

**ASSESSMENT OF ENVIRONMENTAL IMPACTS OF POOR  
WASTE DISPOSAL ON WATER QUALITY.**

A Case study; River Rwizi, Mbarara Municipality, Western Uganda

**BY**

MUMANYE ROLAND

BU/UG/2011/180



**Supervisor**

M/s GIMBO REBECCA

DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL ECONOMICS

**A DISSERTATION SUBMITTED TO FACULTY OF NATURAL RESOURCE AND  
ENVIRONMENTAL SCIENCES FOR THE PARTIAL FULFILLMENT FOR THE  
REQUIREMENTS OF THE AWARD OF A BACHELOR OF SCIENCE IN  
NATURAL RESOURCE ECONOMICS OF BUSITEMA UNIVERSITY.**

**JUNE 2014**

## DECLARATION

I hereby declare that the work in this dissertation is my own original work arrived at through literature review and fieldwork under the guidance of my supervisor and the help of the water quality technicians of National Water & Sewerage Corporation-Mbarara. To the best of my knowledge, it has never been submitted for any academic award in any other university or higher institution of learning. In all cases where other people's ideas were used, they have been duly acknowledged by complete references.

Full name of Student: Mumanye Roland

Signature: Roland.....

Date: 30/06/2014.....

**APPROVAL**

This work has been thoroughly supervised and approved to have fulfilled the requirement leading to the award of a bachelor of science in Natural Resource Economics of Busitema University. Therefore, this dissertation has been submitted for examination with the approval of the supervisor.

Signature

.....

M/s Gimbo Rebecca

Date.....

## **DEDICATION**

I dedicate this dissertation to my parents Mr. Mugizi Robert and Mrs. Edriḍah Mugizi  
**May God bless you**

## **ACKNOWLEDGEMENT**

It was not my capability or aptitude neither was it my prospective to carry out the research successfully, nor my knowledge to prepare this dissertation systematically but the total will and mercy of the Divine Creator who granted me life, wisdom and knowledge. I wish to express my heartfelt appreciation to my Supervisor, M/s Gimbo Rebecca for the patience, guidance and encouragement in shaping this research study up to the last minute. I am also grateful to staff members at the Department of Natural Resources Economics, Namasagali campus, Busitema University. I am deeply indebted to management and staff of the National Water and Sewerage Corporation (NWSC) analytical laboratory-Mbarara area for the kind of assistance offered to me at various stages during the research. I am greatly indebted to my parents and relatives and with sincere gratitude, I acknowledge especially my parents for the moral, material, financial and spiritual support they rendered me before, during and after the course, my sister and brothers who have always stood by side to support and encourage me. Also in special way, I thank my classmates and the entire Christian union of Namasagali campus Busitema University. Thank you for the moral support and a shoulder to lean on.

TO ALL, I SAY; MAY YOU BE BLESSED!

## Table of Contents

DECLARATION .....	i
APPROVAL .....	ii
DEDICATION .....	iii
ACKNOWLEDGEMENT.....	iv
List of figures .....	ix
List of tables.....	x
List of plates.....	x
List of abbreviations.....	xi
ABSTRACT.....	xii
Chapter one: General Introduction.....	1
1.1 Background of the study .....	1
1.2. Problem statement: .....	2
1.3 Objectives of the study.....	2
1.3.1. General objective .....	2
1.3.2 Specific objectives .....	2
1.4 Research questions; .....	3
1.6 Justification of the study; .....	4
1.7 Significance of the Study .....	4
1.10 Operational Definitions .....	5
Chapter two: Literature review.....	6
2.1 Introduction.....	6
2.2 Water pollution due to industrial activities .....	6
2.3 Impacts of sewage effluents .....	7
2.4 Source water management.....	8
2.4.1 Surface water pollution .....	8
2.5 Watershed monitoring.....	9

2.5.1 Land use surveys.....	9
2.5.2 Water quality monitoring.....	9
2.5.3 Microbiological water quality monitoring.....	10
2.6 Effects of nutrients in the water.....	11
2.7 Effects associated with bacterial pollution.....	11
2.8 Biodegradable organic substances.....	12
Chapter three: Methodology.....	15
3.1 Introduction.....	15
3.2 Study area.....	16
3.2.1 Location.....	17
3.2.2 Study population.....	17
3.3 Research design.....	16
3.4 Sampling procedure.....	17
3.5 Sample analysis.....	17
3.6 Data analysis.....	19
Chapter Four: Results and Discussions.....	19
Introduction.....	19
4.2 Electrical conductivity trends.....	23
4.3 Turbidity trends.....	24
4.4 Color trends.....	25
4.5 Nutrients(Phosphorus, Nitrates, Nitrites) trends.....	26
4.5.1 Phosphorus trends.....	26
4.5.2 Nitrates trends.....	27
4.5.3 Nitrites trends.....	27
4.6 Total alkalinity, Total hardness. Total acidity trends.....	28
4.6.1 Total alkalinity trends.....	28
4.6.2 Total hardness trends.....	29

4.6.3 Total acidity trends.....	29
4.7 Bacteriological analysis trends.....	30
4.8.1 Temperature trends.....	31
4.8.2 Oxygen concentration trends.....	32
4.9 Temporal trends of the water quality parameters in different sites.....	33
4.9.1 Site 1.....	34
4.9.1b Total alkalinity, total acidity, total hardness and conductivity trends in different months.....	35
4.9.2 Site 2.....	36
4.9.2a Oxygen concentration, Nitrates, Nitrites, Phosphorus, Temperature mean value trends in different months.....	36
4.9.2b Total alkalinity, total acidity, total hardness and conductivity trends in different months.....	38
4.9.3 Site 3.....	39
4.9.3a Oxygen concentration, Nitrates, Nitrites, Phosphorus, Temperature mean value trends in different months.....	39
4.9.3b Total alkalinity, total acidity, total hardness and conductivity trends in different months.....	40
4.9.4 Site 4.....	41
4.9.4a Oxygen concentration, Nitrates, Nitrites, Phosphorus, Temperature mean value trends in different months.....	41
4.9.4b Total alkalinity, total acidity, total hardness and conductivity trends in different months.....	42
4.9.5 Site 5.....	43
4.9.5a Oxygen concentration, Nitrates, Nitrites, Phosphorus, Temperature mean value trends in different months.....	43
4.9.5b Total alkalinity, total acidity, total hardness and conductivity trends in different months.....	44
4.10 Relationships between different water parameters.....	45
4.10.2 PH and Turbidity.....	46
4.10.4 Nitrates and Turbidity.....	48
Chapter Five: Conclusions and Recommendations.....	49
Introduction.....	49



5.1 Conclusions.....	49
5.2 Recommendations and future research.....	50
LIST OF REFERENCES.....	51
APPENDICES.....	53
APPENDIX 1: Plates showing some of the selected sampling sites.....	53
APPENDIX 2: Plates showing the view of river Rwizi at different sampling sites.....	54
APPENDIX 3: Plates showing the laboratory of NWSC and measurement of waste water from water treatment plant.....	55

## List of figures

Figure 3.1: Map of river Rwizi in Mbarara municipality showing the locations of sampling sites.

Figure 4.1: PH trends at the different sampling sites during the sampling period.

Figure 4.2: Electrical conductivity trends at the different sampling sites during the sampling period.

Figure 4.3 Turbidity trends at the different sampling sites during the sampling period.

Figure 4.4 color trends at the different sampling sites during the sampling period.

Figure 4.5 Nitrates, Nitrites, Phosphorus trends at the different sampling sites during the sampling period.

Figure 4.6 total alkalinity, total acidity, total hardness trends at the different sampling sites during the sampling period.

Figure 4.7 Bacteriological analysis trends at the different sites during the sampling period.

Figure 4.8 Temperature, oxygen concentration trends at the different sampling sites during the sampling period.

Figure 4.9.1 O<sub>2</sub>, NO<sub>3</sub>, NO<sub>2</sub>, P, TEMP trends for site 1 in different months.

Figure 4.9.2 Total alkalinity, total acidity, total hardness, conductivity trends for site 1 in different months.

Figure 4.9.2 O<sub>2</sub>, NO<sub>3</sub>, NO<sub>2</sub>, P, Temp trends for site 2 in different months.

Figure 4.9.4 Total alkalinity, total acidity, total hardness, conductivity trends for site 2 in different months.

Figure 4.9.3 O<sub>2</sub>, NO<sub>3</sub>, NO<sub>2</sub>, P, Temp trends for site 3 in different months.

Figure 4.9.6 Total alkalinity, total acidity, total hardness and conductivity trends for site 3 in different months.

Figure 4.9.4 O<sub>2</sub>, NO<sub>3</sub>, NO<sub>2</sub>, P, Temp trends for site 4 in different months.

Figure 4.9.8 Total alkalinity, total acidity, total hardness and conductivity trends for site 4 in different months.

Figure 4.9.5 O<sub>2</sub>, NO<sub>3</sub>, NO<sub>2</sub>, P, Temp trends for site 5 in different months.

Figure 4.9.10 Total alkalinity, total acidity, total hardness and conductivity trends for site 5 in different months.

Figure 4.10.1 Temperature and Conductivity

Figure 4.10.2 PH and Turbidity

Figure 4.10.3 PH and Oxygen

Figure 4.10.4 Nitrates and Turbidity

### **List of tables**

Table 1: Mean values of water parameters in different sampling sites.

Table 2: Characteristics and human or economic activities in different sampling sites of river Rwizi

Table 3: Different wastes disposed into river Rwizi

Table 4: Values of water parameters for different months in different sampling sites

### **List of plates**

Plate 1: Sewage effluent from Katete to river Rwizi

Plate 2: Collection of water samples from NWSC at Nyamitanga site

Plate 3: View of Ruharo site and Kakoba site

Plate 4: View of Kakoba site

Plate 5: testing for conductivity and temperature of water at water treatment plant

Plate 6: NWSC laboratory at Ruharo site

## **List of abbreviations**

AOAC: Association of Official Analytical Chemists

BOD: Biological Oxygen Demand

CFU: Colony Forming Unit

COD: Chemical Oxygen Demand

EPA: Environment Protection Agency

FTU: Formazin Turbidity Unit

LVEMP: Lake Victoria Environmental Management Project

mg/l: milligrams per litre

ml: millilitres

MST ; Microbial Source Tracking

NEMA: National Environment Management Authority

NTU: Nephelometric Turbidity Unit

NWSC: National Water & Sewerage Corporation

SWAP: Source Water Assessment Programs

TDS: Total Dissolved Solids

TDS: Total Dissolved Solids

WHO: World Health Organization

## ABSTRACT

The environmental impacts of poor waste disposal on quality of water of river Rwizi were assessed so that preventive measures may be taken. The increasing human activities such as deforestation, industrialization have led to the degradation of the environment thus increasing the degree of the disposal of wastes into river Rwizi. Sampling sites were selected based on areas with active human activities, the wastes deposited and physical characteristics of the areas. Samples for water chemistry analysis were collected in duplicate in the morning for a period of four months (December 2013, January 2014, February 2014 and March 2014). An automated sampler was used to get the values of parameters such as conductivity, pH and temperature collected in four months and analyzed. In this study the statistical package used for analysis was SPSS and MS excel.

pH (ranged from 5.55 to 10.75), conductivity (ranged from 79.95 $\mu$ S $cm^{-1}$  to 88.95 $\mu$ S $cm^{-1}$ ), turbidity (ranged from 53.025 NTU to 71.425 NTU), color (ranged from 414 PTU to 533 PTU), bacteriological analysis (ranged from 106.5 CFU/100ml to 141.5 CFU/100ml), total alkalinity (ranged from 35.75 mg/l to 79.3 mg/l), total acidity (ranged from 43 mg/l to 66.5 mg/l), total hardness (ranged from 43 mg/l to 81.25 mg/l), oxygen concentration (ranged from 5.4 mg/l to 8.075 mg/l), nitrates (ranged from 10.875  $\mu$ m to 18.925  $\mu$ m), nitrites (ranged from 14.85  $\mu$ m to 24.725  $\mu$ m), phosphorus (ranged from 4.595  $\mu$ m to 14.97  $\mu$ m), temperature (ranged from 17.225 $^{\circ}$ C to 25.2 $^{\circ}$ C). These values were comparable to those identified by NEMA for water contaminated by wastes for all water resources. Phosphorus was below the detection limits at site 1.

It was found that there is a high degree of waste disposal into river Rwizi and recommendations on reduction of wastes disposed in the river Rwizi and conserving the environment around river Rwizi were made. Sources of wastes disposed in the river Rwizi include the human and economic activities taking place around river Rwizi such as sand mining, brick making, water treatment production plants, agricultural activities, Construction, motor vehicle garage, sewage treatment plants.

Keywords: *Environmental impact, Waste disposal, Water quality.*

## **Chapter one: General Introduction**

### **1.1 Background of the study**

River Rwizi intersects almost five districts located in south western Uganda including Mbarara, Bushenyi, Ntungamo, and Buhweju among others. river Rwizi originates from the Buhweju hills with some tributaries from other parts of Ankole region and pours its waters into lake Victoria via the kooki lakes (Mburo, Kachera, Naively, Kijanebarola, ) System. It is the major inflow into Lake Mburo and other lakes in the system. This river Rwizi is the major source of the main economic activities in the districts and most of these activities take place within the river Rwizi itself and others take place within the catchment. Such activities include water abstraction, sewage treatment, cattle rearing, brick making, basket making, agriculture and agro-forestry and many other practices. These activities are all done without notification of downstream users and as a result river Rwizi has deteriorated both in quantity and quality including drying up of wetlands around, fringing river Rwizi. The total quantity of nutrients discharged into surface waters in river Rwizi basin is normally larger than the nutrient load at the river Rwizi mouth and such discrepancy is explained by the process of nutrient retention which is a collective expression for a large number of biogeochemical and hydrological processes that temporarily decrease, decay, degrade, transform or permanently retard and remove the substances from the river Rwizi channel. Urban Rivers, streams and wetlands are susceptible to pollution and so, river Rwizi in western Uganda faces a similar problem. This river Rwizi is a source of water for domestic, industrial and Agricultural activities for Mbarara municipality but due to poor waste disposal, proliferation of motor garages, washing bays, hotels, hospitals, schools and industrial setups, its water quality could have got compromised. The proposed study at five sampling sites (including entry and exit from the municipality) seeks to assess the water quality of this section of the river Rwizi using biological Agents like faecalcoli forms which acted as an indicator for water quality. The changes of the mentioned biological variables will be assessed considering the seasonal variations. The information generated from this study will be used by relevant stakeholders in water management to design measures aimed at reducing water pollution and make it safe for human and animal consumption.

## LIST OF REFERENCES

- Alice Nakiyemba Were, 2012. Decentralized Governance of Wetland Resources in the Lake Victoria Basin of Uganda- case study of river Rwizi.
- Allan, J.D (1995): Stream ecology of running waters. Kluwer; Academic publishers, London, UK.
- AOAC. (2002): Association of Official Analytical Chemists.
- APHA, (1998): Standard Methods for Examination of Water and Waste water. American Public Health Association. Washington.
- Armstrong, F.A.J., 1963. Determination of Nitrate in Water by Ultraviolet Spectrophometry.
- Atim and Janet, 2012. Application of integrated water resources management in computer simulation of River Basin's status - case study of river Rwizi.
- Birley, M. & Lock, K., (1999): A review of health impacts of peri-urban natural resource development.
- Canter L.W., 1996. Prediction and Assessment of Impacts on the surface-Water Environment. 2nd Edition. University of Oklahoma. Mc Graw-Hill Inc.
- Chennakrishnan C, Stephren A, Manju T and Raveen R (2008): Water Quality status of three vulnerable freshwater Lakes of Suburban Chennai, India.
- Chutter F.M. (1998): Research on the rapid Biological Assessment of Water Quality Impacts in streams and Rivers.
- Davies, B. R. and Walker, K. F. (1986): The ecology of river systems. John Wiley & Sons, New York
- Dix, H.M (1981): Environmental Pollution.
- Dunbabin, J. S. (1992): Potential use of constructed wetlands for treatment of industrial wastewaters containing metals effluent and urban pollution control manual. John Wiley, Chichester
- Developing Countries: Natural Resources Water series No.20, United Nations, New York.
- Kansiime, F., Kateyo, E. and Okot-Okumu, J., (1995): Effects of Pollution on Inner Murchison Bay (Lake Victoria-Uganda) on the Distribution and Abundance of Plankton.
- Lamb, J.C (1985): Water Quality and its control. John Wiley & sons, New York
- Water Quality and its control. John Wiley & sons, New York.
- Luger M. and Brown C., (1999). The impact of Treated Sewage Effluent on Urban rivers: An ecological, Social and Economic Perspective.

- Mathuthu, A.S., Mwanga, K and Simoro A (1997): Impact Assessment of Industrial and Sewage Effluents on Water Quality of receiving Marimba river in Harare.
- Mosley, L., Sarabjeet S. and Aalbersberg, B. (2004): Water quality monitoring in Pacific Island countries. Handbook for water quality managers & laboratories, Public Health officers, water engineers and suppliers, Environmental Protection Agencies and all those organizations involved in water quality monitoring (1st Edition). 43 p; 30 cm, ISSN: 1605-4377: SOPAC, The University of the South Pacific. Suva - Fiji Islands.
- Mott Mac Donald and M& E Associates (2001): Management of Industrial and Municipal Effluents. LVEMP Report, 2001.
- Nadia, M. A. (2006): Study on effluents from selected sugar mills in Pakistan: Potential environmental, health, and economic consequences of an excessive pollution load: Sustainable Development Policy Institute: Islamabad, Pakistan
- NEMA, (1999): The Uganda National Environment (Standards for Discharge of effluent into water or land) Regulations, Kampala, Uganda.
- Perry, R. H., Green, D. W., Maloney, J. O., (2007): Perry's chemical engineers' handbook. — 7th ed. McGraw-Hill: New York
- Safequzaman, M., Tariqul, I. S. M., Tasnuva, A., Kashem, M. A. and Mahedi Al Masud. M., (2008): Environmental impact of sugar industry - a case study on Kushtia Sugar Mills in Bangladesh: Khulna: Green World Foundation
- Stumm, W. and Morgan, J.J (1981): Aquatic Chemistry. John Wiley & Sons, New York
- Tariq, M., Ali, M. and Shah, Z. (2006): Characteristics of industrial effluents and their possible impacts on quality of underground water: Soil Science Society of Pakistan Department of Soil & Environmental Sciences, NWFP Agricultural University, Peshawar
- UNDTCD, (1991): Criteria for and Approaches to Water Quality Management in
- UNESCO, WHO and UNEP, (1996): Water quality assessments - A guide to use of biota, sediments and water in environmental monitoring - Second Edition. E&FN Spon. Chapman & Hall, London.
- Young-Jin Suh and Rousseaux P., 2001, McIntyre 1995, Klaus Koop and Pat Hutchings 1996
- Zabel T., Milne I. and McKay G., 2001. Approaches adopted by the European Union and selected Member States for the control of urban pollution. Urban Water 3 (2001).