Biochemical Oxygen Demand Prediction in the Buriganga River of Bangladesh Using Novel Hybrid Machine Learning Algorithms

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1. Introduction

In Bangladesh, the river water system is tremendously dynamic and considered to be the most important natural resource for domestic, irrigation, and recreational purposes.

Degradation of the inland surface water quality due to the rapid expansion of population and polluting industries in cities and the increased use of fertilizers

Continuous monitoring of water quality parameters is essential for controlling severe organic loading conditions in water and maintaining aquatic life ecosystems.

Traditional approaches used for measuring biochemical oxygen demand (BOD₃) is time-consuming as it requires a five-day incubation period.

Surface water quality undergoes rapid seasonal and local fluctuations, and the 5-day BOD test results would be no longer relevant to the current field condition.

2. Research Purpose

To provide an efficient water data management system using AI/ML techniques and develop improved pollution control strategies to protect natural source water from domestic and industrial pollutants in developing countries such as Bangladesh.

Objectives of the study:

- Develop and analyze the performance efficiencies of novel hybrid ML models for prediction of BOD₃
- Identify the most influential water quality parameters in predicting BOD₃ of the highly polluted river in Bangladesh.

3. Study Area

Location background

- Bangladesh is a south Asian country located at east of India at the Bay of Bengal.
- One of the most densely populated countries in the world with an estimated 171 million people (in 2021)
- Dhaka is the capital and largest city of Bangladesh
- Thousands of factories located around the rivers near Dhaka city release their wastes into the rivers and make the river system highly polluted.

Study Area

- Buriganga River system at southwest region of Dhaka, Bangladesh
- Catchment area: 253 km² with a length, width, and depth of 27 km, 400 m, and 10 m, respectively
- Monitoring sites and sampling period: Eight monitoring sites along Buriganga River and five monitoring sites along Turag River with a sampling period of 2015-2017.

4. River Water Pollution

Current situation of the Buriganga River

Level of organic pollution (BOD₃) during the sampling year of 2015

- Higher level of BOD₃ (organic loading) in dry season than the wet season.

5. Machine Learning Analysis

Parameters affecting organic loading (BOD₃)

Chemical oxygen demand, total dissolved solids, conductivity, total solids, suspended solids, and turbidity are the most influential parameters for predicting BOD₃.

Prediction model performance

Hybrid ML algorithms indicate satisfactory model execution in BOD₃ prediction with precision accuracy ranging from 86% to 91%, the best-performing prediction model was the hybrid RF-SVM model with an accuracy of 91%.

6. Conclusion

- Novel hybrid ML models were developed to predict BOD₃ in a highly polluted river of Bangladesh.
- The best performing hybrid model RF-SVM provided the most reliable measurement of BOD₃ with a prediction success of 91%.
- The most important water quality parameters affecting BOD₃ are chemical oxygen demand, total dissolved solids, conductivity, total solids, suspended solids, and turbidity.
- This study suggested that properly tested and optimized ML hybrid models can potentially be used in forecasting BOD₃. This will alert the river water operators about the BOD levels associated with possible future pollution events.
- The application of the novel hybrid models provides a more accurate and direct measure of BOD₃ without extensive laboratory analysis including a five-day incubation period and allows timely information to the operators about any river contamination for control purposes.

References


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