

BUSITEMA UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF AGRICULTURAL MECHANIZATION
AND IRRIGATION ENGINEERING

MASTER'S THESIS

APPLICATION OF A GIS BASED MULTI-CRITERIA
EVALUATION TECHNIQUE IN LAND SUITABILITY
ASSESSMENT FOR SURFACE IRRIGATION
CASE STUDY: TORORO DISTRICT

By

EBIC ANDREW
BU/GS14/MID/17



This master's thesis is submitted to the Directorate of Graduate School in partial fulfillment of the requirement for the award of the Degree of Master of Science in Irrigation and Drainage Engineering.

SEPTEMBER 2017



**BUSITEMA
UNIVERSITY**
Pursuing Excellence

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SUPERVISORS: **Dr. Catherine Wandera
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Eng. Mohamed Badaza**

**This master's thesis is submitted to the Directorate of Graduate School of
Busitema University for Examination.**

SEPTEMBER 2017

ABSTRACT


The importance attached to agriculture in Uganda is enormous providing livelihood to more than 70% of the population and a great contributor to GDP. Over reliance on rainfall is undermining this importance, irrigation practice is still very low hampered by high initial investment costs, limited knowledge on the irrigation best practices, methods and suitability. This research focused on evaluation of land suitability for surface irrigation system. The main objective of this study was to develop a land suitability map of surface irrigation of Tororo District of Malaba sub-catchment by developing spatial database of physical land resource, determining hydrological sequence and land suitability for surface irrigation and lastly, modeling surface irrigation suitability using MCE tools in ArcGIS.

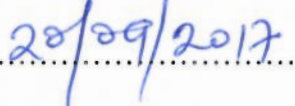
From the assessment, Tororo terrain is generally flat with black and grey clay loam and reddish brown sandy clay loam soils. The favored classes of are highly suitable and moderately suitable represented by 6.34% and 61.47% respectively of the total district area. With minimal soil, water and agronomic amendments, third class represented by 29.77% can be transformed to the favored class. The combined not suitable class represent 2.42% are attributed to by hills, out growths and marked distance from water sources like streams and rivers; other water sourcing method like ground water abstraction can be employed. A vast proportion of the district land is suitable for surface irrigation, first priority in terms of suitability for investment is Nagongera, Kirewa, Paya, Sop-Sop, Merikit, Nabuyoga and Iyolwa respectively; a big proportion of the land is covered with either highly suitable or moderately suitable for irrigation in relation to criterion used in this research.

This research was structured into five main chapters; chapter one presented the background outlining the need for land evaluation for irrigation using GIS tools, statement of the problem, objectives, justification and scope of the study. Chapter two took a critical look at what other authors did and theories which have been used in relation to the subject of the study. The content of this chapter reviews discussions on land evaluation, its assessment and potential analysis. Chapter three described a multi criterion land suitability study of Tororo District so as to map the suitable locations for surface irrigation. A number of constrains and criterion with positive influence of cultivation of maize were identified and evaluated. Chapter four presented results and discussions regarding suitability and evaluation for surface irrigation system. Appendices and references are presented in chapter five.

DECLARATION

I **EBIC ANDREW** declare that I am the sole author of this thesis and that this thesis - in part or as a whole - has not been submitted to any other university for a degree award. Any other author's work that was used in creating an establishment for the study reported in this thesis has been duly acknowledged. Any views expressed in this thesis are those of the author and in no way represent those of Busitema University.

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APPROVAL

I hereby approve this master's thesis with the title "*Application of a GIS based Multi-Criteria Evaluation Technique in Land Suitability Assessment for Surface Irrigation in Tororo District*" as a true record of the research work that was undertaken under my supervision in partial fulfillment of the requirement for award of the degree of Master of Science in Irrigation and Drainage Engineering.

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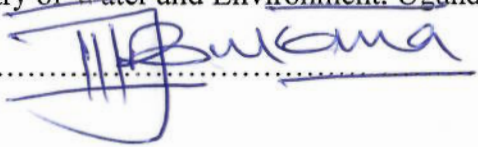
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DEDICATION

This thesis is dedicated to my wife, Mama SHARON JOY AKELLO for the support, guidance and providence during the course of writing this thesis. May our family remain under God's care forever and ever, Amen!

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LIST OF ACRONYMS

AHP	Analytic Hierarchy Process
CWR	Crop Water Requirement
EAC	.....	East African Community
EC	.....	Electrical Conductivity
ESP	.....	Exchangeable Sodium Percentage
FAO	.....	Food and Agricultural Organization
GCP	.....	Ground Control Points
IDF	.....	Intensity-Duration-Frequency
IDW	.....	Inverse Distance Weight
LUT	.....	Land Use Type
MAR	.....	Mean Annual Rainfall
MCE	.....	Multi-Criteria Evaluation
MWE	.....	Ministry of Water and Environment
NDVI	.....	Normalized Difference Vegetation Index
OLI	.....	Operational Land Merger
OM	.....	Object Model
OM	.....	Organic Matter
SAR	.....	Sodium Absorption Ratio
SPI	.....	Standardized Precipitation Index
TCI	.....	Temperature Condition Index
TIRS	.....	Thermal Infrared Sensor
TRRL	.....	Transport and Roads Research Laboratory
UBOS	.....	Uganda Bureau of Statistics
UgDEM	.....	Uganda Digital Elevation Model
USGS	.....	United States Geological Surveys
VCI	.....	Vegetation Condition Index

CHAPTER ONE: INTRODUCTION

1.1 Background

Agriculture remains the mainstay of Uganda's food security at both the household and national levels, and has been a significant contributor to gross domestic product (>20%), export revenues (48%) as well as providing the livelihood of over 70% of the population (UBOS, 2014). The sector however, is dominated by rainfed farming systems, the viability of which is becoming increasingly compromised by climate variability and change; its productivity is reducing in the case of some crops and the ability to contribute to national food security is decreasing due to one of the high population growth. Despite the fact that irrigation can mitigate climate change risk and obviate the perceived risks of diversified or intensified farming, its practice is low and hampered by high initial investment costs coupled with limited knowledge on the irrigation best practices, methods and suitability. Low inputs are also leading to low productivity at farm levels. According to Uganda final draft irrigation master plan (2010 - 2035), Section 5 presents an estimate of Uganda's irrigation potential in terms of land (around 550,000 ha made up of some 295,000 ha of easily irrigated "Type A¹" and 275,000 ha of "Type B²", this suitability and potential is at national level only.

According to FAO, 1976 definition, land suitability classification, *is defined as appraisal and grouping of areas of land in terms of their suitability for a given land use type (LUT)*. Land suitability evaluation for surface irrigation are in terms of suitability ratings ranging from highly suitable to not suitable based on climatic and soil properties. Crop-land suitability analysis is a prerequisite to achieving optimum utilization of the available land resources for sustainable agricultural production. Land evaluation and crop-land suitability analysis for surface irrigation using Geographical Information System (GIS) and remote sensing will help provide better land-use options to the farmers. Productivity of land can be determined by environmental components such as climate, local topography (roughness, steepness, and exposure), soil type, water source proximity and existing vegetation. Improper land use results in land degradation and decline in agricultural productivity.

¹ Land situated close to reliable water resources

² Land requiring storage and/or significant conveyance systems.

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