



FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF WATER RESOURCES ENGINEERING

FINAL YEAR PROJECT REPORT

A DECISION SUPPORT TOOLBOX FOR AUTOMATED CHANNEL SIZING.

CASE STUDY: SIRONKO RIVER, UGANDA

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ABSTRACT

Flooding, a major natural hazard, results in significant economic losses and endangers human lives globally. In Uganda, manual channel sizing methods often lead to inaccuracies due to complex local hydrological processes, exacerbating flood risks and causing infrastructure damage. This research aims to develop an automated decision support toolbox to improve channel sizing accuracy, integrating advanced hydrological models tailored for Ugandan catchments. The primary objective is to create a toolbox that assists professionals in precise channel sizing, flood discharge determination, and flood extent prediction. The study focuses on the Sironko River basin, employing the TRRL East African Flood Model for rainfall-runoff analysis. This model, designed for East African catchments, addresses data scarcity and regional hydrological complexities. The methodology involves mixed research approaches, combining qualitative and quantitative data. Historical rainfall data, catchment characteristics, and channel geometry are analyzed using MATLAB. The TRRL model's iterative process refines rainfall-runoff estimations, ensuring accurate peak discharge predictions. Calibration and validation were performed using observed discharge data from 1990 to 2011 for calibration and 2012 to 2019 for validation. The model's initial peak discharge was adjusted from 216.16 m³/sec to 16.4990 m³/sec, achieving a 4.5% discrepancy. During validation, the simulated discharge was 21.53 m³/sec with a 4.56% difference from observed values, indicating robust model accuracy. With the obtained discharge value, flood extents or various flooding areas are sited out where 1D modelling of the flood was used in the MATLAB code using the Saint Venant Equations with segments also obtained along the river where the channel cross sections are to be obtained and saved in an excel document. The flood extents are plotted and visualized helping the user spot out the affected points of the natural channel. The obtained discharge and cross sections of affected points or areas along the river are to be fed into the channel sizing tool where hydraulic calculations based on open channel flow knowledge are carried out by the tool giving the most optimal channel cross section that may convey flow in it without flooding based on the design discharge given. The search for obtaining the most optimal channel cross section, channel dimensions or geometry are altered basing on either the slope or width or depth. The toolbox incorporates functionalities for watershed delineation, flood hazard mapping, and channel design, enhancing flood risk assessment capabilities. The findings demonstrate the TRRL model's effectiveness in providing accurate discharge estimates for Ugandan catchments. The developed toolbox offers a user-friendly interface for efficient channel design, contributing to improved flood mitigation strategies and infrastructure planning. The adoption of automated tools and advanced modeling techniques, as demonstrated in this research, is essential for enhancing the accuracy and reliability of channel design in Uganda.

DECLARATION

I, AWORI MAURINE, KAWERU PIUS TONNY and OMODING MERVYN solemnly declare that this final year project report is our own research, and has never been submitted to Busitema University or any other institution of higher learning for any academic award.

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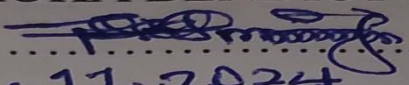
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APPROVAL

This is to confirm that the project report was written by us under the guidance of our supervisors and is prepared for submission to the Department of Water Resource Engineering, Busitema University.

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LIST OF EQUATIONS

$CA = C_s * CL$	3-1	18
$RO = CA * (P - Y) * A * 10^3$ (in cubic meters, m ³)	3-2	20
$\bar{Q} = 0.93 * RO / (3600 * TB)$ (in cubic meters per second, m ³ /s)	3-3	20
$TB = T_p + 2.3K + TA$	3-4	21
$R_{TB1} = TB1 / 24 * (24.33 / (TB1 + 0.33))^n * RT$	3-5	21

ARF1 = 1 - 0.04 * Tp ^ (1/3) * sqrt(A)	3-6
21	
P1=R_TB1 * ARF1	3-7
	22
TA1 = 0.028 * L / (Q1 ^ 0.25 * S ^ 0.5)	3-8
22	

ACRONYMS

GEF	Global Environment Fund
HEC-RAS	Hydrological Engineering Centre – River Analysis System
CN	Curve Number
SDG	Sustainable Development Goal
SRTM	Shuttle Radar Topography Mission
RF	Random Forest
AHP	Analytical Hierarchy Process
LSTM	long Short-Term Memory
IDW	Inverse Distance Weighted
AHP	Analytical Hierarchy Process
EBA	Ecosystem-based adaptation
NRCS	Natural Resources Conservation Service
GIS	Geographic Information System
EPA	Environmental Protection Agency
DEM	Digital Elevation Model
LULC	Land Use and Land Cover
1D	One-Dimensional
2D	Two-Dimensional
USGS	United States Geological Survey
IDF	Intensity-Duration-Frequency curve
AU	African Union
TC	Time of Concentration
TRRL	Transport and Road Research Laboratory
AI	Artificial Intelligence
DSS	Decision Support tools

TRRL	Transport and Road Research Laboratory
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Finally, the developed toolbox's functionalities for design flood discharge estimation and flood hazard mapping enhance flood risk assessment capabilities, early identification of vulnerable areas through this method allows for improved flood mitigation strategies and infrastructure development, contributing to Uganda's water security goals.

5.2 RECOMMENDATIONS

We recommend the necessity of a field verification through real-world data collection and comparison with observed discharges in representative catchments so as to solidify the TRRL model's effectiveness in Ugandan contexts.

Additionally, integrating flood inundation modelling functionalities within the toolbox using Geographic Information Systems (GIS) would be highly beneficial for visualizing potential flood extents through GIS would significantly aid engineers in making informed channel design decisions.

To promote wider adoption and ensure successful implementation, developing training workshops and resources for Ugandan water engineers is vital. Equipping them with the necessary knowledge and skills to utilize the TRRLbased toolbox would empower them to contribute to sustainable water resource management across the country.

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