

REPLICATION STUDY

Replication and Bayesian Hierarchical Modelling of Water Treatment Risk Reduction in Uganda

A Methodological Evaluation

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ABSTRACT

Background: Previous studies on water treatment risk reduction in Uganda have relied on conventional frequentist models, which can be limited when analysing sparse or heterogeneous facility-level data. The replication of these studies is crucial for validating prior findings and assessing methodological robustness in a practical engineering context.

Purpose and objectives: This study aimed to replicate a prior risk assessment using a Bayesian hierarchical framework to methodologically evaluate its advantages in quantifying uncertainty and integrating multi-level data from decentralised treatment systems.

Keywords: *Bayesian hierarchical modelling, Water treatment, Risk reduction, Sub-Saharan Africa, Replication study, Methodological evaluation, Frequentist statistics*

Article Highlights

- Bayesian replication reveals substantial heterogeneity in facility-level risk reduction.
- Posterior estimates indicate high certainty for overall treatment effect.
- Methodological shift provides superior framework for engineering decisions.
- 30% of facilities showed negligible risk reduction in the hierarchical analysis.

Methodological Contribution

This replication demonstrates the practical advantages of Bayesian hierarchical modelling over conventional frequentist approaches for quantifying uncertainty in heterogeneous infrastructure data.

This methodological evaluation confirms core findings while advancing analytical practice for engineering risk assessment.



ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.



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