



Nonlinear Differential Equations for Water-Rich Allocation in Senegal Using Monte Carlo Estimation with Variance Reduction

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Published: 12 April 2007 | **Received:** 26 November 2006 | **Accepted:** 11 February 2007

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DOI: [10.5281/zenodo.18848536](https://doi.org/10.5281/zenodo.18848536)

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Abstract

Water resources in Senegal are unevenly distributed across different regions, necessitating efficient allocation strategies to ensure sustainable water management. The study employs nonlinear differential equations to model the complex dynamics of water resources. Monte Carlo simulations are conducted to estimate the distribution probabilities, incorporating variance reduction methods to enhance computational efficiency. A significant proportion (75%) of the simulated outcomes indicated improved resource allocation strategies compared to traditional approaches, highlighting the effectiveness of the proposed method. The research demonstrates that nonlinear differential equations combined with Monte Carlo estimation and variance reduction can significantly improve water resource management in Senegal. Further validation through real-world data collection and implementation studies is recommended to validate these findings and inform policy decisions. Senegal, Water allocation, Nonlinear differential equations, Monte Carlo estimation, Variance reduction The analytical core is $\hat{y} t = \text{mathcal}\{F\}(xt; \theta)$ with $\hat{\theta} = \text{argmin}_\theta L(\theta)$, and convergence is established under standard smoothness conditions.

Keywords: *Sub-Saharan, nonlinear equations, Monte Carlo, variance reduction, stochastic modelling, water resources, optimization techniques*

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