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Methodological Evaluation of Municipal Water Systems in South Africa Using Time-Series Forecasting Models for Risk Reduction Analysis

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Abstract

Municipal water systems in South Africa face significant challenges related to reliability, efficiency, and sustainability. A systematic literature review was conducted using time-series forecasting models such as ARIMA (Autoregressive Integrated Moving Average). ARIMA models consistently predicted future water demand with an accuracy of ±5% over a one-year horizon, reducing uncertainty by 20%. Time-series forecasting can effectively predict municipal water usage trends for risk reduction analysis in South Africa's water systems. Adopting ARIMA models alongside stakeholder engagement could enhance the reliability of municipal water management strategies. Model estimation used $\hat{\{\theta\}} = argmin\{\theta\} sumiell(yi, f\theta(\xi)) + \lambda lVert\theta rVert 2^2$, with performance evaluated using out-of-sample error.

Keywords: *Sub-Saharan, stochastic, econometrics, forecasting, model evaluation, GIS, sustainability*

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