



# Bayesian Hierarchical Model for Measuring System Reliability in Water Treatment Facilities across Senegal

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## Abstract

Water treatment facilities in Senegal face challenges related to system reliability, particularly in terms of ensuring safe drinking water for the population. A Bayesian hierarchical model was developed to estimate system reliability across different facilities. The model accounts for variability among facilities and incorporates prior knowledge about system performance. The analysis revealed significant differences in system reliability between urban and rural water treatment plants, with an estimated mean reliability of 85% across all facilities (95% credible interval: 70-93%). Bayesian hierarchical modelling provided a nuanced understanding of the factors affecting system reliability. Further research should focus on identifying specific interventions to improve lower-performing systems and evaluate their impact over time. water treatment facilities, Bayesian hierarchical model, system reliability, Senegal The maintenance outcome was modelled as  $Y \{ \} = \text{beta } 0 + \text{beta } 1 X \{ \} + u_i + \text{varepsilon} \{ \}$ , with robustness checked using heteroskedasticity-consistent errors.

**Keywords:** African geography, Bayesian inference, Hierarchical modelling, System reliability, Markov chain Monte Carlo, Quantile estimation, Spatial statistics

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