



# Methodological Assessment of Municipal Water Systems Efficiency in Ethiopia Using Panel Data Estimation

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## Abstract

Municipal water systems in Ethiopia face challenges in meeting the growing demand for clean drinking water. Poor efficiency can lead to service disruptions and increased costs. The study employs a Data Envelopment Analysis (DEA) framework with stochastic frontier analysis (SFA) to estimate input-output ratios and technical efficiencies. Uncertainty is addressed through robust standard errors. Panel data reveal mixed efficiency levels, indicating that some systems operate at or above average efficiency while others show room for improvement in terms of water supply reliability and cost-effectiveness. The application of DEA-SFA successfully highlights the need for targeted interventions to enhance municipal water system performance in Ethiopia. Investment in infrastructure upgrades, training of staff, and possibly decentralization strategies could lead to significant efficiency gains. The empirical specification follows  $Y = \beta_{0+\beta} p X + \text{varepsilon}$ , and inference is reported with uncertainty-aware statistical criteria.

**Keywords:** *African geography, panel data, econometrics, water management, efficiency analysis, stochastic frontier, spatial econometrics*

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