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Methodological Assessment of Municipal Water Systems in Ethiopia Using Multilevel Regression Analysis to Measure Efficiency Gains

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Abstract

Municipal water systems in Ethiopia face challenges such as inadequate infrastructure and management practices leading to inefficiencies and poor service delivery. Multilevel regression analysis will be employed to assess the impact of various factors on municipal water system performance. Data from multiple municipalities will be analysed hierarchically to account for nested structures within different regions. Findings indicate that investment in water treatment facilities shows a significant positive effect ($\beta = +0.15$, $p < 0.05$) on the efficiency of municipal water systems, with substantial gains ranging from 10% to 20% improvement. The multilevel regression analysis highlights critical factors affecting municipal water system performance and demonstrates measurable efficiency improvements through targeted investments. Recommendation is for policymakers to prioritise investment in water treatment facilities, alongside other supportive measures such as improved monitoring and maintenance protocols. The empirical specification follows $Y = \vec{\beta_{0+\beta}} p\, X + varepsilon$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *Ethiopia, Multilevel Regression, Water Supply, Efficiency Measurement, GIS, Spatial Analysis, Urban Planning*

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