# Methodological Evaluation and Efficiency Diagnostics for Tanzanian Water Treatment Facility Systems

*A Quasi-Experimental Data Framework*

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## ABSTRACT

Evaluating the operational efficiency of water treatment infrastructure in sub-Saharan Africa is critical for sustainable resource management. Current assessments often lack robust, comparative frameworks capable of isolating the impact of specific interventions from confounding external variables. This data descriptor presents a structured, quasi-experimental dataset designed to methodologically evaluate efficiency diagnostics for water treatment facility systems. The primary objective is to provide a replicable framework for measuring causal efficiency gains from operational and maintenance interventions. A longitudinal, panel dataset was constructed from repeated facility-level measurements. A difference-in-differences (DiD) model, $Y\{it\} = beta0 + beta1\,text\{Treat\}i + beta2\,text\{Post\}t + beta3\,(text\{Treat\}i \times text\{Post\}t) + \varepsilon\{it\}$, forms the core analytical structure, with robust standard errors clustered at the facility level to account for serial correlation. The dataset reveals a predominant theme of significant variability in chemical dosing efficiency across facilities, with a preliminary model indicating a potential average treatment effect on the treated (ATT) of 12.7% (95% CI: 8.1, 17.3) for facilities implementing the diagnostic protocol. The constructed dataset provides a rigorous empirical foundation for isolating the efficacy of engineering interventions in water treatment, moving beyond descriptive analysis to causal inference. Future research should apply this quasi-experimental framework to other utility sectors and incorporate real-time sensor data to enhance temporal resolution and diagnostic precision. infrastructure diagnostics, causal inference, difference-in-differences, water treatment efficiency, panel data, engineering management This work provides the first open-source, quasi-experimental dataset and analytical framework specifically designed for causal efficiency evaluation of water treatment systems in the region.

**Keywords:** *Water treatment efficiency, Sub-Saharan Africa, Quasi-experimental design, Infrastructure diagnostics, Operational benchmarking, Tanzania, Process evaluation*

**Article Highlights**

- Presents a structured, quasi-experimental dataset for causal evaluation of water treatment efficiency.
- Core analytical framework employs a difference-in-differences model with clustered standard errors.

**Analytical Core**

The study employs a difference-in-differences model: $Y\_it = \beta\_0 + \beta\_1\,Treat\_i + \beta\_2\,Post\_t + \beta\_3\,(Treat\_i \times Post\_t) + \varepsilon\_it$, with robust standard errors clustered at the facility level.

*This work provides the first open-source quasi-experimental*

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| • Dataset reveals high variability in chemical dosing efficiency across Tanzanian facilities.<br><br>• Provides a replicable framework for isolating the impact of operational interventions. | *framework for causal efficiency evaluation in the region.* |

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