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UNIVERSITY**
Pursuing Excellence

FACULTY OF ENGINEERING

**DEPARTMENT OF AGRICULTURAL MECHANIZATION & IRRIGATION
ENGINEERING**

FINAL YEAR PROJECT REPORT

**A PREDICTIVE MODEL FOR QUANTIFYING THE COMBINED EFFECT OF LAND
USE CHANGE AND CLIMATIC VARIABILITY ON SEDIMENTATION IN MALABA
SUB CATCHMENT.**

By

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BU/GS21/MID/10

**This Dissertation is submitted to the Directorate of Graduate studies, Research and
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ABSTRACT

This research aimed at using SWAT as a predictive model to assess the impacts of historical, current, future climate change and land use land cover changes on sedimentation in Malaba sub catchment. Four scenarios were modeled in SWAT during this study, the first scenario focused on historical (1990 to 2005) sedimentation and flow in the catchment. The second scenario focused on the current (2006 to 2020) sediment yield and flow in the catchment. Calibration and validation were done using SWAT CUP software version 5.1.6. The calibrated and validated model was then used to further simulate two future scenarios. The two future scenarios used projected land use data and projected weather data. Land use data was projected using Clerk Labs TerrSet software while weather data was projected using the Statistical Downscaling Model (SDSM) version 4.2 considering RCP 4.5 and RCP 8.5. The third scenario focused on flow and sediment yield of 2023 to 2035. The fourth scenario focused on flow and sediment yield of 2036 to 2050. The results obtained from climate change analysis indicated un even changes to occur from 2020 to 2050, rainfall over the catchment is expected to increase by an average of 19.6% (RCP 8.5) and 18% (RCP 4.5), maximum temperature is expected to increase by 1.02°C (RCP 8.5) and 0.85°C (RCP 4.5), minimum temperature is expected to increase by an average of 0.5°C (RCP4.5) and 0.75°C (RCP 8.5) Land use change results indicated that from 2020 to 2050 cropland is expected to increase from 65% to 72.32% of the total catchment area by 2050 while built-up area is expected increase from 2.26% to 3.67%. Forests are expected to reduce from 6.5% to 1.9% of the catchment area while water bodies (streams, wetlands and swamps) are expected to reduce from 3.3% to 1.42%. Average annual Sediment yield is expected to generally increase from 2431.4 tons/km²/year (1993 to 2020) to an average annual sediment yield of 3147.6 tons/km²/year from 2020 to 2050, that is to say an increase of 29.5%. The average rate of annual sediment yield increase is estimated at 1.056% per year. Therefore, mitigation measures should be adopted to ensure sustainable management of the catchment. The study findings of this research shall be relevant for planning, design and management of reservoirs, dams, irrigation systems and sustainability of eco systems in the catchment.

DECLARATION

I Ologe Hector Daniel, do declare that this thesis is my own original work and has never been submitted to any University or to any other institution for funding or partial fulfillment for any award of master's degree.

Ologe Hector Daniel

Signature: 

Date...5th/03/2024.....

APPROVAL

This dissertation is submitted as a partial fulfillment for the award of Degree of Masters of Science in Irrigation & Drainage Engineering of Busitema University, with our approval as the Academic Supervisors.

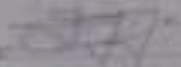
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DEDICATION

I dedicate this dissertation to my parents Mr. and Mrs. Obbo Gideon Ologe in honor to their unmeasurable love, encouragement and supported rendered to me during this process.

I also dedicate my dissertation to my Dear loving wife who has guided and encouraged me to remain focused amidst the struggles.

However, I also dedicate my university supervisors notably Dr Joseph Ddumba Lwanyaga, Eng. Badaza Muhammed.

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NOMENCLATURE.

AOGCMs	Atmosphere Ocean General Circulation Models
AR	Annual Report
CMI	Climatic Moisture Index
DEM	Digital Elevation Model
DWRM	Directorate of Water Resources Management
ENSO	El Nino Southern Oscillation
ESDMs	Empirical statistical downscaling models

FDC	Flow Duration Curve
FMI	Finnish Meteorological Institute
GCM	Global Circulation Model
GHG	Green House Gases
GLUE	Generalized Likelihood Uncertainty Estimation
HADCM3	Hadley Centre Coupled Model, version 3
HADGEM	Hadley Centre Global Environmental Model, version 1
HRU	Hydrological Response Unit
ICSU	International Council of Scientific Unions
IGBP	International Geosphere Biosphere Programme
IPCC	Intergovernmental Panel on Climate Change
IS	Importance Sampling
ISRIC	International Soils Reference and Information Centre
LAM	Limited Area Models
LARS-WG	Long Ashton Research Stochastic Weather generator
LH-OAT	Latin Hypercube One-factor-At-a-Time
LOCA	Localized constructed Analogs
MAKESENS	Mann-Kendall Test and Sen's Slope Estimate
MCMC	Markov chain Monte Carlo
MNPD	Ministry of National Planning and Devolution
MWE	Ministry of Water and Environment

NBI	Nile basin Initiative
NSE	Nash-Sutcliffe Efficiency
NWP	Numerical Weather Prediction
ParaSol	Parameter Solution
PBias	Percentage Bias
PSO	Particle Swarm Optimization
R ²	Coefficient of Determination
RCM	Regional Circulation model
RCPs	Representative Concentration Pathways
RMSE	Root Mean Square Error
SDSM	Statistical Downscaling Model
SRES	Special Report on Emissions Scenarios
SUFI	Sequential Uncertainty Fitting
SWAT	Soil and Water Assessment Tool
SWAT-CUP	SWAT Calibration and Uncertainty Programs
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural
WMO	World Meteorological Organization
WWAP	World Water Assessment Report

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

River sediment yield is directly influenced by climate and land use variation (Guo *et al.*, 2018). In most developing countries, the effects of land-use change are today manifesting through accelerated rates of soil erosion (Duveiller *et al.*, 2020; Schürz *et al.*, 2020). Globally, surface soil is being eroded from river basins at a rate of 60 billion tons per year, this results in 24 billion tons of sediment being released into the world's water bodies and almost 25 billion tons of soil being removed from agricultural land (Deltares, 2018). Urbanization, agriculture, and deforestation are just a few of the everyday anthropogenic activities that have altered spatial and temporal changes in land use and cover (Deltares, 2018). River sedimentation and stream flow are normally affected by changes in land use and land cover (Deltares, 2018).

Understanding and predicting sedimentation in river systems is a crucial global concern due to its impact on water quality, aquatic life, flood risks, and reservoir lifespans (Aljumaily *et al.*, 2023). Land use and land cover, and climate change play significant roles in the amount of sediment entering rivers. As such, predictive models are essential tools in quantifying the intertwined effects of these factors. In Africa, where land degradation, deforestation, and climate change are major challenges, these models are particularly important for understanding the dynamics of sedimentation (Dibaba *et al.*, 2021). Historical climate change has been observed and further changes are anticipated (Alava *et al.*, 2018). According to the Intergovernmental Panel on Climate Change (IPCC), the average temperature on the planet has increased by about 0.6 degrees Celsius over the past century, and it is expected to further increase by 4 degrees by the end of the 21st century (Allen *et al.*, 2018). Sedimentation and increased nutrient loads of rivers in Uganda has increased due to unsustainable farming practices and other poor land management practices like deforestation (Mubiru *et al.*, 2017). Sediment discharge is one of the main water quality concerns in integrated watershed management, a proper identification of sediment sources is therefore important to the success of watershed conservation programs (Yongbo *et al.*, 2015). A comprehensive understanding of land-use changes processes and their future trajectories is essential for the development of land-use management plans required for conservation of ecological resources (Stanly *et al.*, 2022).

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