UNIVERSITI TEKNOLOGI MARA

BIOCHEMICAL OXYGEN DEMAND (BOD) PREDICTIVE MODEL BASED ON WATER QUALITY CHARACTERISTICS WITH DEEP LEARNING NEURAL NETWORK

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ABSTRACT

Water is an essential element on this earth in which humans, animals, and plants depend entirely on water sources for a living. Unfortunately, human activities have polluted water sources. Water pollution is typically caused by organic or chemical impurities. Organic matter is contaminated by microorganisms such as bacteria and viruses that are formed by human, animal, and plant waste. Pesticides such as nitrates and phosphates, industrial acids, hydrocarbons, home products, and heavy metals all contribute to chemical contamination. Water is often examined for pollution in its physical, biological, and chemical properties. In Malaysia, the Klang River experiences high water pollution levels every year and takes a long time to rectify the problem. As a solution, each river must have a smart system capable of assessing water quality and monitoring the water quality index readings. In redressing this situation, water quality must be tested for pollution. However, to test and determine the reasonable acceptance level for all water parameters takes some time. Some of the value of the parameter is not available impromptu. The most critical indicator parameter in the assessment of water quality is the Biochemical Oxygen Demand (BOD). The amount of oxygen required to eliminate waste organic matter from water is measured as BOD. When assessing water quality, the most important factor is BOD. BOD readings can be obtained through time-consuming laboratory tests that are influenced by environmental factors at the time the test is performed. Therefore, the emphasis is on implementing environmentally friendly techniques that do not necessitate the use of physical tools for measurement. The deep learning neural network has emerged over the past several years as a promising and versatile method for data prediction in many fields. A deep learning neural network is used by making predictions using samples and previous readings of the water parameters being tested. Water quality data collected over a seven-year period was utilized to validate the deep learning neural network model's accuracy. Nevertheless, a problem arises where the water quality data recorded throughout the period is not uniform due to various human and environmental factors. This suggests that the data gathered by the personnel does not adhere to a set timetable and that there may be variations in the water's quality because of heat, rainfall, and turbidity. The uneven gap found in the water quality data is restructured by using interpolation techniques to reorganize the data. Interpolation is a form of mathematics for predicting the values between known data points. This procedure aids in filling in the gaps. To compare the prediction results made by deep learning neural network techniques, three models were used, namely LSTM, bi-LSTM and GRU. These models were chosen based on past reports on their effectiveness in making water quality predictions. The benefits of LSTM, biLSTM, and GRU models that can deal with long-term sequential data contribute to the prediction of BOD values using water parameters, where BOD is a key factor in determining WQI readings. The results show that, the GRU and LSTM models both generate most identical results compared to biLSTM. The RMSE test results show that the LSTM model has a value of 0.4020, while the GRU model has a value of 0.4060. The RMSE value for biLSTM, on the other hand, is 0.3774. Furthermore, the biLSTM model takes the longest time to predict the BOD, averaging 38 seconds. LSTM and GRU were faster, at 21 and 18 seconds, respectively. This discovery demonstrates that important BOD values for calculating WQI readings can be obtained using water parameters and processed using a deep learning neural network system.

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CHAPTER 1

INTRODUCTION

1.1 Background Study

Water affects how humans, animals, and plants live on this planet. Access to safe drinking water is critical for a healthy lifestyle. Not only do plants require water to thrive, but plants that live submerged also require high-quality water to reproduce and perform their functions in the water. Malaysia is a developing country dedicated to enhancing its citizens' quality of life. Typically, development entails the process of modernization through the conversion of less developed rural areas to more progressive metropolitan areas. This trend will indirectly draw a rising number of people as new prospects for improving living conditions become available. There will be both short and long-term implications on the ecosystem due to population growth. Agricultural and livestock activities, automobile servicing and repair, home waste disposal and sewage treatment, and manufacturing businesses have been significant contributors to environmental contamination, notably water pollution in human settlements (Singh et al., 2016; Mununga Katebe et al., 2023; Awasthi et al., 2018; Ferronato & Torretta, 2019).

The Malaysian government launched the Green Technology Master Plan Malaysia (GTMP) 2017-2030 in 2017 to address these issues. GTMP is the resulting program of Malaysia's Eleventh Malaysia Plan (2016-2020) to redirect the country's growth path toward green technology, which has been dubbed one of the six game-changers. The GTMP focuses on six critical areas: energy, manufacturing, transportation, buildings, sewage, and water, with the shared goal of achieving sustainable resource usage. One of the GTMP's primary recommendations for the water sector is to focus on adapting and adopting appropriate technology to improve the efficiency and optimization of finite water resources as water on Earth is finite, circulating indefinitely between oceans, atmosphere, and land, remains the same throughout the planet (Valhondo & Carrera, 2019). Appropriate technology will enhance and provide more affordable treatment alternatives. The aim for the water sector in GTMP is shown in Table 1.1 (KeTTHA, 2017).