ABSTRACT

A HYBRID ARIMA–LSTM MODEL WITH THE ADAMW OPTIMIZATION ALGORITHM FOR FORECASTING TOTAL SUSPENDED SOLIDS IN WASTEWATER STABILIZATION PONDS

by

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Long-term water quality monitoring in wastewater treatment plants (WWTPs) is essential to ensure effective and consistent treatment performance. One important parameter in wastewater quality assessment is Total Suspended Solids (TSS). Forecasting TSS concentrations supports data-driven operational decision-making. However, single forecasting approaches such as the Autoregressive Integrated Moving Average (ARIMA) model have limitations in capturing long-term dependencies in time series data. To overcome this limitation, this study integrates ARIMA with Long Short-Term Memory (LSTM) through a hybrid ARIMA–LSTM model optimized using the AdamW algorithm. ARIMA is used to model linear patterns in TSS data, while residuals from ARIMA forecasts are learned using LSTM. The AdamW algorithm is applied during LSTM training to improve residual learning stability through decoupled weight decay. This study aims to construct and evaluate the forecasting accuracy of the hybrid ARIMA–LSTM model for TSS prediction. Exogenous variables, including pH and temperature, were initially considered but did not improve model performance; therefore, ARIMA was selected as the base model. Validation results show that for a one-month forecasting horizon, the inlet Mean Absolute Percentage Error (MAPE) decreases from 28.97% (ARIMA) to 25.97% (hybrid), while the outlet MAPE decreases from 16.09% to 15.96%. For a six-month forecasting horizon, the inlet MAPE decreases from 60.22% to 51.08%, and the outlet MAPE decreases from 22.36% to 22.23%. These results indicate that the hybrid ARIMA–LSTM model with AdamW optimization provides more consistent forecasting accuracy, particularly for longer forecasting horizons, and can support time series–based WWTP management.

Keywords: *AdamW optimizer, ARIMA-LSTM, hybrid, TSS.*