



**BUSITEMA
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**SPATIOTEMPORAL IMPACT OF URBAN EXPANSION ON CARBON SEQUESTRATION
IN JINJA CITY**

BY

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**A dissertation submitted to the Directorate of Graduate Studies, Research And Innovation
in partial fulfillment for the award of Master of Science in Climate Change and Disaster
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Declaration

I sincerely certify that the work in this proposal, titled “Spatial-Temporal Impact of Urban Expansion on Carbon Sequestration in Jinja City,” is my original creation and has not been submitted for any award at any higher education institution. The project was carried out under the guidance of Prof. Moses Isabirye and Dr. Saul Daniel Ddumba, my supervisors.

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Approval

This study, titled “ Spatial-Temporal Impact of Urban Expansion on Carbon Sequestration in Jinja City” was conducted by ANTONY KADUUMA as part of the requirements for his Master’s degree at Busitema University. It has been reviewed and approved, confirming that it meets the necessary academic and ethical standards for scholarly research.

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Dedication

I dedicate this research to my family, especially my wife, Dr. Nakimuli Florence, whose unwavering support and encouragement have been my greatest strength, and to my mentors and colleagues, whose guidance and insights have shaped my academic journey. Special appreciation goes to the people of Jinja City, whose evolving urban landscape inspired this study. May this work contribute to a deeper understanding of urban expansion and its impacts, fostering sustainable development and environmental conservation for future generations.

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Abbreviations /Acronyms

AGB Above-ground Biomass

AR6 sixth assessment report

CASA Carnegie-Ames-Stanford Approach

GHG Green House Gas

IPCC international panel on climate change

NPP Net Primary Productivity

UNFCCC United Nations Framework Convention on Climate Change

LG local government

ULI urban land index

UEI urban expansion index

UNCCD United Nations Convention to Combat Desertification

UG Government of Uganda

Abstract

Uganda's rapid urbanization at 5.2% annually includes Jinja's quick growth, with 3% population increase driven by various factors. Despite concerns about encroachment, Jinja's green infrastructure remains vital for climate mitigation because it absorbs CO₂, though growth hampers sequestration. This study analyzed how urban expansion affects Jinja's carbon sequestration to support SDGs 11 and 13 using a spatial-temporal quantitative research design, GIS analysis of 2001, 2011, and 2021 remotely sensed satellite data, with the CASA model and indices like the Urban Expansion Index and urban land index.

This study analyzes the relationship between urban expansion and carbon changes from 2001 to 2021 using Landsat data. The study calculated NPP, carbon stocks, sequestration, and calculated urban expansion metrics like ULI and UEI. Results show rapid development: Jinja's built-up area nearly doubled, with ULI rising from 6.54% in 2001 to 9.85% in 2021, and UEI from 0.142% (2001–2011) to 0.188% (2011–2021). Jinja experienced significant outward growth from 2001 to 2011, driven by unregulated urban sprawl into high-carbon green spaces, resulting in a substantial loss of carbon stocks, consistent with the UNCCD PRAIS4 Uganda report. Northern Division (which includes Mafubira, Bugembe, and Budondo) has become the main growth area, whereas the Southern Division (the old municipality) experienced slower spatial expansion. spatial regression analysis reveals, from 2001 to 2011, the urban expansion coefficient was statistically significant and negative (–23,760; $p = 0.001$)

Quantifying both urban expansion and carbon sequestration from past trends enhances understanding of climate dynamics and supports sustainable urban planning for future urban growth, emphasizing the development of green cities.