Methodological Evaluation of Multilevel Regression Analysis for Measuring Adoption Rates in Municipal Water Systems in Rwanda: An African Perspective

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Abstract

Recent studies have highlighted the importance of understanding adoption rates in municipal water systems to enhance sustainability and efficiency. In Rwanda, where access to clean drinking water is a critical public health issue, there is a need for robust statistical methods to analyse these factors. This research employs multilevel regression analysis to examine data collected from surveys conducted across various municipalities in Rwanda. The model includes fixed effects for district-level characteristics and random intercepts for individual households to account for spatial heterogeneity and unobserved household-specific factors. A key finding indicates that the proportion of households adopting water treatment technologies was significantly higher ($p < 0.05$) where there were more community-led initiatives, suggesting a positive correlation between such interventions and adoption rates. The multilevel regression analysis demonstrated its effectiveness in capturing complex relationships within municipal water systems, particularly revealing the impact of community-level policies on household behaviour. Given the strong evidence supporting community-led interventions, policymakers should prioritise these initiatives to promote sustainable water system use in Rwanda. Future research could explore additional factors influencing adoption rates and their interactions with policy measures. The empirical specification follows $Y = \beta_{0+\beta}^{\rightarrow} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Geographic, Multilevel, Regression, Analysis, Adoption, Sustainability, Evaluation*

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