



FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF WATER RESOURCES ENGINEERING

FINAL YEAR PROJECT REPORT

PREDICTION OF FUTURE LAND USE CHANGES FOR URBAN CATCHMENTS

USING A CA-ANN MODEL

CASE STUDY: MURCHISON BAY CATCHMENT

By

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**This Final Year Project Report is submitted to the Department of Water Resources Engineering
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ABSTRACT

This study develops and validates an advanced Cellular Automata-Artificial Neural Network (CA-ANN) model to predict future land use and land cover (LULC) changes in Uganda's ecologically sensitive Murchison Bay Catchment. Leveraging high-resolution (10m) Sentinel2 satellite imagery from 2016-2024, the research first characterizes historical LULC dynamics, revealing a 12% expansion of built-up areas (28.13 km² to 31.44 km²) and alarming 58% wetland loss during the study period. The model incorporates six key spatial drivers - elevation, slope, aspect, population density, and proximity to roads and urban centers - identified through rigorous correlation analysis ($VIF < 5$) and validated against actual 2024 data with 93.2% accuracy ($Kappa = 0.93$).

The CA-ANN architecture employs a Multi-Layer Perceptron (MLP) with 15,000 training samples, 5 hidden layers, and 0.001 learning rate, significantly outperforming traditional CAMarkov models used in similar Ugandan catchments ($Kappa$ improvement of 0.08-0.12). Projections to 2032 indicate continued urbanization (31.9 km² built-up area) but also identify potential wetland recovery zones under conservation scenarios. These findings provide critical insights for Kampala's Physical Development Plan, particularly regarding: (1) northern subcatchment protection priorities, (2) infrastructure planning to minimize wetland encroachment, and (3) climate-resilient urban design.

Methodologically, the study demonstrates the superiority of Sentinel-2 data over Landsat for detecting small-scale changes in tropical urban environments, while substantively contributing to Uganda's Vision 2040 and SDG 15 targets through science-based policy recommendations. The replicable framework addresses key gaps in African LULC modeling by: (1) integrating high-resolution temporal data, (2) quantifying non-linear driver interactions through ANN, and (3) providing validated short-term (2028) and medium-term (2032) projections for adaptive management. Future research directions include incorporating land tenure data and testing hybrid LSTM-CA models for enhanced temporal sensitivity.

DECLARATION

I, Muwonge John Bosco, declare that the work presented in this final year project report is mine and has never been presented in any University or institution for examination for an academic award.

Signed

A handwritten signature in black ink, appearing to read 'Muwonge John Bosco', is written over a set of horizontal and vertical grid lines.

MUWONGE JOHN BOSCO

APPROVAL

I hereby clarify that this final year project report was written and compiled by
MUWONGE JOHN BOSCO and is ready for submission to the Department of Water
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SIGN: 

DATE: 10th May 2025

DEDICATION

This research is dedicated to my loving parents, Mr. Nsamba Charles and Ms. Nanyondo Oliver.

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I recognize the Almighty God for being with me through it all. Utmost thanks to my parents and relatives for the support in all ways.

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Abbreviations/ Acronyms

AHP-Analytical Hierarchy Processing

ANN-Artificial Neural Network

CA-Cellular Automata

CNN-Convolutional Neural Network

LSTM- Long-Short Term Memory

LUC- Land Use Change

LULC- Land Use Land Cover

LULCC- Land Use Land Cover Change

MC-Markov Chain

MLP-MultiLayer Perceptron

MOLUSCE-Modules for Land Use Change Evaluation

RNN-Recurrent Neural Network

SCP-Semi-Automatic Classification Plugin

SCL- Scene Classification Layer

OA-Overall A