BUSITEMA UNIVERSITY
*Pursuing Excellence*

## FACULTY OF ENGINEERING

## DEPARTMENT OF MINING AND WATER RESOURCES ENGINEERING

# DROUGHT RISK ASSESSMENT USING GIS AND REMOTE SENSING

# CASE STUDY: KOTIDO IN KARAMOJA REGION


**SUBMITTED BY**

**LUBANGA NICHOLAS**

**BU/UG/2013/99**

*nicholaslubanga7@gmail.com*




**MAIN SUPERVISOR: Mr. MUGISHA MOSES**

**CO-SUPERVISOR: MISS. NAKABUYE HOPE NJUKI**

***This final year project report 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.***

**MAY 2017**

## DECLARATION

I LUBANGA NICHOLAS 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: ...27.../...05.../...2017...

## 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. MUGISHA MOSES

CO – SUPERVISOR

SIGNATURE:

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

Miss NAKABUYE HOPE NJUKI

## ACKNOWLEDGEMENT

It gives me great pleasure on the successful completion of my project report. Glory and great honor be to Almighty God who led me through the course of the work by providing me His blessings and guidance.

I express my heartfelt thanks to my supervisors, Mr Mugisha Moses and Miss Nakabuye Hope Njuki for providing constant help during the entire project phase. With their expertise in the field, they provided me with innovative ideas and helped in formulating my thesis scientifically in order to improve the quality of my work. There precious guidance and support helped me in completing my thesis systematically.

I express my sincere gratitude to my classmates for spending their valuable time in discussions at times when I was stuck in my work. They were there to help and support despite of the busy schedule.

A very special thanks to my friend Kajubi Enock for his technical help and moral support during the entire phase of my thesis.

I express my honest and sincere gratitude towards my family for their encouragement to pursue this course. Though I cannot express my thankfulness to them in words, I can say that it's only because of their love, support and blessings that I gained the strength to complete this project successfully. Thank you dear parents for always being a source of inspiration to me. Very special thanks to my sisters and brothers for their love and time-to-time support. Besides Almighty's blessings and my efforts, I owe my success to my parents, my sister and brother.

## ABSTRACT

Drought is the most complex but least understood of all natural hazards. It is broadly defined as "severe water shortage". Low rainfall and fall in agricultural production has mainly caused droughts.

A droughts impact constitutes losses of life, human suffering and damage to economy and environment. Droughts have been a recurring feature of the Ugandan climate therefore study of Historical droughts may help in the delineation of major areas facing drought risk and thereby management plans can be formulated by the government authorities to cope with the disastrous effects of this hazard.

In recent years, Geographic Information Science (GIS) and Remote Sensing (RS) have played a key role in studying different types of hazards either natural or man-made. This study stresses upon the use of RS and GIS in the field of Drought risk Evaluation. In the present work an effort has been made to derive drought risk areas facing agricultural as well as meteorological drought by use of satellite images United States Geological Survey (USGS) based Normalized Difference Vegetation Index (NDVI) (1984- 2016) and meteorological based Standardized Precipitation Index (SPI).

Resultant risk map obtained by integrating agriculture and meteorological drought risk map indicates the areas facing a combined hazard.

It was evident from the study that central and eastern parts of Kotido are more prone to drought either agricultural or meteorological. The research shows motivating results that can be used in taking corrective measures timely to minimize the reduction in agricultural production in drought prone areas.

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# ACRONYMS

| | |
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| NDVI | Normalized Difference Vegetation Index |
| SPI | Standardized Precipitation Index |
| TCI | Temperature Condition Index |
| VCI | Vegetation Condition Index |
| GIS | Geographic Information System |
| NASA | National Aeronautical Space Application |
| NIR | Near infrared |
| AVHRR | Advanced Very High Resolution Radiometer |

**Definitions....in context of this report**

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| **Agriculturalists:** | Individuals or groups of people who cultivate the land for food production, whether it is grain crops or horticulture |
| **Agro-pastoralists:** | Individuals or group of individuals who base their livelihood income on a mixture of both crop production and livestock rearing |
| **Drought:** | A deficiency of precipitation from expected or "normal" that, when extended over a season or longer period of time, is insufficient to meet demands. This may result in economic, social, and environmental impacts. It should be considered a normal, recurrent feature of climate. Drought is a relative, rather than absolute, condition that should be defined for each region. Each drought differs in intensity, duration, and spatial extent (Knutson et al.1998). The UNDP (2008) defines drought as the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems. |
| **Drought Impact:** | A specific effect of drought. People also tend to refer to impacts as "consequences" or "outcomes." Impacts are symptoms of vulnerability (Knutson et al. 1998). |
| **Early Warning:** | The provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response. Early warning systems include a chain of concerns, namely: understanding and mapping the hazard; monitoring and forecasting impending events; processing and disseminating understandable warnings to political authorities and the population, and undertaking appropriate and timely actions in response to the warnings (UNISDR 2004). |
| **Hazard:** | A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. |

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| | Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydro meteorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability (UNISDR 2004). Hazard in the context of this study refers to drought caused by hydro-meteorological elements causing dry periods such as lack of precipitation, high temperatures, high winds and evapotranspiration. |
| **Risk** | The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions (UNISDR 2004). Conventionally risk is expressed by the notation; Risk = Hazards x Vulnerability/coping capacity. Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability. Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes. |
| **Risk assessment** | A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend.<br>Knutson et al. (1989) define drought risk analysis as "the process of identifying and understanding the relevant components associated with drought risk as well as the evaluation of alternative strategies to manage that risk". The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, |

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| | social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios. |

# CHAPTER ONE

## BACK GROUND

Drought is considered by many to be the most complex but least understood of all natural hazards, affecting more people than any other hazard (Hagman, 1986). However, there remains much confusion within the scientific and policy communities about its characteristics. It is precisely this confusion that explains, to some extent, the lack of progress in drought preparedness in most parts of the world. Drought is a slow-onset, creeping natural hazard that is a normal part of climate for virtually all regions of the world; it results in serious economic, social, and environmental impacts. Drought onset and end are often difficult to determine, as is its severity. The impacts of drought are largely non-structural and spread over a larger geographical area than are damages from other natural hazards. The non-structural characteristic of drought impacts has certainly hindered the development of accurate, reliable, and timely estimates of severity and, ultimately, the formulation of drought preparedness plans by most governments. The impacts of drought, like those of other hazards, can be reduced through mitigation and preparedness.

Drought preparedness planning should be considered an essential component of integrated water resources management. Increasing society's capacity to cope more effectively with the extremes of climate and water resources variability (i.e., floods and droughts) is a critical aspect of integrated water resources management. Drought preparedness planning will also provide substantial benefit in preparing for potential changes in climate. Historically, more emphasis has been given to flood management than drought management. With increasing pressure on water and other natural resources because of increasing and shifting populations (i.e., regional and rural to urban), it is imperative for all nations to improve their capacity to manage water supplies during water-short years.

In the world, droughts and their effects such as exteme famine, have been known to human kind since ancient times and still occur today with starvation and malnutrition being some of the tragic outcomes in many parts of the world (Theodoros II)

Drought risk is a product of a region's exposure to the natural hazard and its vulnerability to extended periods of water shortage (Wilhite, 2000). If nations and regions are to make progress in reducing the serious consequences of drought, they must improve their understanding of the hazard and the factors that influence vulnerability. It is critical for drought-prone regions to better

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