BUSITEMA UNIVERSITY

FACULTY OF ENGINEERING

OPTIMUM WATER ALLOCATION PLANNING IN THE LAKE KOCHOBO SUB-CATCHMENT, UGANDA

by

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Declaration

I Eriamu Sam do hereby declare that this work is my own and has never been presented for any award or publication at any institution anywhere.

Signature: .... Date....14/09/2018

Approval

I do hereby approve that this research proposal is an original work of the researcher and has never been presented at any educational institution.

I do certify that it has been done under my supervision.

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Dedication

This thesis research is dedicated to the Almighty God for His blessings, to my wife Dorothy Adeke and to my Extended Family

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List of Acronyms and Abbreviations

ACMP	Awoja Catchment Management Plan
CMP	Catchment Management Plan
DEM	Digital Elevation Model
DSS	Decision Support Systems
DWD	Directorate of Water Development
DWRM	Directorate of Water Resources Management
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System
KWMZ	Kyoga Water Management Zone
LULC	Land Use and Land Cover
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MCM	Million Cubic Meters
MWE	Ministry of Water and Environment
NSE	Nash-Sutcliffe Efficiency
PBIAS	Percent Bias
RSR	Root Mean Square Error
SRTM	Shuttle Radar Topography Mission
TLU	Total Livestock Unit
UBOS	Uganda Bureau of statistics
UNMA	Uganda National Meteorological Authority
USGS	United States Geological Surveys
WEAP21	Water Evaluation and Planning System, Model 21
WRA	Water Resources allocation
WRM	Water Resources Management
LKSC	Lake Kochobo Sub-Catchment

ABSTRACT

Given Uganda's per capita water availability (1004 m^3) as of 2014, basin hydrologic modelling can sustainably help in: planning for the anthropogenic actions and changing climate effect on scarce water resources and reviving ecologically sensitive areas. The competing water uses within the Lake Kochobo Sub-Catchment (LKSC) has resulted into increased water demand on River Awoja. Previous studies within the Lake Kochobo Sub-Catchment focused on the precipitation trend and climate change scenarios analysis, impact of land use and climate change on soil fertility among other studies. There are no hydrologic studies evaluating the combined impacts of land use and other human activities within the Sub-Catchment and thus affecting water allocation among competing users. This research aimed at investigating and evaluating optimum Water Allocation Planning in the LKSC (974 km^2) where unsustainable water abstractions have impacted, using Water Evaluation and Allocation Planning (WEAP21) system. In a bid to assess the impact of possible mitigation measures for future, the research study considered quantifying catchment water uses in regards to their current uses and demands. This aimed at establishing a baseline for future forecasts. The Parameter Estimation Tool (PEST) was used in system calibration. Calibration focused on reproducing daily-observed runoff hydrographs for the 2007-2017 period. To evaluate the model performance for calibration, the Coefficient of determination (R^2), Nash-Sutcliffe efficiency (NSE), Root Mean Square Error (RSR) and Percent Bias (PBIAS) criteria were exploited. The year 2007 was used as a base year for scenario simulations due to minimal data gaps in the available data. The projections of the current study stretch up to the year 2050. The study aimed at estimating the water demand within the catchment under the reference, current and future scenarios through scenario building and analysis. As a result, sustainable management strategies were recommended to the decision makers for implementation. It was concluded that the basin's hydrologic behavior basing on the current and proposed future demand sites is significant to both positive and negative scenarios. The results give an insight into the water demand and supply implications and can guide in developing ecologically sound Sub-Catchment management and development strategies.

Keywords: Lake Kochobo Sub-catchment, WEAP, Water Resources Allocation, Water Demand, Uganda

1 INTRODUCTION AND BACKGROUND

1.1 Introduction

Water is a key strategic resource, vital for sustaining life, promoting development and maintaining the environment (Mugagga, 2015; Muyodi et al., 2005; Sandford & Adeel, 2012; Urama & Ozor, 2010; Waititu, 2009) which collectively aim at improving human wellbeing (Nsubuga, Namutebi, & Nsubuga-ssenfuma, 2014). However, water resources have and are still experiencing increasing pressures resulting from: climatic change and variability; population growth and urbanization; catchment degradation; disaster risks due to extreme events; pollution and general water quality degradation; and the water-energy-food-ecosystem nexus among other complexities (Arranz & Mccartney, 2007; Hamlat & Errih, 2013).

According to (Mekonnen & Hoekstra, 2016), two-thirds of the global population live under conditions of severe water scarcity at least 1 month of the year. Over 30 percent of the developing countries are expected to experience severe water scarcities in this century despite huge annual water amounts expected to continuously flood out to sea from water-scarce regions.

Besides, the water demands by most of these countries is hardly met by the erratic spatial and temporal distribution of precipitation. The growing water demand is likely to complicate its allocation among the competing users. To meet the competing water needs such as domestic, industrial, agricultural among others, sustainable water supply through storage is required (Keller, Sakthivadivel, & Seckler, 2000).

IWRM looks beyond the traditional description of water resource allocation and balancing demand. The concept emphasizes cooperation among the different sectors, integrating demand and allocation while considering the environment and ecological aspects. Modelling demand and supply helps to observe and understand a wide long-term challenge to WRM. Besides, the procedures, related framework and strategies guide in identifying solutions to the conflicts among the different interest groups and stakeholders.

The growing global water scarcity has led to increasing importance to design and implement sustainable WRA plans and agreements for resolving the current/future international, regional and local conflicts over water accessibility. Despite the objective and approach evolutions, the basic fundamental concept of WRA is still the determinant of water available and its equitable sharing amongst competing users (Roa-García, 2014). There are various water resources' related challenges such as increase in abstractions, decrease of available water infrastructure sites, climate

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