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

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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

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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 .

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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  ……

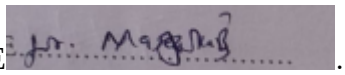
Date…22…/…02……/…2024…….

APPROVAL

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

SUPERVISOR

MR. MUGISHA MOSES

SIGNATURE  ……

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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