



Spectral Methods and Condition-Number Analysis for Numerical Optimization in Water-Resource Allocation in Rwanda

Habyarimana Mwarukwa¹, Gaterenye Umuhire², Nyiransabarama Ndagwesa³, Kabuga Mutagiza¹

¹ University of Rwanda

² Department of Advanced Studies, University of Rwanda

³ Department of Research, Rwanda Environment Management Authority (REMA)

Published: 11 July 2013 | **Received:** 08 March 2013 | **Accepted:** 05 June 2013

Correspondence: hmwarukwa@gmail.com

DOI: [10.5281/zenodo.18994250](https://doi.org/10.5281/zenodo.18994250)

Author notes

Habyarimana Mwarukwa is affiliated with University of Rwanda and focuses on Mathematics research in Africa. Gaterenye Umuhire is affiliated with Department of Advanced Studies, University of Rwanda and focuses on Mathematics research in Africa.

Nyiransabarama Ndagwesa is affiliated with Department of Research, Rwanda Environment Management Authority (REMA) and focuses on Mathematics research in Africa.

Kabuga Mutagiza is affiliated with University of Rwanda and focuses on Mathematics research in Africa.

Abstract

Water-resource allocation in Rwanda faces complex optimization challenges due to varying water availability across different regions and sectors. Spectral methods were applied using eigenvalue analysis to optimise allocation strategies. A condition-number analysis was conducted to assess the sensitivity of solutions to perturbations. Eigenvalues indicated significant variations in system stability across regions, with some areas requiring higher precision for optimal allocation. The spectral and condition-number analyses provided insights into water resource distribution efficiency. Further empirical studies are recommended to validate findings and inform policy decisions. Optimization, Numerical Methods, Water Resources, Condition Number, Stability Analysis Model selection is formalised as $\hat{\theta} = \underset{\theta}{\operatorname{argmin}} \{ L(\theta) + \lambda \omega(\theta) \}$ with consistency under mild identifiability assumptions.

Keywords: *Geography, Optimization, Spectral Methods, Condition Number, Eigenvalues, Iterative Algorithms, Numerical Analysis*

ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

✉ **REQUEST FULL PAPER**

Email: info@parj.africa

Request your copy of the full paper today!

SUBMIT YOUR RESEARCH

Are you a researcher in Africa? We welcome your submissions!

Join our community of African scholars and share your groundbreaking work.

Submit at: app.parj.africa



Scan to visit app.parj.africa

Open Access Scholarship from PARJ

Empowering African Research | Advancing Global Knowledge