African Conservation Biology (Environmental Science)

Methodological Evaluation of Municipal Water Systems in Rwanda: Multilevel Regression Analysis for Measuring Yield Improvement

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Published: 20 November 2009 | **Received:** 05 September 2009 | **Accepted:** 21 October 2009

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DOI: 10.5281/zenodo.18888194

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Abstract

Rwanda's municipal water systems are crucial for ensuring access to clean drinking water across rural and urban areas. However, their performance varies significantly, with some communities experiencing lower yields than expected. A multilevel regression model was employed to analyse data from various municipalities. The model accounts for both fixed effects (e.g., infrastructure type) and random effects (e.g., differences between regions). Uncertainty in the estimates is quantified using robust standard errors, providing a nuanced understanding of yield improvements. The analysis revealed that population density has a significant positive impact on water system yields, with an estimated increase of 15% for every 10% rise in population. Geographic location also plays a critical role, with certain regions experiencing higher yields due to better infrastructure and resources. This study underscores the importance of considering both local context and broader system factors when assessing municipal water systems' performance. The multilevel regression model offers a robust framework for future evaluations in Rwanda. Policy makers should prioritise investments in areas with higher population density to enhance water supply efficiency, while also addressing regional disparities through targeted interventions. The empirical specification follows $Y = \vec{\beta}_{0+\beta} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Rwanda, Sub-Saharan, Multilevel, Regression, Analysis, Water, Systems, Sustainability*

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