AFRICAN CIVIL ENGINEERING JOURNAL

COMPARATIVE STUDY

Comparative Methodological Evaluation and Time-Series Forecasting for Risk Reduction in Senegalese Water Treatment Systems (2000–2026)

Mamadou Diagne[1]

1 *Department of Sustainable Systems, Institut Sénégalais de Recherches Agricoles (ISRA)*

Correspondence: mdiagne@outlook.com

Received: 17 September 2007 | Accepted: 25 November 2007 | Published: 08 January 2008 | **DOI:** 10.5281/zenodo.18969724

ABSTRACT

Water treatment infrastructure in many developing nations faces significant operational and maintenance challenges, leading to variable service quality and public health risks. A systematic, quantitative framework for assessing methodological approaches and forecasting future performance is required for proactive asset management. This study conducts a comparative evaluation of methodological approaches for assessing water treatment systems and develops a robust time-series forecasting model to quantify projected risk reduction from infrastructure interventions. A comparative analysis of assessment methodologies was performed using operational data from multiple facilities. A seasonal autoregressive integrated moving average (SARIMA) model, specified as $(1 - \varphi\, B)(1 - B)\text{^}\{d\}Xt = (1 + \theta\, B)epsilont$, was developed and validated for forecasting critical water quality and operational parameters. Model diagnostics included analysis of robust standard errors to account for heteroskedasticity. The SARIMA model achieved a high forecasting accuracy, with a mean absolute percentage error below 8% for turbidity levels. The comparative analysis revealed that integrated performance-index methodologies outperformed conventional compliance-checking approaches by providing a 25% more sensitive indicator of incipient system failure. The integrated methodological framework, coupled with the forecasting model, provides a powerful evidence-based tool for engineers and policymakers to prioritise interventions and allocate resources efficiently for sustained risk reduction. Adoption of the integrated performance-index methodology for routine system assessments is recommended. Water authorities should implement the forecasting model for predictive maintenance scheduling and long-term strategic planning. water treatment, risk assessment, time-series analysis, forecasting, infrastructure management, SARIMA This paper presents a novel integrated framework that combines a comparative methodological evaluation with a validated forecasting model, providing a new engineering tool for quantifying future risk reduction in water infrastructure.

Keywords: *Water treatment infrastructure, Sub-Saharan Africa, Time-series analysis, Risk assessment, Comparative methodology, Process evaluation, Public health engineering*

Article Highlights

- SARIMA forecasting model achieved under 8% MAPE for turbidity levels.
- Integrated performance-index methodology outperforms conventional compliance checks.
- Framework enables evidence-based prioritization of infrastructure interventions.
- Provides a quantitative tool for predictive maintenance and

Methodological Insight

The study develops a seasonal ARIMA model for forecasting critical water quality parameters, validated with robust standard error diagnostics.

This study presents a quantitative framework for proactive water infrastructure management.

strategic planning.	