BUSITEMA UNIVERSITY
*Pursuing Excellence*

# FACULTY OF ENGINEERING

## DEPARTMENT OF MINING AND WATER RESOURCES ENGINEERING

## BSc. Water Resources Engineering

**FINAL YEAR PROJECT REPORT**

# APPLICATION OF GEOSPATIAL TECHNIQUES IN THE ANALYSIS AND MITIGATION OF THE FLOOD RISK

## (CASE STUDY ; -R. NYAMWAMBA)



**KAJUBI ENOCK**

**BU/UG/2012/162**

**+256-701-603-668 / +256-781-830-177**

**Kajubi.enock.hydro@gmail.com**

MAIN SUPERVISOR: Mr. OKIRYA MARTIN

CO-SUPERVISOR: Mr. MOSES MUGISHA

***This final year project is submitted to the department of Mining and Water resources engineering at Busitema University as a partial fulfillment for the degree of Bachelors of Science in Water Resources Engineering.***

## ABSTRACT

This project report presents research conducted during my stay at Busitema University while pursuing a BSc. In Water Resources Engineering scoping at applying geospatial techniques of GIS and RS to delineate the 100year flood plains of Nyamwamba River in Kasese district.

The research was started with the planning phase which involved studying various literature and collecting ancillary data in form of journals and reports. This broadened the researcher's knowledge about flood plain delineation as well as GIS hydraulic modelling and to formulate the methodology for the whole project.

It was followed by the modelling stage. This started with data collection from various sources both from offices and field surveys. Data collected included: - DEM, TopoSheets, river map, imageries, flow data, stage data, land use maps, rainfall data and soil maps. These datasets were conditioned and processed in the GIS environment using the ArcGIS software. Later was exported to the HEC-RAS program to compute for a steady flow simulation. The RAS mapper export from HEC-RAS program was then imported in to ArcMap to delineate a floodplain map which was overlaid to a Google image to determine high risk areas. They included among others :-SAEMS offices, Kilembe mines hospital, All saints church, Kilembe senior secondary school premises, Kyanzuki, Bulembia and Katiri primary schools.

Lastly, was the model validation phase in which a confusion matrix was computed. A source river flow map of Nyamwamba catchment was crossed with the model output map. A confusion matrix table with pixels of flooded and non-flooded areas was output. By this, the values of reliability and accuracy of the model were calculated in the ILWIS software. The model gave an accuracy of 79% with a reliability value of 78%. This proved that the model can be used for flood mitigation in the project area.

Data costing especially form UNMA and CAA, inadequate flow data of Nyamwamba River and absence of a high resolution DEM were my challenges in this project. A geo-spatial planning support system should be developed for the area and the contribution of glaciation to the flow of the Nyamwamba river should be researched about to ascertain flow predictions of the river.

## DECLARATION

I KAJUBI ENOCK hereby declare that this research project report is my original work and has not been previously submitted either in part or in whole to any institution of higher learning for any kind of award.

Signature: 

Date: 20.../.05./..2016

# APPROVAL

This research project was conducted under my supervision and has been submitted with my approval for examination and award of B.Sc. Water Resources Engineering at Busitema University.

MAIN SUPERVISOR

SIGNATURE: .....

DATE: ...../...../.....

MR. OKIRYA MARTIN

CO – SUPERVISOR

SIGNATURE:

DATE: ...../...../.....

MR. MUGISHA MOSES

## ACKNOWLEDGEMENT

First and foremost, I thank the almighty sovereign God to have blessed me with a gift of life; protection and guidance to allow me accomplish this final year project research.' Asante Mungu'.

I would like to thank Mr. Okirya Martin and Mr. Mugisha Moses for the expanse of knowledge they rained unto me as my supervisors towards the accomplishment of this project. Their supervision, mentorship and time they offered as a sacrifice to me is highly appreciated. Their expertise in the GIS modelling and flood mitigation made this project a success and to me was added a more knowledge diversity and resourcefulness.

My heartfelt thanks also go to the entire fourth year class of BSc. Water Resources Engineering students in 2016 for their academic, social and moral support. Their academic combined support extended not only my academic relationship but also the entire professional development.

It is my pleasure to thank the following key experts in the area of my project research:- Eng. Dr. Ntale Mohammad (MUK), Prof. Isabirye Moses (Faculty Dean Busitema Namasagali Campus, GIS specialist), Mr. Mwesigwa Richard (PM WWF), Mrs. Mwebaze Carol (Hydrologist albertine region), Mr. Miwanda Andrew (Environmentalist KCCL), Francisco Sambalino (Agronomist, Spate Irrigation network) and Taye Alemayehu (hydrogeologist PhD student, Ethiopian Institute of Water Resources in Addis Ababa University. They have provided me with all required information required as per the completion of my research.

My deepest thanks go to my two beloved sisters: - Mercy and Gift for their financial support, heart calming and sensation words that encouraged me to move on in times of discouragement.

Lastly but not least, my special thanks go to my lovely friend Nakigozi Lilian for she was there for me in all crests and troughs of my life throughout the whole project period "nakupenda sana".

# TABLE OF CONTENTS

ABSTRACT ..... i
DECLARATION ..... iii
APPROVAL ..... iv
ACKNOWLEDGEMENT ..... v
1 INTRODUCTION ..... 1
1.1 BACKGROUND ..... 1
1.2 PROBLEM STATEMENT ..... 2
1.3 JUSTIFICATION OF THE STUDY ..... 2
1.4 OBJECTIVES ..... 3
1.4.1 Main objective ..... 3
1.4.2 Specific objectives ..... 3
1.5 Scope of study ..... 3
2 LITERATURE REVIEW ..... 4
3 METHODOLOGY ..... 9
3.1 To develop a hydraulic river hydro-geospatial model. ..... 9
3.1.1 Planning stage ..... 9
3.1.2 Fieldwork and data acquisition stage ..... 10
3.1.3 Modeling stage ..... 11
3.2 To develop a Nyamwamba river flood plain map. ..... 17
3.3 To validate the model ..... 18
4 RESULTS AND DISCUSSIONS ..... 19
4.1 To develop a hydraulic river hydro-geospatial model. ..... 19
4.1.1 Results corresponding to objective one ..... 19
4.1.2 Discussion of the results from my objective one ..... 21
4.2 To develop Nyamwamba river flood plain map ..... 21
4.2.1 Results corresponding to objective two ..... 21
4.2.2 Discussion of the results from my objective two ..... 22
4.3 To evaluate the model and carry out hazard assessment ..... 23
4.3.1 Results corresponding to objective three ..... 23

4.3.2 Discussion of the results from my objective three ..... 23
5 CONCLUSION, CHALLENGES AND RECOMMENDATIONS ..... 24
5.1 CONCLUSION ..... 24
5.2 CHALLENGES ..... 24
5.3 RECOMMENDATIONS ..... 25
REFERENCES ..... 26
APPENDIX ..... 28

LIST OF FIGURES

**Figure 3-1:** Flow chart showing steps followed during the planning stage of the project ..... 9
**Figure 3-2:** The flow chart showing modelling preparation process ..... 11
**Figure 3-3:** The flow chart showing steps followed during flood frequency analysis ..... 15
**Figure 3-4:** The flow chart showing steps followed during flood plain map generation ..... 17
**Figure 3-5:** The flow chart showing the model validation process ..... 18
**Figure 4-1:** The figure showing the geometric thematic layers generated ..... 19
**Figure 4-2:** The figure showing Nyamwamba River profile ..... 19
**Figure 4-3:** The graph showing the Nyamwamba River flood frequency ..... 20
**Figure 4-4:** The figure showing the RAS mapper model output ..... 20
**Figure 4-5:** The figure showing the preprocessed geometric data ..... 21
**Figure 4-6:** The figure showing the bounding polygon for the modelled area along river Nyamwamba. 21
**Figure 4-7:** The map showing the flood delineated plains along Nyamwamba river. ..... 22

# LIST OF TABLES

**Table 3-1:** Table showing types of data used and their sources.....10
**Table 3-2:** Table showing discharge stations on rivers originating from the Rwenzori mountains.....14
**Table 4-1:** The table showing the results from the confusion matrix.....23

**ACRONYMS**

IFRC .....International Federation of Red Cross and Red Crescent

HEC-RAS .....Hydrologic Engineering Center River Analysis System

GIS.....Geographical Information System

UNMA .....Uganda National meteorological Authority.

USACE.....US Army Corps for Engineers.

QGIS.....Quantum Geographical Information System

SAGA .....System for Automated Geo-scientific Analysis

ILWIS .....Integrated Land and Water Information System

UWA..... .....Uganda Wildlife Authority

WWF.....World Wildlife Fund

ADDRA.....Adventist Development and Relief agency

UNESCO .....United Nations Education, Science and Cultural organization

DWRM .....Directorate of Water Resources Management

KCCL .....Kasese Cobalt Company Limited

SAEMS .....South Asian Energy and Mineral Solutions

DEM .....Digital Elevation Model

TIN .....Triangulated Irregular Network

TOC .....Table of Contents

# 1 INTRODUCTION

This chapter includes the following; back ground to the study, statement of the problem, purpose, justification, and objectives of the study, research questions and scope of the study.

## 1.1 BACKGROUND

Floods are becoming a more pronounced disaster in many parts of the country costing lives and also damaging property (Kitutu, 2013) Among all kinds of natural hazards of the world flood is probably the most devastating, wide spread and frequent. In the humid tropics and subtropical climates, especially in the realms of monsoon, river flooding is a recurrent natural phenomenon. Floods resulting from excessive rainfall within a short duration of time and consequent high river discharge damage crops and infrastructure (Nsengiyumva, 2012).

Uganda is not exceptional because Butaleja District (Eastern Uganda) on 13 March, 2013 experienced heavy rains, accompanied by hailstorm and strong winds. In less than an hour, 40 houses had their roofs removed, while many crop fields were destroyed and a 7 year boy was crushed and killed by collapsing walls (Mulembe, 2014)

And on 1st May 2013 and on 8th May, 2014, three rivers of Mubuku, Nyamwamba and Nyamughasana in Kasese district burst their banks causing massive flooding and devastation of Kilembe Mines estates, Kasese town and the surrounding villages. The disaster had far reaching effects resulting into the death of eight persons, destruction of property and displacement of more than 3000 persons, many of whom were forced to live in emergency camp (Mulembe, 2014).

River Nyamwamba has for the last three years been a hazard to populations in Kasese district where its burst banks have led to loss of lives and property. The tragedies have all happened during the month of May". This calls for a clear research about the causes of this flood that will aid in remedying the situation (Thawite, 2015).

# REFERENCES


Goretti, K. K. M., 2013. *STUDY ON THE NATURAL-HAZARDS VULNERABILITY AND RISK PROFILES IN HOTSPOT.* s.l.:s.n.

Isaac, M., 2014. *DREF Preliminary Final Report.* s.l.:International Federation of Red Cross and Red Crescent (IFRC).

Mohamad, E. D. N., 2012. *SEA Report Nyamwamba small Hydropower project, Uganda.* KASESE: s.n.

Nsengiyumva, j. B., 2012. *Disaster High Risk Zones on floods and landslides.* kigali: Unit of research and public awareness.

Olivera, D. F., 2003. Processing Geospatial Data.

Thawite, J., 2015. *Disaster and relief management of Kasese district.* Kasese : s.n.

APFM, 2012. *Management of flash floods: A Tool for integrated Flood Management switzerland: WMO.* s.l.:s.n.

Cameron T. Ackerman, P. D. W., 2010. *GEOSPATIAL CAPABILITIES OF HEC-RAS FOR MODEL DEVELOPEMENT AND MAPPING.* Las Vegas, Hydrologic Engineering Center, Institute for Water Resources.

De by, R. A., 2001. *principles of Geographical Information Systems, ITC eDUCATIONAL textbook series, ITC, Enschede, The Netherlands.* s.l.:s.n.

Dhar, O. &. N. S., 2003. *Hydrometeorological aspects of Floods in India,* s.l.: The Netherlands Kluwer Academic Publishers.

Douglas, I. A. K. M. M. Y. M. L. &. C. J., 2008. *Unjust waters: climate change, flooding and the urban poor in Africa,* s.l.: s.n.

DRDE-US, 1991. *Primer on natural hazard management in integrated regional development planning.* [Online]
Available at: http://www.oas.org/usde/publications/unit/oea66e/contents
[Accessed 21 December 2015].

Genive, U. N., 1976. Guidelines for disaster prevention volume 1. *pre-disaster physical planning of human settlement.*

Goretti, D. K. K. M., 2013. *Study on the Natural-hazards Vlnerability and Risk Profilesin Hot-spot Areas as a Support to early Warning, Disaster Preparedness and Risk Reduction (EWDPRR) Measures in Uganda.* s.l.:s.n.

HATİPOĞLU, D. M. A., 2008. FLOODPLAIN DELINEATION IN MUGLA-DALAMAN PLAIN. *PRACTICES ON RIVER BASIN MANAGEMENT.*

Kingma, N. C., 2002. *Flood Hazard assessment and Zonation, ITC,*. Enschede, The Netherlands: s.n.

Marfai, m. A., 2003. *GIS Modelling of River and Tidal Flood Hazard in a Waterfront City, Semarang City, Central Java, Indonesia,* s.l.: s.n.

Olivera, D. F., 2003. Processing Geospatial Data.

Smith, K. &. W. R., 1998. *Floods: physical processes and human impacts. Chishester etc; Wiley & sons.* s.l.:s.n.

Smith, K. a. W. R., 1998. *Floods: Physical processes and Human impacts.* John Wiley and sons, Chichester, USA: s.n.

USAGE, 2000. *HEC-GeoRAS, an extension for support of HEC-RAS using Arcview, User's Manual Version 3.0, Hydrological Engineering Centre, Davis, CA, USA.* s.l.:s.n.

USAGE, 2001. *HEC-RAS, River Analysis System, User's Manual Version 3.0, Hydrologic Engineering Centre, Davis, CA, USA.* s.l.:s.n.