



Methodological Evaluation of Municipal Water Systems in South Africa Using Multilevel Regression Analysis for Cost-Efficiency Measurement

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Abstract

Municipal water systems in South Africa are critical for agricultural productivity and rural development. However, their efficiency varies significantly across different municipalities. A systematic literature review was conducted to analyse existing studies on the cost-effectiveness of municipal water systems. The study employed multilevel regression models to assess the impact of various factors such as population density, climate, and service area size on system performance. The analysis revealed that multilevel regression models are effective in measuring cost-effectiveness when accounting for both individual-level (e.g., household consumption) and aggregate-level (e.g., municipality-wide usage) variations. A specific proportion of municipalities showed significant improvements in efficiency with investments exceeding

10 million. Multilevel regression analysis provides a robust framework to the cost-effectiveness of municipal water systems.

$Y = \beta_0 + \beta_1 X + \epsilon$, inference is reported with uncertainty-aware statistical criteria.

Keywords: African agriculture, multilevel regression, cost-effectiveness, water management, rural development, statistical methods, econometrics

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