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A Bayesian Hierarchical Model for Evaluating Water Treatment System Adoption in Tanzania, 2000–2026

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ABSTRACT

Background: Universal access to safe drinking water remains a critical engineering challenge in sub-Saharan Africa. Understanding the dynamics and drivers of water treatment technology adoption is essential for infrastructure planning and investment, yet robust predictive models are lacking.

Purpose and objectives: This study aimed to develop and validate a novel Bayesian hierarchical model to evaluate the adoption rates of different water treatment systems, and to project future adoption trajectories under varying policy scenarios.

Keywords: *Bayesian hierarchical modelling, water treatment systems, technology adoption, sub-Saharan Africa, sustainable development goals*

Article Highlights

- Bayesian hierarchical model quantifies adoption heterogeneity and uncertainty.
- Education level strongly predicts adoption of point-of-use filters (OR: 1.85).
- Community chlorination remains prevalent, but household solutions grow fastest.
- Framework provides robust tool for infrastructure planning and investment.

Methodological Contribution

A novel Bayesian hierarchical model explicitly quantifies uncertainty in technology adoption forecasts, offering a superior framework for probabilistic infrastructure planning.

This study provides a probabilistic framework for evaluating water treatment adoption under uncertainty.