FACULTY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF WATER RESOURCES ENGINEERING

FINAL YEAR PROJECT REPORT

MITIGATING THE IMPACT OF PITLATRINES ON GROUNDWATER QUALITY

Case study: Busitema sub county.

By

NSAWO JOHN

BU/UP/2020/0303

SUPERVISOR: Eng Dr. JOSEPH DDUMBA LWANYAGA

Final year project report submitted to the department of water Resources Engineering in the partial fulfilment of the requirement for the award of a Bachelor of Science in Water Resources Engineering at Busitema University

September 2024

ABSTRACT

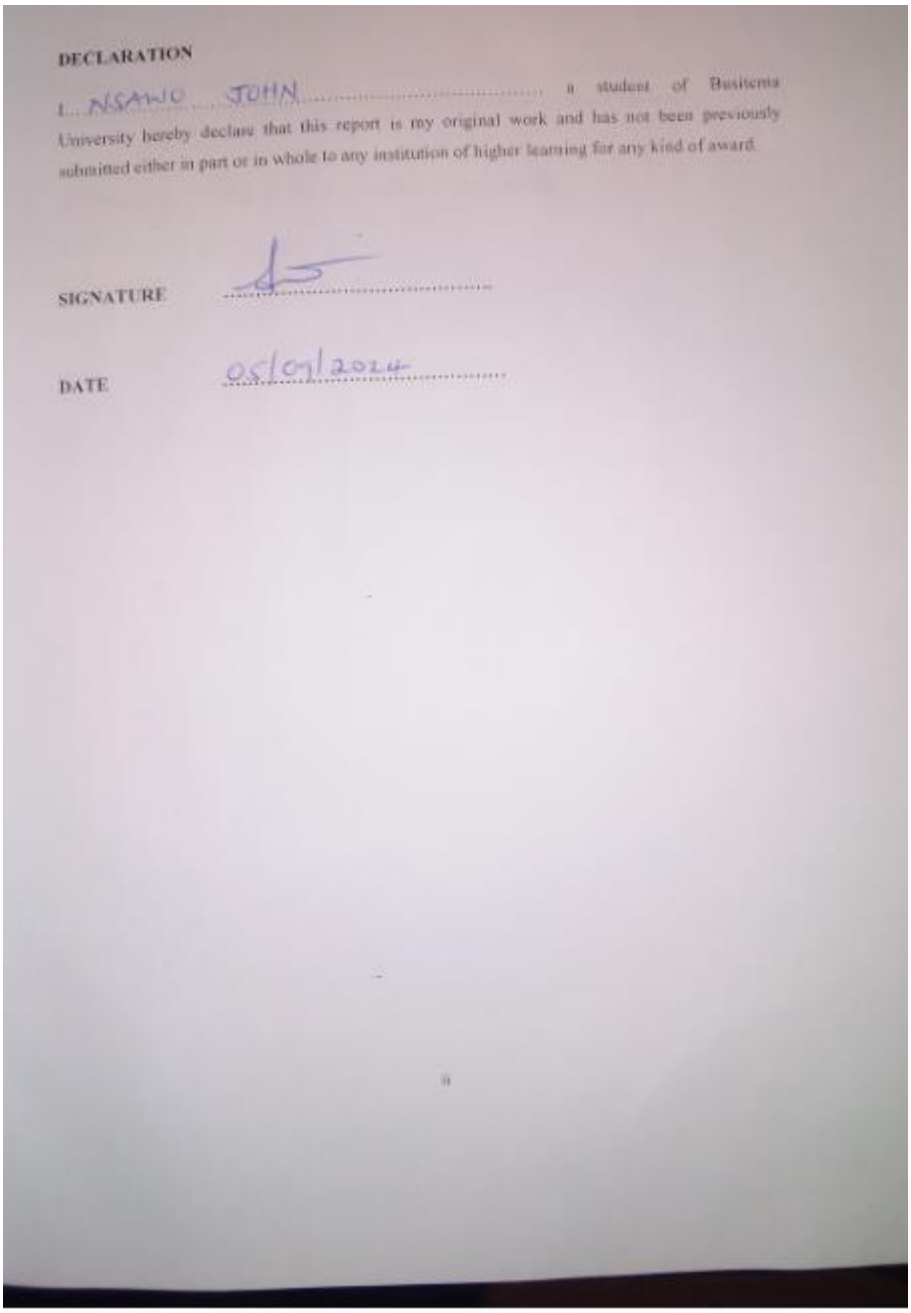
This study investigated the impact of pit latrines on groundwater quality in areas reliant on this resource for drinking water. It employed a mixed-method approach, combining hydrogeological and sanitation engineering principles.

The primary concern addressed was the potential pollution of groundwater sources by fecal matter originating from pit latrines. This contamination posed a significant health risk due to the presence of pathogens in human waste.

The main objective was to develop a comprehensive understanding of this issue and propose effective mitigation strategies. The specific objectives were threefold; to characterize groundwater within Busitema sub county, to develop a pollutant tracking model to predict the movement of fecal matter into groundwater and to evaluate existing mitigation strategies for their effectiveness in reducing fecal matter contamination in groundwater. The study employed a combination of methods. Groundwater characterization involved physicochemical and microbiological analysis of water samples. Pollutant tracking involved the development and application of a numerical model. Finally, existing mitigation strategies, such as pit latrine siting regulations and lining materials, were evaluated through literature review and potentially field studies. The key findings of the study were expected to include the development of a predictive model for contaminant movement, and a critical evaluation of existing mitigation strategies.

These findings would lead to crucial conclusions on the best practices for minimizing the impact of pit latrines on groundwater quality. Based on these conclusions, the study would propose specific recommendations for improved sanitation infrastructure design, siting regulations, and potential novel mitigation techniques. This research would contribute significantly to safeguarding public health by providing valuable insights for communities and policymakers working to ensure

safe drinking water supplies.



DECLARATION

I... NSANJO JOHN ..... a student of Busitema University hereby declare that this 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 05/09/2024 .....

APPROVAL

This report has been produced under my supervision and has been submitted with my approval for examination and award of B.Sc. Water Resources Engineering at Busitema University.

SUPERVISOR: Eng Dr. JOSEPH DDUMBA LWANYAGA

SIGNATURE .....

DATE 2024/09/12

iii

ACKNOWLEDGMENT

I extend my sincere thanks to the Almighty God who has gifted me with the gift of life and has enabled me to reach this academic height as He has been the provider of all the necessary requirements.

Great thanks to my beloved parents, Mr. Samanya Paul and Mrs. Naigaga Elizabeth for their endless encouragement, moral support, and most importantly their unwavering financial backing that helped achieve this milestone. Their love and belief in me have been instrumental in my success.

I would also like to express my gratitude to my friends for their prayers and advice given to me in the course of this project.

My sincere gratitude also goes to my supervisor Eng Dr. Joseph Ddumba Lwanyaga and Mr. Maseruka. Bendicto for their continuous guidance during this research. Their advice and tireless effort in following up the progress of this project was quite instrumental for its success

TABLE OF CONTENTS

Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

GIS-Geographical Information System

HC-Health Centre

NDP-National Development Plan

NTU-Nephelometric Turbidity Units

SDG-Sustainable Development Goal

TDS- Total Dissolved Solids

UBOS- Uganda Bureau Of Statistics

UNICEF-United Nations International Children's Emergency Fund

UNBS-Uganda National Bureau of Standards

WHO- World Health Organization

CHAPTER ONE: INTRODUCTION

1.1 Background of the study.

Globally, approximately 1.77 billion people rely on pit latrines as their primary means of sanitation, constituting 24% of the world's population(Water & Winny, 2019).While they provide a basic level of sanitation compared to sewer systems, concerns about their potential to pollute groundwater, a critical source of drinking water for many communities, have driven research in this area.

Across Africa, over 500 million people rely on pit latrines for sanitation, making it the most common sanitation method on the continent(Evans et al., 2015).While pit latrines offer a significant improvement over open defecation, their impact on groundwater quality, a vital resource for many communities, raises concerns.

The primary driver behind this research is the threat to human health posed by contaminated groundwater. Pit latrines harbor pathogenic bacteria like E. coli, Salmonella typhi and Vibrio cholera, along with nitrates and other contaminants. These can leach into groundwater, polluting nearby wells and amplifying the risk of waterborne diseases like cholera, typhoid, and diarrhea. Vulnerable populations, particularly children and pregnant women, bear the brunt of this contamination, facing a disproportionately higher risk of these waterborne illnesses(Graham & Polizzotto et al., 2023).

Over 50% of the United States population depends on groundwater for drinking water. Groundwater is also one of our most important sources of water for irrigation. Unfortunately, groundwater is susceptible to pollutants(Rahaman, 2018).

Despite the abundance of surface water in Uganda (18% of the land area) over 70% of the rural population including small towns relies almost exclusively on groundwater for portable water supply. As a result, provision of safe water to rural communities in Uganda has depended primarily upon the construction of wells and protection of spring discharge. Particular attention has recently been directed at developing the shallow – well aquifer since the formation is less costly and recent study has found it to be more productive than deeper, bedrock aquifer. The promotion of Pit Latrines has traditionally been done with very little knowledge of its impact on the quality of groundwater in Uganda (Town, 2019).`

REFERENCES

Aboagye, D., & Zume, J. T. (2018). Assessing groundwater quality in peri-urban localities of Kumasi , Ghana. *African Geographical Review*, *00*(00), 1–16. https://doi.org/10.1080/19376812.2018.1484781

Appl, J. et al. (2019). *Evaluation of groundwater quality characteristics in Lagos city*.

Engström, E. (2015). *Predicting the transport of escherichia coli to groundwater* (Issue May). https://doi.org/201504

Farooqui, A., Khan, A., & Kazmi, S. U. (2009). *Investigation of a community outbreak of typhoid fever associated with drinking water*. *6*, 1–6. https://doi.org/10.1186/1471-2458-9-476

Fernández-Arévalo, T., Lizarralde, I., Fdz-Polanco, F., Pérez-Elvira, S. I., Garrido, J. M., Puig, S., Poch, M., Grau, P., & Ayesa, E. (2017). Quantitative assessment of energy and resource recovery in wastewater treatment plants based on plant-wide simulations. *Water Research*, *118*, 272–288. https://doi.org/10.1016/J.WATRES.2017.04.001

Graham, J. P., & Polizzotto, M. L. (2013). *Review Pit Latrines and Their Impacts on Groundwater Quality : A Systematic Review*. *121*(5), 521–530.

Gwimbi, P., George, M., & Ramphalile, M. (2019). *Bacterial contamination of drinking water sources in rural villages of Mohale Basin , Lesotho : exposures through neighbourhood sanitation and hygiene practices*. 1–7.

Impact, S., For, A., Morikiswa, P., Solar, M., Piped, P., & District, T. (2023). *PROPOSED MORIKISWA MINI SOLAR POWERED PIPED WATER*. *May*.

Moses. (2019). *Intrinsic groundwaterpollution vulnerability of Masama east well field, Khurutshe Area, Botswana*.

NWSC. (2020). *No Title*.

Okame, R. (2022). *A POLLUTANT TRACKING MODEL FOR THE MITIGATION OF MERCURY-*. *November*.

Rahaman, A. R. and H. (2018). *Contamination of arsenic , manganese and coliform bacteria in groundwater at Kushtia District , Bangladesh : human health vulnerabilities Aminur Rahman*

and Hafezur Rahaman. https://doi.org/10.2166/wh.2018.057

Talk, A. (2003). *Ground water pollution*.

Town, B. (2019). *Pit Latrines & their Impact on Groundwater in Small Towns in Uganda*. 3.

Water, G., & Winny, N. D. (2019). *FACULTY OF ENGINEERING DEPARTMENT OF WATER RESOURCES AND MINING ENGINEERING FINAL YEAR PROJECT REPORT DEVELOPMENT OF A POLLUTANT TRACKING MODEL FOR THE MITIGATION OF FECAL MATTER MOVEMENT INTO*.

WHO/UNICEF. (2017). *Safely managed drinking water*.

Wook, D. L. J. (2004). *World Health Organization Water, Sanitation and Hygiene Links to Health FACTS AND FIGURES – *updated November 2004*. *November*.

Zhang, F., Zhang, T., Zhu, H., & Borody, T. J. (2019). Evolution of fecal microbiota transplantation in methodology and ethical issues. *Current Opinion in Pharmacology*, *49*(Cd), 11–16. https://doi.org/10.1016/j.coph.2019.04.004