FACULTY OF ENGINEEERING

DEPARTMENT OF WATER RESOURCES ENGINEERING

A PREDICTIVE WATER QUALITY MODEL FOR THE ESTIMATION OF WATER POLLUTION.

CASE STUDY: RIVER MALABA

BY: ODONGO JOSEPH JOB EKAAL

BU/UP/2019/71876

SUPERVISOR: Mr.MUGISHA MOSES

A final year project report submitted to the Department of Water Resources Engineering as a partial fulfilment of the requirements for the award of a Bachelor of Science degree in Water Resources Engineering

SEPTEMBER 2023

ABSTRACT

Water is an essential element to both human life and the entire ecosystem .This water pollution caused by different activities such as agricultural activities ,indiscriminate waste disposal among others .River Malaba located in Eastern Uganda which is transboundary water body shared by Uganda and Kenya and whose water flows to lake Kyoga is at risk of pollution as a result of the human activities taking place along the river such agricultural practices, ,sand mining , industrial effluent and urban waste from Malaba town among others this therefore puts the beneficiary population at risk of water pollution adverse effects like waterborne diseases such as diarrhea ,typhoid among others. This study developed a machine learning predictive water quality model basing on Random Forest classifier algorithm having produced an accuracy of 87.6% on the following physio-chemical parameters PH, Dissolved Oxygen, Nitrates, Phosphates, Color, Turbidity and total coliform after model testing .This model is therefore developed to assist in real-time control of future water quality changes thus simplifying judgement of the degree of water pollution of water pollution hence improving management level of river Malaba and also providing data to policy makers and environment management teams around the river acting as basis for early warning .

ACKNOWLEDGEMENT

I wish to appreciate the Almighty GOD who has gifted me with life and has enabled me to reach this academic height . Great thanks to my beloved family and friends for their endless encouragement and moral support and for their prayers and advise given to me. My sincere gratitude also goes to my supervisor Mr. Mugisha Moses, for his continuous guidance towards this work. His advice and effort in following up the progress of this work was quite instrumental for its success. Also, appreciation goes to the water resources engineering class of 2019 for the guidance and cooperation towards achieving this work.

DECLARATION

I ODONGO JOSEPH JOB EKAAL declare that this report is a result of my own research and has never been submitted to any institution of higher learning for any academic award. I stand to account for all this information contained in this report and to regret any queries that may arise out of it if there is any.

ODONGO JOSEPH JOB EKAAL

Signature ……

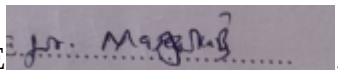
Date…22…/…02……/…2024…….

APPROVAL

This final year research project has been submitted to the Department of Water Resources Engineering under my supervision.

SUPERVISOR

MR. MUGISHA MOSES

SIGNATURE  ……

DATE……22……/……02……/……2024……

TABLE OF CONTENTS

Contents

ABSTRACT i

ACKNOWLEDGEMENT ii

DECLARATION iii

APPROVAL iv

LIST OF ACRONYMS ix

1.0 Introduction 1

1.1 Back Ground 1

1.2 Problem statement 2

1.3 Objectives of the study 2

1.3.1 Main objective 2

1.3.2 Specific objectives 2

1.4 Scope of the study 2

1.4.1 Geographical Scope 2

1.4.2 Conceptual Scope 3

1.4.3 Time Scope 3

1.5 Significance 3

2.0 LITERATURE REVIEW 3

2.1 potential sources of water pollution 3

2.2 Water quality predictive Modelling 4

2.2.1 Water Quality assessment 4

2.2.1 Water quality index 5

2.2.2 Predictive water quality modelling 5

2.3 To develop effective mitigation measures and management strategies of water pollution 9

3.0 METHODOLOGY 11

3.1 Introduction 11

3.3 Data acquisition and analysis 12

3.4 Secondary data Collection techniques 12

3.5 Primary data collection and analysis techniques 12

3.6 Qualitative data collection 12

3.6.3 Questionnaires 13

3.7 Data processing Tools used for the study 13

3.8 Specific objective one: To identify the potential pollution sources around the river Malaba area. 14

3.8.1.1 PH Analysis on the water samples 14
3.8.1.2 Turbidity tests on water samples 14
3.8.1.3 Dissolved oxygen 15
3.8 Specific objective two; To develop water quality model that predicts water quality along river Malaba. 16
3.8.1 Data collection 16
3.8.2: Data preprocessing 16
3.8.3: Training the model 18
3.8.4: Model evaluation 19
3.8.7 User interface development 20
3.8.7.1 System validation 20
3.9 Specific objective three; To develop effective water pollution mitigation measures and management strategies. 22
3.9.1 Data collection 22
3.9.2 Focus group discussions (FGDs) 22
3.9.3 Review of existing data/policies 22
3.9.5 Stakeholder engagement approach. 22
4.0 RESULTS AND DISCUSSION 23
4.1 Specific objective one; 23
4.1.2 Results from GIS and Google earth. 25
4.3 specific objective three; 28
4.3.1 Proposed water pollution mitigation measures 28
5.2 CHALLENGES 31
5.0 REFERENCE 33
6.0 APPENDIX 35
6.1 FINAL YEAR RESEARCH PROJECT QUESTIONNAIRE 35

List of tables

Table 1table showing different accuracy of classifiers used in model development 19
Table 2table showing different equipment used for water quality analysis 23
Table 3Table showing water quality test results..... 24

List of figures

Figure 1 Figure showing study area location 11
Figure 2 A map showing different land use types along the river..... 25
Figure 3 Figure above shows the general outlook of the prediction model(website) 26
Figure 4 Figure above shows how a User can make predictions Using WQI Values obtained from the Laboratory analysis of water quality 27
Figure 5 Figure above shows a predicted water Quality..... 27
Figure 6Figure 6 figure showing water quality analysis equipment 51
Figure 7figure showing respondents attending the questionnaire 52

LIST OF ACRONYMS

NWSC- National water and sewerage cooperation

MWE -Ministry of water and Environment

DWRM-Directorate of water Resources management

TDLG-Tororo District Local government

1.0 INTRODUCTION

This chapter consists of back ground of the study, problem statement, objectives, scope of the study significance and justification.

1.1 Back Ground

The Malaba River located in Eastern Uganda is a transboundary water resource shared by Uganda and Kenya, whose water flows to River Nile through Lake Kyoga is rich with biodiversity and many natural resources, and plays an important role in the sustainable development of the country. The river therefore benefits the population of both countries. Unfortunately, its water quality has always been compromised as a result of unplanned anthropogenic activities such as Malaba town, agricultural activities other human activities like sand mining, distillation and the indiscriminate disposal of untreated waste mostly from the Kenyan side. (NewVision,2017 and URN 2021). The main issues in managing water resources include pollution (toxic chemicals) and excessive nutrient levels. (Sadeghi an, 2017). As a way of combating these effects associated with contaminated water, it is essential to assess different aspects of water quality. Predicting water quality parameters a few steps ahead can be beneficial to achieve this. When determining the source, concentration, distribution and risk of chemical pollutants in a specific surface water body, AI-based models are very helpful tools. The results of these models are vital for environmental impact assessments and may offer environmental management organizations a helpful method for decision-making in relation to increasing water pollution. (Izhar Shah et al., 2021). Accurate forecasting value will undoubtably improve the management level of water resources as most water quality monitoring stations but cannot play the role of water quality prediction, however the monitoring process can provide a predictive basis for some data driven models through real time control of future water quality changes, water pollution changes can be judged thereby

5.0 REFERENCE

Chen, Y., Song, L., Liu, Y., Yang, L., & Li, D. (2020). A review of the artificial neural network models for water quality prediction. *Applied Sciences (Switzerland)*, *10*(17). https://doi.org/10.3390/app10175776

Izhar Shah, M., Alaloul, W. S., Alqahtani, A., Aldrees, A., Ali Musarat, M., & Javed, M. F. (2021). Predictive modeling approach for surface water quality: Development and comparison of machine learning models. *Sustainability (Switzerland)*, *13*(14). https://doi.org/10.3390/su13147515

Patel, J., Amipara, C., Ahanger, T. A., Ladhva, K., Gupta, R. K., Alsaab, H. O., Althobaiti, Y. S., & Ratna, R. (2022). A Machine Learning-Based Water Potability Prediction Model by Using Synthetic Minority Oversampling Technique and Explainable AI. *Computational Intelligence and Neuroscience*, *2022*. https://doi.org/10.1155/2022/9283293

Sadeghian, A. (2017). *Water Quality Modeling of Lake Diefenbaker*. 1–324.

Solanki, A., Agrawal, H., & Khare, K. (2015). Predictive Analysis of Water Quality Parameters using Deep Learning. *International Journal of Computer Applications*, *125*(9), 29–34. https://doi.org/10.5120/ijca2015905874

Chen, Y., Song, L., Liu, Y., Yang, L., & Li, D. (2020). A review of the artificial neural network models for water quality prediction. *Applied Sciences (Switzerland)*, *10*(17). https://doi.org/10.3390/app10175776

Izhar Shah, M., Alaloul, W. S., Alqahtani, A., Aldrees, A., Ali Musarat, M., & Javed, M. F. (2021). Predictive modeling approach for surface water quality: Development and comparison of machine learning models. *Sustainability (Switzerland)*, *13*(14). https://doi.org/10.3390/su13147515

Patel, J., Amipara, C., Ahanger, T. A., Ladhva, K., Gupta, R. K., Alsaab, H. O., Althobaiti, Y. S., & Ratna, R. (2022). A Machine Learning-Based Water Potability Prediction Model by Using Synthetic Minority Oversampling Technique and Explainable AI. *Computational Intelligence and Neuroscience*, *2022*. https://doi.org/10.1155/2022/9283293

Sadeghian, A. (2017). *Water Quality Modeling of Lake Diefenbaker*. 1–324. http://hdl.handle.net/10388/8225

Solanki, A., Agrawal, H., & Khare, K. (2015). Predictive Analysis of Water Quality Parameters using Deep Learning. *International Journal of Computer Applications*, *125*(9), 29–34. https://doi.org/10.5120/ijca2015905874