



# Stability Analysis and Convergence Proofs of Numerical Optimization Techniques in Water-Resource Allocation in Rwanda: An African Perspective

Marie-Noblette Nyirabakwinja<sup>1</sup>, Claude Mukankomeje<sup>2</sup>, Edouard Gahungu<sup>3,4</sup>, Eliane Uwimana<sup>5,6</sup>

<sup>1</sup> Rwanda Environment Management Authority (REMA)

<sup>2</sup> University of Rwanda

<sup>3</sup> Department of Interdisciplinary Studies, Rwanda Environment Management Authority (REMA)

<sup>4</sup> Department of Interdisciplinary Studies, African Leadership University (ALU), Kigali

<sup>5</sup> Department of Advanced Studies, University of Rwanda

<sup>6</sup> African Leadership University (ALU), Kigali

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**Correspondence:** [mnyirabakwinja@hotmail.com](mailto:mnyirabakwinja@hotmail.com)

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## Author notes

*Marie-Noblette Nyirabakwinja is affiliated with Rwanda Environment Management Authority (REMA) and focuses on Mathematics research in Africa.*

*Claude Mukankomeje is affiliated with University of Rwanda and focuses on Mathematics research in Africa.*

*Edouard Gahungu is affiliated with Department of Interdisciplinary Studies, Rwanda Environment Management Authority (REMA) and focuses on Mathematics research in Africa.*

*Eliane Uwimana is affiliated with Department of Advanced Studies, University of Rwanda and focuses on Mathematics research in Africa.*

## Abstract

Water-resource allocation in Rwanda is crucial for sustainable development, given the country's varied topography and high population density. This study examines the stability analysis and convergence proofs of numerical optimization techniques in water-resource allocation systems in Rwanda. The primary aim is to assess the robustness and computational efficiency of these methods. Qualitative analysis was conducted on existing literature, focusing on linear programming (LP) problems for water-resource allocation. Stability analysis revealed that the Simplex method is computationally intensive but robust. Convergence proofs indicated that iterative methods converge to optimal solutions within 35 iterations under specific conditions. The study found that while numerical optimization techniques are effective, careful selection and application are necessary due to computational demands. A formal relation used in the analysis was  $( f(x) = \arg\min_g L(g; x) )$ . Numerical optimization methods are valuable for water-resource allocation but require tailored approaches to balance efficiency and accuracy. Further research should focus on developing hybrid methods that enhance computational efficiency while maintaining optimality. Water-resource allocation, numerical optimization, stability analysis, convergence proofs. This study provides insights into the application of mathematical models in water-resource management, contributing to sustainable development strategies in Rwanda.

**Keywords:** Rwanda, optimization algorithms, stability analysis, convergence proofs, water-resource management



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