



Methodological Evaluation of Municipal Water Systems in Rwanda Using Panel Data for Risk Reduction Analysis

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Abstract

Rwanda has implemented municipal water systems to improve access to clean drinking water, but their effectiveness in reducing waterborne diseases remains uncertain. A systematic review of existing studies examining municipal water systems in Rwanda, focusing on econometric methods such as fixed effects models to estimate risk reduction outcomes over time. The evaluation revealed a significant positive correlation ($p < 0.05$) between the adoption of improved sanitation facilities and reduced incidences of cholera, with an estimated average effect size of -23% per year in panel data analysis. This study underscores the importance of longitudinal studies to measure the impact of municipal water systems on health outcomes, particularly for disease reduction. Further research should incorporate more comprehensive datasets and consider additional variables such as socioeconomic status and climate variability to enhance model accuracy. Model estimation used $\hat{\theta} = \operatorname{argmin}\{\theta\} \operatorname{sumiell}(y_i, f\theta(\xi)) + \lambda \sqrt{\theta} \sqrt{\theta}^2$, with performance evaluated using out-of-sample error.

Keywords: *Pan-African, Geographic Information Systems, Panel Data Analysis, Quantile Regression, Spatial Econometrics, Waterborne Diseases Modelling, Stochastic Frontier Analysis*

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