BUSITEMA UNIVERSITY
Pursuing Excellence

FACULTY OF ENGINEERING

DEPARTMENT OF MINING AND WATER RESOURCES ENGINEERING

FINAL YEAR PROJECT REPORT

APPLICATION OF GIS IN ASSESSMENT OF IRRIGATION POTENTIAL BASED ON SURFACE WATER AVAILABILITY

(Case Study: Busitema Sub-County)

By

AZIRA ROGERS PATRICK

BU/UP/2013/266

+256778707106/+256754230368

azirarogerspatrick@gmail.com

MAIN SUPERVISOR: MR. MUGISHA MOSES

CO-SUPERVISOR: MR. WANGI MARIO

A final year project report submitted in partial fulfillment of the requirement for the award of the Bachelor of Science degree in Water Resources Engineering of Busitema University

MAY, 2017

ABSTRACT

Assessing available land and water resources for irrigation is important for planning their use. This study was initiated with the objective of assessing the water and land resources potential of Busitema Sub county for irrigation development and generating geo-referenced map of these resources by using Geographic Information System.

Geospatial maps preparation, identification of potential irrigable land, and estimation of irrigation water requirement and surface water resources of Busitema Sub County were the steps followed to assess this irrigation potential. Results of Geospatial maps preparation led to identification of potential irrigable land, irrigation suitability factors such as soil type, slope, land cover/use, and distance from water supply (source) were taken into account.

The irrigation suitability analysis of these factors indicate that 63.6% of the soil and 97.2% of the slope in the study area are in the range of highly suitable to suitable for sprinkler irrigation system. In terms of land cover/use, 69.1% of land cover/use is highly suitable where as 7.9% is restricted from irrigation development. Weighted overlay analysis of these factors (land, slope, land cover) gave potential of 86.8% of the area in the range of highly suitable to suitable for sprinkler irrigation system. Finally when Euclidean distance was considered an area of 50.3km^2 was obtained in the range of highly suitable to suitable for sprinkler irrigation system.

DECLARATION

I **AZIRA ROGERS PATRICK** hereby declare that the report and work presented in it are my work and has been generated by my efforts and the work of my supervisors. This report has not been submitted in any form to any institute of higher learning.

SIGNATURE: .....

DATE: 29th/05/2017

APPROVAL

This report has been submitted in partial fulfillment of Bachelor of Science in Water Resources Engineering under the persistent and constant efforts of my supervisors.

SUPERVISORS

MAIN SUPERVISOR

MR. MUGISHA MOSES

SIGNATURE: .....

DATE: .....

CO-SUPERVISOR

MR. WANGI MARIO

SIGNATURE: .....

DATE: .....

DEDICATION

I hereby dedicate this report to my Supervisors Mr. Mugisha Moses and Mr. Wangi Mario, my parents, my brothers, my sisters and friends who were there by my side to guide me and give me the courage that I can do best so long as I took a path to try a task.

ACKNOWLEDGMENTS

First of all, I would like to thank the 'Almighty God' for giving me the life, patience, wisdom and who made it possible, to begin and finish this work successfully.

I would gratefully like to acknowledge the Directorate of Water Resources Management specifically Monitoring and Assessment Department and secondly Uganda Meteorological Authority for allowing me access River Malaba data, climatic data of Tororo respectively.

I consider it a profound pleasure to express my deep sense of indebtedness, gratitude and profound thanks to my supervisor, Mr. Mugisha Moses, without whom the entire work would not come into existence. His critical comments and helpful guidance gave me a chance to explore further. I have learned a lot from him.

I am forever grateful to my beloved father, mother, sisters and brothers especially Mr. Lwabi Charles. They have always been the constant source of my strength and hope in every aspect of my life.

And last but not least, I would like to extend my deepest gratitude to my friends. Oguti Victoria, Onen, Okuu Kennedy, Wokoto Stephen for their words of encouragement and material support during my project and mostly **KYATEREKERA BRENDA** whose project I based on by detecting its loopholes and recommendations(LAND EVALUATION FOR IRRIGATED AGRICULTURE).

LIST OF ACRONYMS

AHP..... Analytical hierarchy process

AWC..... Available Water Content

DEM..... Digital Elevation Model

DWRM .....Directorate of Water Resources Management

ESRI..... Environmental Systems Research Institute

ETc..... .Crop Evapo-transpiration

ETo..... Reference Crop Evapo-transpiration

FAO..... Food and Agriculture Organization

GIS.....Geographic Information System

GPS.....Global Positioning System

ILWIS.....Integrated Land and Water Software

IWR.....Irrigation Water Requirement

KARI..... Kawanda Agricultural Research Institute

LUCC.....Land Use Classification Code

MWE.....Ministry of Water and Environment

NFA.....National Forestry Authority

QGIS.....Quantum Geographic Information System

UBOS.....Uganda Bureau of Statistics

UNMA .....Uganda National Meteorological Authority

Table of Contents

Pages

TABLE OF FIGURES

LIST OF TABLES

LIST OF TABLES IN THE APPENDIX

CHAPTER ONE

1.0: Introduction

This chapter briefly gives the general information relevant to the research of irrigation potential of an area. It shows how the research has reduced the problem through achieving of the different objectives.

1.1: Background of the study

Small-scale informal irrigation has been practiced in Uganda since the 1940s. The majority of farms are located not too far from lakes, rivers and fringes of swamps which makes them suitable for irrigation. Formal irrigation development in the country commenced in the 1960s with the following schemes: Mubuku irrigation settlement scheme in the Kasese IN 1998, Kiige scheme in the Kamuli District in 1998 etc.

Uganda has a water withdraw of 0.259km^3 in Agriculture, 0.328km^3 for municipal, 0.05km^3 for industrial and a total area equipped for irrigation, as a percentage of cultivated area is 0.1217% and as a percentage of area equipped for irrigation 94.9% .(FAO,AQUASTAT country fact sheet)

Surface water resources include rivers and lakes. Uganda has major water bodies that include lakes Victoria (the world's second largest freshwater lake), Kyoga, Albert, George and Edward while major rivers include the Nile (the world's longest river), Ruizi, Malaba, Katonga, Kafu, Mpologoma and Aswa covering up to 15% of the total land area. Surface water is unevenly distributed, especially in the dry (cattle) corridor that stretches from the southwest to the northeast. Uganda has eight major catchments which drain to major water receiving bodies within and outside the country. These vary in size from the very large catchment discharging into Lake Victoria with an area of 59,858 km2, including the Ugandan part of Lake Victoria to the very small Kidepo Basin at the extreme north-eastern part of the country with an area of 3,129 km2. The country is divided into eight sub-basins all of which drain into different reaches of the Nile inside Uganda or the Equatorial Lakes. These are: 1-L.Victoria, 2-L. Kyoga, 3-Victoria Nile, 4-L.Edward, 5-L. Albert, 6-Aswa, 7-Albert Nile and 8-Kidepo. (Anon., 2005)(Uganda National Water Development Report, 2005).

With declining productivity in rain fed agriculture and with the need to double food production over the next two decades, water has been recognized as the most important factor for the transformation of low productive rain-fed agriculture into most effective and efficient irrigated agriculture (FAO, 1994). It is obvious that the utilization of water resources in irrigated agriculture provide supplementary and full season irrigation to overcome the effects of rainfall variability and unreliability. Hence, the solution for food insecurity could be provided by irrigation development that can lead to security by reducing variation in harvest.

In this regard, sustainable food production that can be expected through an optimal development of water resources, in conjunction with development of land depends on the method of irrigation considered (FAO, 2003). These methods, however, can be broadly classified into three categories: surface (basin, border, and furrows), sprinkler, and drip /micro irrigation/ methods. Surface irrigation is the application of water by gravity flow to the surface of the field, either the entire field is flooded (basin irrigation) or the water is fed into small channel (furrow) or strip of land (borders). It is the oldest and still the most widely used method of water application to agricultural lands.
The suitability of the land must also be evaluated on condition that water can be supplied to it. The volume of water obtainable for irrigation will depend on the outcome of hydrological studies of surface water (FAO, 1985).

Irrigation water supplies and their requirements are therefore, important physical factors in matching the available supply to the requirements.
However, these factors should be assessed in an integrated manner, geo-referenced and mapped for surface irrigation development possibilities. With an adequate database, Geographic Information Systems (GIS) can serve as a powerful analytic and decision-making tool for irrigation development (Aguilar-Manjarrez and Ross, 1995). 1995). Large area extent of GIS as well as its ability to collect store and manipulate various types of data in a unique spatial database, helps performing various kinds of analysis and thus, extracting information about spatially distributed phenomena. In this kind of situation, the factors that are involved for irrigation potential assessment such soil, land cover/use, land slope and distance between water

With declining productivity in rain fed agriculture and with the need to double food production over the next two decades, water has been recognized as the most important factor for the transformation of low productive rain-fed agriculture into most effective and efficient irrigated agriculture (FAO, 1994). It is obvious that the utilization of water resources in irrigated agriculture provide supplementary and full season irrigation to overcome the effects of rainfall variability and unreliability. Hence, the solution for food insecurity could be provided by irrigation development that can lead to security by reducing variation in harvest.

In this regard, sustainable food production that can be expected through an optimal development of water resources, in conjunction with development of land depends on the method of irrigation considered (FAO, 2003). These methods, however, can be broadly classified into three categories: surface (basin, border, and furrows), sprinkler, and drip /micro irrigation/ methods. Surface irrigation is the application of water by gravity flow to the surface of the field, either the entire field is flooded (basin irrigation) or the water is fed into small channel (furrow) or strip of land (borders). It is the oldest and still the most widely used method of water application to agricultural lands.
The suitability of the land must also be evaluated on condition that water can be supplied to it. The volume of water obtainable for irrigation will depend on the outcome of hydrological studies of surface water (FAO, 1985).

Irrigation water supplies and their requirements are therefore, important physical factors in matching the available supply to the requirements.
However, these factors should be assessed in an integrated manner, geo-referenced and mapped for surface irrigation development possibilities. With an adequate database, Geographic Information Systems (GIS) can serve as a powerful analytic and decision-making tool for irrigation development (Aguilar-Manjarrez and Ross, 1995). 1995). Large area extent of GIS as well as its ability to collect store and manipulate various types of data in a unique spatial database, helps performing various kinds of analysis and thus, extracting information about spatially distributed phenomena. In this kind of situation, the factors that are involved for irrigation potential assessment such soil, land cover/use, land slope and distance between water

supply and suitable command area should be weighted and evaluated by the use of GIS according to their suitability for irrigation.

1.2: Problem statement

There are erratic and unevenly distributed rains in Busitema Sub County, and the way to solve this is by establishing irrigation schemes. This is constrained by potential irrigable areas in the area not being identified and matched with the water requirements of some crops commonly grown.

This calls for research of irrigation potential of Busitema Sub County.

1.3: Main objective

- To apply GIS in assessment of irrigation potential in Busitema Sub county.

13.1: Specific objectives

- To develop relevant geospatial maps of Busitema Sub-county
- To conduct land suitability analysis for irrigation.
- To classify the final irrigable areas.
- To carry out a water resources assessment.

1.4: Justification

This study will help in;

- ✓ Knowledge of irrigation potential could guide the government and private sector in investing in the area.
- ✓ Use of GIS and Cropwat provides relatively cheaper and faster suitability analysis.

1.5: Scope of the study

This study was limited to only the irrigation potential of Busitema Sub County. It focused on the analysis of specific datasets such as climate data (rainfall and temperature), land cover data, river characteristics, topographic data and soil data to provide geo-referenced map of two resources

(water and land resources) and ranked the identified irrigable areas among the Sub-County for future planning and development possibilities.

1.6: The location of the study

Busitema Sub County is located in Busia District in Eastern Uganda

The area has a flat topography with relatively steep slopes in the middle parts next to Busitema University. The area receives annual rainfall of 1500mm and receives an average minimum temperature of 17.3^{0}C and average maximum temperature of 32.1^{0}C. Busitema Sub County has an area of 61.60Km^2.The elevation ranges between 1082m and 1200m.

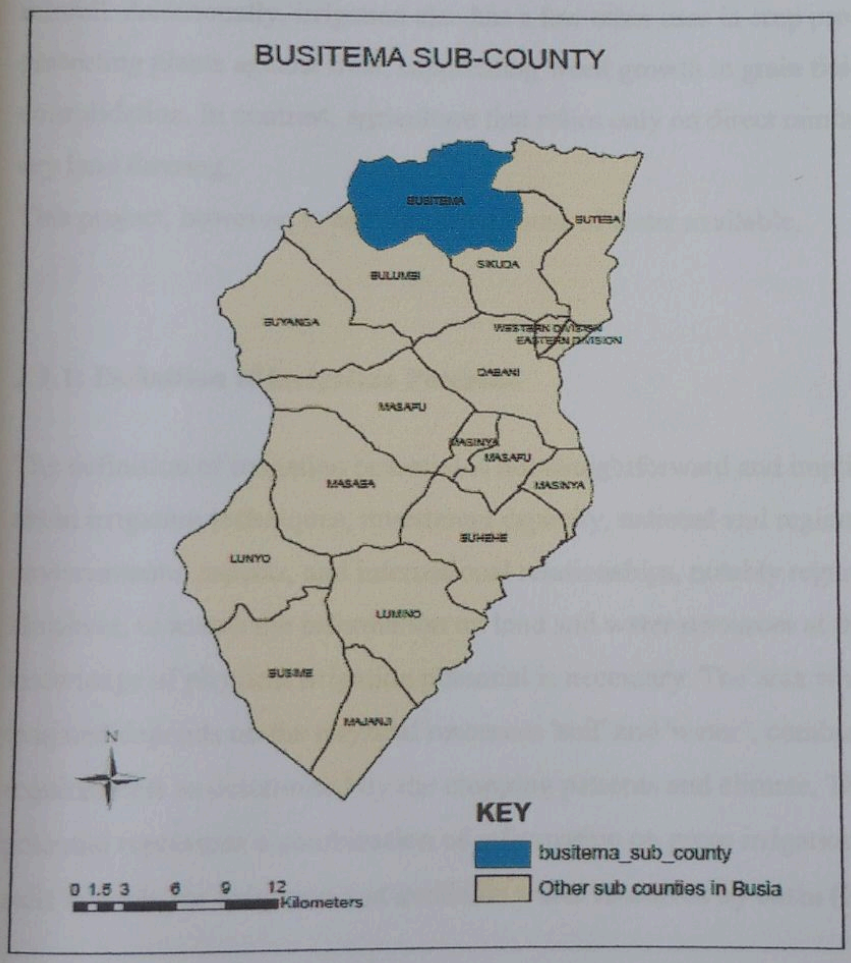

Figure 1: Map showing location of Busitema sub-county

References

Anon., 2005. *Uganda National Water Development Report,* s.l.: s.n.

Bontero, B., 2006. *Across systems comparative assessment of Hare community managed irrigation schemes performance,* Arba Minch University: s.n.

Campbel, 1984. *introductory cartography.* Prentice Hall: Englewood Cliffs.

DFID, 2004. *predicting and minimizing sedimentation small Dams,* Zimbabwe and Tanzania: s.n.

Dingman, S., 2002. *Physical hydrology.* second edition printice ed. Hall New Jersey: s.n.

FAO, 1976. *A framework for land evaluation. FAO Soils Bulletin No. 32. FAO, Rome,* s.l.: s.n.

FAO, 1997. *Irrigation Potential in Africa: A basin approach FAO Land and Water Bulletin 4,* s.l.: s.n.

FAO, 1998. *Guidelines for computing Crop Water Requirements, Irrigation and Drainage,* s.l.: s.n.

FAO, 2007. *Land evaluation towards a revised framework. Land and Water Discussion Paper,* s.l.: s.n.

Ganole, K., 2010. *GIS based surface irrigation potential assessment of river catchments for irrigation development in Dale, Woreda, Sidama Zone, SNNP,* Haramaya University: s.n.

Haile, E., 2008. *Land cover/use dynamics and erosion susceptibility analysis.* Addis Ababa University: s.n.

Jaruntorn, B. D. W. a. K., 2004. *GIS based land suitability assessment for Musa. Graduate School of Agricultural science, Ethime University, Japan,* s.l.: s.n.