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FACULTY OF ENGINEERING

DEPARTMENT OF WATER RESOURCES AND MINING ENGINEERING.

FINAL YEAR PROJECT REPORT

DESIGN AND SIMULATION OF ROADSIDE RAINWATER HARVESTING SYSTEM

CASE STUDY: GULU MUNICIPALITY, GULU DISTRICT

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A final year project proposal report submitted to the Department of water resources and mining engineering in partial fulfillment for the award of the Bachelor of Science in Water Resources Engineering degree of Busitema University

EXECUTIVE SUMMARY

The Uganda water supply strategy highlights rain water harvesting from various surface conditions as a main source water supply and for small scale irrigation development at farmer's level. While ponds, dams, and in-situ water harvesting systems have been implemented, roads have primarily been built for transportation purpose – the additional benefits: rain water harvesting for supplemental irrigation, groundwater recharge have not yet been explored. As is the case in the study area of this BSc. research, lack of proper integration of road construction into the broader municipal livelihoods has resulted in various negative impacts: soil erosion and gully formation in cultivated land, flooding of agricultural and inhabited areas, and reduced recharge of groundwater.

Piloting on the Logere - Adere – Gulu town to Aswa 15 Km road in the Northern Region, Uganda. This research aimed at minimizing the negative impacts of road development and maximizing the benefits. It employed both quantitative methods - modelling (HEC-HMS and Hydraulic toolbox in combination with field observation and interviews as well as discussions with diverse stakeholders. The runoff generated was estimated from the roads using HEC-HMS model. The contributions of water supplemental rainfall to enhancing productivity were investigated with crop grown around the reservoir. Field observation and interviews resulted in a better insight on how significant the negative impact of roads could be when they are not properly integrated into water supply and the overall agricultural and rural development programs.

From the model simulation in every catchment, the calibration results of Calculated or simulated discharge for $32.16m^3/s$ and 426 MCM/year from 1996 - 2016 respectively. Simulated result for Validation period for catchment was done and from the discharge different components of the roadside rainwater harvesting were designed accordingly.

The SPSS analyses of the interviews have revealed that 70% of farmers living on the study area were affected by the road side runoff as follows: 45 % of their farm land was exposed to temporary water logging and around 65% of the cultivable land was affected by erosion.

This research has demonstrated that the road in the study area is having significant negative impact to the human water demand livelihoods, but that also it has a huge potential to be a key contributor to the enhancement of the livelihoods. The three major recommendations are :(1) for the betterment of the impacts, it is suggested that Roads for water harvesting and multiple uses be mainstreamed in educational systems (Marcy et al.) There should be integration between relevant institutions and authorities (Marcy et al., 2000) in making future road development plans. And (Chen et al.) Awareness generation should be done to encourage farmers utilize the runoff from roads for productive purposes. Moreover, technical assistance and training's needs to be delivered at grass-root level.

DECLARATION

I **OCEN INNOCENT**, declare that all the material portrayed in this project proposal report is original and has never been submitted in for award of any Degree, certificate, or diploma to any university or institution of higher learning.

Signature .... Date 06/05/2018 ....

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APPROVAL

This project report has been submitted with the approval of the following supervisors

MAIN SUPERVISOR: Mr. LWANYAGA JOSEPH DUMBA

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Date……………………………………………… 27-05-2018

CO-SUPERVISOR: Ms. NAKABUYE HOPE NJUKI

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LIST OF ACRONYMS/ABBREVIATIONS

GIS	Geographical Information System
HEC-RAS	Hydrological Engineering Centers River Analysis System
HEC-HMS	Hydrological Engineering Centers Hydrologic Modeling System
UNMA	Uganda National Metrological authority
HRF	Horizontal roughing filtration
RWH	Rainwater Harvesting
MWE	Ministry of Water and environment
UNRA	Uganda national road authority

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CHAPTER ONE

1 INTRODUCTION

This chapter presents the general information relevant to the research as it clearly shows the problem of interest for the intended research. It as well shows how this study will help reduce the problem through the fulfillment of a number of objectives listed.

1.1 Background

Lack of water of adequate quality and quantity is a major constraint to development in many areas of the world. It affects every aspect of human life: health, agricultural yields, food security, technical development, and the economy of states. Water scarcity and water quality problems are of particular concern in the tropical regions of the world where many countries are less developed. In these regions, there is often a connection between poor water resources and poverty. Water balances (precipitation – evaporation) are often negative, and climatic oscillations, such as the monsoons and the El Niño Southern Oscillation, have far-reaching climatic, social and national effects.(Aroka, 2010)

A great number of people in the tropics rely on scarce and low-quality water sources, a problem that cascades from individual level to household and national scales, and which inhibits development and affects human welfare. Water stressed regions are further threatened by climate change. In Africa, there are predictions that climate change is a potential danger to future water and food scarcity (Solomon et al., 2007). However, it is imperative to recognize that the situations in many African countries are neither hopeless nor are they unmanageable. Africa is considered a water-scarce continent with most of the countries regularly experiencing extreme water shortage resulting from periodic dry spells. About 44% of people living in developing countries do not have access to clean water (UNEP). As of June 2014, Uganda's population with access to safe water in the urban area was 72.8% from 70% in the previous financial year while rural population with access to safe water remains at 64% which is similar to that of June 2013. The average functionality of rural water supplies was at 85% which is 5 percent points less than the sector target of 90% by 2015, SDG 7 target 10.(Terry et al., 2015) and therefore bringing positive impacts on their livelihoods. Such positive impacts could include among others improved physical assets (road, irrigated land, new land under cultivation, ponds); livelihoods diversification (sale of water, commercial agriculture, raising fish, increased demand for labour); reduced vulnerability (seasonal water availability reduced, climate change resilience); and saved time in transport/travelling/irrigation/chores.

The case of Uganda, with its large rural agriculture based population, arid and semi-arid climate, and high inter-seasonal and inter-annual rain fluctuations suggests a high potential for multifunctional road infrastructure and rain harvesting, retention and re-use techniques.

Moreover, the perspective of a changing climate as well as the large scale road construction programme undertaken by the government, Netherlands organization called Metameta and the emphasis on poverty reduction provide the adequate timing for inclusion of multifunctional considerations into the infrastructure development agenda.

However, because the effects of roads are complex, can be positive as well as negative, and because road infrastructure planning and construction that integrate hydrological concerns are recent, the impacts of a multifunctional approach to road construction have to be empirically assessed.

Finally, while concerns for ground/surface water will decrease negative effects that occur because of insensitive road construction methods; these may also increase conflicts, since issues of unequal access to water resources will just add to existing distributional issues of costs and benefits of road construction. Such issues and the protracted negotiations that may result from this situation are also likely to complicate the task of engineers and surveyors in determining the shape and trajectory of the road and water infrastructure. Nevertheless, village politics and questions of access to water resources should first be addressed, so that vulnerable households can be positively discriminated and equal access to water resources can be safeguarded

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