



# Methodological Evaluation of Water Treatment Facilities Systems in Ethiopia Using Multilevel Regression Analysis for System Reliability Assessment

Mulugeta Abay<sup>1,2</sup>, Kedir Abeba<sup>3,4</sup>

<sup>1</sup> Bahir Dar University

<sup>2</sup> Adama Science and Technology University (ASTU)

<sup>3</sup> Department of Electrical Engineering, Adama Science and Technology University (ASTU)

<sup>4</sup> Department of Sustainable Systems, Bahir Dar University

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**Correspondence:** [mabay@outlook.com](mailto:mabay@outlook.com)

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## Author notes

*Mulugeta Abay is affiliated with Bahir Dar University and focuses on Engineering research in Africa.*

*Kedir Abeba is affiliated with Department of Electrical Engineering, Adama Science and Technology University (ASTU) and focuses on Engineering research in Africa.*

## Abstract

This study addresses a current research gap in Engineering concerning Methodological evaluation of water treatment facilities systems in Ethiopia: multilevel regression analysis for measuring system reliability in Ethiopia. The objective is to formulate a rigorous model, state verifiable assumptions, and derive results with direct analytical or practical implications. A mixed-methods design was used, combining survey and interview data collected over the study period. The results establish bounded error under perturbation, a convergent estimation process under stated assumptions, and a stable link between the proposed metric and observed outcomes. The findings provide a reproducible analytical basis for subsequent theoretical and applied extensions. Stakeholders should prioritise inclusive, locally grounded strategies and improve data transparency. Methodological evaluation of water treatment facilities systems in Ethiopia: multilevel regression analysis for measuring system reliability, Ethiopia, Africa, Engineering, intervention study This work contributes a formal specification, transparent assumptions, and mathematically interpretable claims. The maintenance outcome was modelled as  $Y = \beta_0 + \beta_1 X + u_i + \epsilon_i$ , with robustness checked using heteroskedasticity-consistent errors.

**Keywords:** Ethiopia, Multilevel Regression, System Reliability, Engineering Methodology, Geographic Information Systems, Data Analysis Techniques, Quantitative Research Methods

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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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