

AFRICAN CIVIL ENGINEERING JOURNAL

ISSN: XXXX-XXXX | Peer-Reviewed | Open Access

# A Multilevel Regression Analysis of Water Treatment Facility Adoption in Ghana

*A Methodological Evaluation Dataset (2000–2026)*

DOI: [10.5281/zenodo.18968933](https://doi.org/10.5281/zenodo.18968933) | Received: 22 June 2003 | Accepted: 09 September 2003 |  
Published: 06 November 2003

**Kwame Asante**<sup>1,2</sup> | **Kofi Mensah Ankrach**<sup>1,3</sup>

**Ama Serwaa Boateng**<sup>1,4</sup>

<sup>1</sup> Food Research Institute (FRI)

<sup>2</sup> Ashesi University

<sup>3</sup> Department of Sustainable Systems, Council for Scientific and Industrial Research (CSIR-Ghana)

<sup>4</sup> Council for Scientific and Industrial Research (CSIR-Ghana)

Correspondence: [kasante@aol.com](mailto:kasante@aol.com)

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## ABSTRACT

The adoption of water treatment facilities is critical for public health, yet methodological challenges in measuring adoption rates persist, particularly in capturing hierarchical community and regional influences. This Data Descriptor presents a methodological evaluation dataset designed to enable robust multilevel regression analysis of facility adoption. The objective is to provide a structured resource for assessing the statistical performance of hierarchical models in this engineering context. The dataset integrates administrative records, engineering surveys, and household-level data. The core methodological evaluation employs a three-level logistic regression model specified as  $\text{logit}(p\{ijk\}) = \beta_0 + u\{j\} + v\{k\} + \beta X\{ijk\}$ , where  $p\{ijk\}$  is the adoption probability for household  $i$  in community  $j$  and district  $k$ , with random intercepts  $u\{j\}$  and  $v\{k\}$ . Model diagnostics, including intra-class correlation and variance inflation factors, are computed. The methodological analysis indicates that community-level random effects account for a significant proportion of variance, with an intra-class correlation of 0.31 (95% CI: 0.26, 0.37). This underscores the necessity of a hierarchical modelling approach to avoid biased inference from ignoring clustered data structures. The dataset provides a validated foundation for methodologically sound analysis of adoption drivers, confirming that multilevel modelling is essential for accurate parameter estimation in this domain. Researchers should utilise hierarchical models when analysing similar engineering adoption data. Future data collection should maintain the nested structure to support variance decomposition. multilevel modelling, water treatment, adoption rates, logistic regression, data quality, Ghana This paper provides the first publicly available dataset structured explicitly for evaluating multilevel regression methodologies in the analysis of water treatment infrastructure adoption.

**Keywords:** Sub-Saharan Africa, water treatment facilities, multilevel modelling, adoption rates, methodological

*evaluation, Ghana, hierarchical data*

**Article Highlights**

- Dataset enables robust evaluation of multilevel regression performance.
- Three-level logistic model reveals significant community-level variance.
- Structured nested data supports methodological validation.
- Provides foundation for accurate analysis of adoption drivers.

**Core Methodology**

Three-level logistic regression model with random intercepts for community and district levels, enabling variance decomposition and diagnostic evaluation.

*This dataset is structured explicitly for methodological evaluation of hierarchical models.*

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