silt. The sub catchment of Narire is characterized largely by a lithology composed of deeply weathered basic rocks. The soil dominated by silt and sand is generated from a metasedimentary rock.

The Muhanda river cross a granite rock before flowing into Nyabuyumbu and the latter in the Mubarazi The soil of the area is dominated by a sandy-loam. The sand comes from the weathering of granite giving an arena. The sand, through erosion, settle in the bottom of Muhanda and its surroundings.

The Munyinya sub-basin includes two main lithologies namely basic rocks which occupy a large part of the slope, the quartzite on the crest and on certain points, there are enclaves of schists. The presence of basic rocks (gabbro) and quartzites conduct to the nature of sediments found in river Munyinya: predominantly of silt and sand in less amount.

Finally, the river Narire cross a lithology dominated by a syenite. Therefore, we have a high composition in silt, gravel in medium and less gravel. Considering the results of all analysis, we can conclude that the rivers in the Burundi Nile Basin area are not extremely polluted. The pollution is higher in rivers crossing areas with high rate of population density and with a high rate of agricultural activities which lead to a high rate of erosion. The latter conduct to a high turbidity of the rivers.

Chemically, the rivers are polluted with phosphates and Nitrates but only in the high populated areas because of the use of chemical fertilizers. Heavy Metals as Lead, Zinc, Mn are almost inexistent. This is related to the low rate of industrializing of the country.

The recommendation will be to continue the study on the other rivers so that we can catch a good picture of the all composition of the all rivers in the Nile Basin catchment-Burundi.

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Photo 1: NBCBN Team researchgroup Burundi



Photo 2: Mubarazi upstream 2 river by Karuyenzi

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Comments: Water is grey and very poor in turbidity because of the good vegetal coverage.



Photo 3: Mubarazi upstream 1 river by Karuyenzi

Comments: Water is clear and very poor in turbidity because of the good vegetal coverage.



Photo 4: Mubarazi by Gatabo (downstream area in Kirimiro natural region).

Comments: The same Mubarazi river but downstream with high iron content due to the high rate of weathering and erosion, high population density and low vegetal coverage.

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Photo 5: Ruvyironza river (downstream area by Kirimiro natural region).

Comments: Redish water related to high rate of erosion and high population density and low vegetal coverage in this region. The turbidity is very high.



# Analysis of the Nature of the Sediments Load in the Nile Basin, Burundi Case

The study of the hydrological basin of the Nile Basin is now an urgent necessity. Indeed, under the initiative of the Nile, the Nile countries have developed several frameworks including the project "Nile Basin Capacity Building Network River Engineering (NBCBN-RE). The latter is responsible for strengthening the capacity of researchers from the Nile Basin Countries.

This research fills a pressing need to increase knowledge on the hydrology of the Nile Basin Burundi. In the context of this research, 11 rivers have been targeted in subbasins with different lithology, vegetation and various population density. After analyses, it emerges that the rivers from upstream to downstream, given the factor of vegetation coverage and stand, undergo changes in their physico-chemical properties. Indeed, the rivers flowing into areas with dense vegetation experiencing low turbidity vis-à-vis those passing through populated areas and reduced vegetation coverage.

Publisher: The Nile Basin Capacity Building Network, 2010