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Why Artificial Intelligence Is Beneficial For Low Intermediate Level Waste Management for Long-Term Sustainable Near Surface Disposal Design: Enhancing Groundwater Monitoring Using Time Series Forecasting

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To support the development of a Near-Surface Disposal (NSD) facility in Serpong Indonesia for the interim storage of low- and intermediate-level radioactive waste (LILW) generated by research reactors, nuclear industrial and medical activities in Indonesia, it is essential to study and forecast groundwater behavior for the safe disposal of radioactive waste to prevent contamination and guarantee long-term environmental safety. A NSD site is selected for low- and intermediate-level radioactive waste from research reactors due to its cost-effectiveness, engineered barrier feasibility, ease of monitoring, and suitability for shorter-lived waste. The pioneer assessment of technological NSD facility design criteria to meet the International Atomic Energy Agency (IAEA) standard was conducted, including groundwater parameters, such as depth, pH, and total dissolved solids (TDS). Notably, no comparable groundwater assessment for NSD systems using artificial intelligence currently exists. Therefore, in this study, effective monitoring and control require forecasting by using a robust time series forecasting model based on historical records of groundwater quality from 2012 to 2019. The study forecasted groundwater quality over 50 years. The predictive capacities of three machine learning models, such as Long Short-Term Memory (LSTM), Prophet, and Exponential Smoothing State Space (ESSS), were tested. Results showed that the Prophet model performed better with lower error metrics, including depth parameter at Mean Absolute Error (MAE)=0.71, Mean Squared Error (MSE)=0.77, Root Mean Squared Error (RMSE)=0.88, and Mean Absolute Percentage Error (MAPE)=7.41%, pH parameter at MAE=0.21, MSE=0.10, RMSE=0.32, MAPE=4.89% and TDS parameter at MAE=12.16, MSE=830.9, RMSE=28.82, and MAPE=31.62%. The study concluded that groundwater depth increases, pH decreases with time, and TDS changes seasonally, signifying the requirement for effective groundwater management strategies. The findings highlight the efficacy of machine learning models in supporting sustainable groundwater monitoring NSD sites over 50 years that can be beneficial for the long-term sustainable design of radioactive waste disposal.

Technical Track

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