

Methodological Evaluation and Risk Reduction in Ghanaian Water Treatment Systems

A Multilevel Regression Analysis

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ABSTRACT

Background: Water treatment systems in many developing nations face persistent operational and water quality challenges. There is a recognised need for robust methodological frameworks to evaluate these systems and quantify the efficacy of interventions aimed at mitigating public health risks.

Purpose and objectives: This case study aims to develop and apply a methodological framework for evaluating water treatment facilities. Its objectives are to assess systemic performance, identify key risk factors, and measure the potential for risk reduction through targeted improvements.

Keywords: Water treatment systems, Sub-Saharan Africa, Multilevel regression analysis, Risk reduction, Ghana, Process evaluation, Water quality management

Article Highlights

- Coagulation-flocculation efficiency is the most significant facility-level predictor of final water quality.
- Multilevel regression quantifies the measurable impact of targeted engineering interventions.
- Substantial performance variation is attributable to differences in maintenance protocols.
- The framework enables data-driven prioritisation of resources for risk reduction.

Core Analytical Model

A two-level hierarchical linear model was employed: $y_{ij} = \beta_{0j} + \beta_{1j}x_{1ij} + \dots + \epsilon_{ij}$, where $\beta_{0j} = \gamma_{00} + \gamma_{01}z_{1j} + u_{0j}$. Robust standard errors accounted for heteroskedasticity.

This study presents a quantitative framework for evaluating and improving water treatment system performance.

ABSTRACT-ONLY PUBLICATION

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