Developing a Real-Time Forecasting Model and Evaluating the Potential for Improving Pollution Levels in the Cau Bay River, Hanoi

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Introduction: The Cau Bay River is an important drainage waterway for the Long Bien-Gia Lam area (Hanoi). Effective water quality monitoring and real-time predictive modeling are critical for long-term water management. Research questions: 1. Can we evaluate the water quality status, pollution sources, and self-purification capacity of the Cau Bay River? 2. How do aeration and microbial augmentation affect pollutant transformation, and how accurately can these processes be modeled using mathematical formulas? 3. How can programming platforms and AI-based approaches be integrated with real-time environmental data to develop a predictive and early-warning system? Methods & Results: Collected water samples were analyzed for BOD5, NH4?, and NO3?. The is polluted, with a low self-cleaning capacity. Then collected water samples were prepared into three experiments to assess the effects of natural flow (sample 0); forced aeration (Sample 1) and forced aeration with aerobic microorganisms (sample 2). The quadratic polynomial model achieved a high degree of fit ($R^2 = 0.9$), accurately reflecting the trends of BOD5, NH4?, and NO3? (except for NO3? in natural flow). The model was implemented using Next.js, integrating real-time meteorological data from the OpenWeather API and AI models like a chatbot interface, speech recognition, and a weather-driven water quality model to provide automatic real-time updates. This system lets users query the model, alter parameters, and get automatic analytical results. Conclusion: This study provides reasonable and sustainable strategies to improve the Cau Bay River's water quality, which is applicable to other urban rivers.

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