FACULTY OF ENGINEERING

DEPARTMENT OF WATER RESOURCES ENGINEERING

ESTIMATION OF GROUNDWATER RECHARGE USING GIS AND REMOTE SENSING

Case study: Kabayongo Catchment, Nakitoma Sub-County, Nakasongola District.

FINAL YEAR PROJECT

By

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ABSTRACT

Groundwater is one of the best alternatives that can be used to augment water demand of an area especially those found in arid and semi-arid environments where rainfall is un reliable. However, this cannot sustainably be achieved unless accurate prediction of recharge to the groundwater aquifer is done (Tleane & Ndambuki, 2020). The objectives of this study were to estimate the groundwater recharge with a view of ensuring adequate and sustainable groundwater resources in Kabayongo Catchment, Nakitoma Sub-County, Nakasongola District in Central Uganda and to map groundwater potential recharge zones after considering thematic layers of different factors with significant influence on Groundwater Recharge. For example, rainfall, soil properties, land use and land cover, lithology and topography of the area. The thematic layers were integrated together to generate a GWPZ map by the use of Analytic Hierarchy process (AHP) which was used for weight assignment, and Weighted Index Overlay Analysis in ArcGIS 10.8.2. The rainfall map was generated in ArcGIS 10.8.2 environment using the IWD tool in spatial analysis tools. This map was used to obtain the average annual rainfall of the study area, and the recharge was estimated from Chaturvedi empirical formula (Addisie, 2022). The results showed that about 15% of the average annual rainfall recharges the aquifer to replenish the groundwater resource of the study area.

DECLARATION

I **MUGENI JOSHUA** do hereby declare that to the best of my knowledge and belief this report is my original work and has never been submitted to any other University, college, or Institution of higher learning for the purpose of meeting any academic requirement. It is therefore authentic and where any references or secondary information have been used, they have been given due acknowledgement.

Signed.....

MUGENI JOSHUA

Date.....

APPROVAL

I ..... declare that, I have supervised this study and that in my opinion, it confirms to accepted standards of scholarly report in partial fulfillment for the award of Bachelor of science in water resources engineering of Busitema University.

Signed.....

(Project Supervisor)

Date.....

DEDICATION

I dedicate this work to my brother Ephraim with love and hope that one day by the grace of God he shall be a person he always desired.

ACKNOWLEDGEMENT

I greatly acknowledge a number of persons whom without their support I would not have made it this far. Firstly, I bless the name of my Lord Jesus Christ for the life and grace throughout my academic journey and thank the Spirit of God for the wisdom which has enabled me to make right decisions in life and thus I have been reserved to this end. I also thank my pastors, Samuel Okudan and John Kennedy for their support and guidance to me.

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My beloved parents Mr. Wafula Augustine and Mrs. Nekesa Scovia, I thank you so much and I belief you are a great blessing to me from the Lord God, due to the fact that you have always been seeking the best for me. To my loving sister Nandera Mary and your family, I surely bless the name of the Lord for you, you have always come through for me in all life. I also acknowledge all my brothers and sisters for supporting and believing in me all this far.

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ACRONYMS

WME; Ministry of Water and Environment

GWPZ; Groundwater potential recharge zones

GIS; Geographical Information System

SWAT; Soil Water Assessment Tool

RS; Remote Sensing

AHP; Analytic Hierarchy process

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1 CHAPTER ONE

1.0 INTRODUCTION

This chapter includes the Background of the study, problem statement, objectives, justification, significancy of this study, and scope.

1.0.1 BACKGROUND OF THE STUDY

Water being the essential element on earth due to its need in society, economy and environment, there has been un stable reliability and doubtful quality on surface water worldwide which has led to an increase in need for groundwater supply in the recent years through borehole sinking. Due to its storage underneath the surface, groundwater is less contaminated with pollution therefore it doesn't require large investments in treatment and it is considered the second largest available reservoir for fresh water after the majority being locked away in ice caps and glaciers (Baker *et al.*, 2016). This makes groundwater an important natural resource that provides drinking water for humans and animals, as well as irrigation for agriculture and industrial processes.

In groundwater water exploration, the hydrogeological surveys are carried out to understand the occurrence of water in the underground aquifers and the reports obtained from these surveys are used to give recommendations to borehole drillers. Unfortunately, these reports do not address the potential recharge zones which are the potential areas for siting and the recharge estimations of the supplies. Areas with high potential recharge zones are likely to have a greater recharge estimate as compared to areas of a low potential recharge zones. To ensure that such groundwater supplies are sustainable, it is important that accurate prediction of recharge to the groundwater aquifer is done (Tleane & Ndambuki, 2020). This can also help in determining how much can be withdrawn from the aquifer without a depletion.

Generally Nakasongola District is found in semi-arid areas of Uganda often characterized by rampant drought (Egeru *et al.*, 2022). Because of un reliable rainfall in the area, there should be alternative suggestions to address water scarcity. The Government of Uganda under its Ministry of Water and Environment has opted to constructing valley tanks in the area and also doing bulky water transfer from lake Kyoga to areas of scarcity. And according to (#NewVision Uganda, 15th

5.0.3 Recommendations

- Nakasongola District at large faces a challenge of water scarcity therefore exploration of sustainable groundwater resources can help in solving this challenge. This can be achieved through integration of vertical electrical sounding method with GWPZ mapping.
- The GWPZ maps should be generated and protected measures established to protect the potential recharge zones.
- The artificial recharge systems should be adopted for those boreholes that are not lying in the excellent recharge zones.
- I recommend the government to do bulk water transfer from the areas of plenty (lake Kyoga) to areas of scarcity.

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empirical methods. *H2Open Journal*, *5*(3), 457–468. https://doi.org/10.2166/h2oj.2022.026

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