EVALUATION OF BASIN LEVEL CLIMATE CHANGE IMPACTS ON STREAMFLOW AND RESERVOIR OPERATIONS - A CASE STUDY ON DEDURU OYA RESERVOIR

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Degree of Master of Science

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DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Names of the supervisor: Dr R. L. H. L. Rajapakse

Signature of the supervisor: ……. Date: ……

Evaluation of Basin Level Climate Change Impacts on Streamflow and Reservoir Operations - A Case Study on Deduru Oya Reservoir

Abstract

Global climate change is known to trigger local and regional hydrologic variations like changes in precipitation patterns, surface temperatures and streamflows. Apt and efficient water management is extremely important as climate change can considerably affect the water supply-demand balance. Focusing on reservoirs and their management, it is very important to study climate change impacts on streamflow input and reservoir operations with a proper analysis. Targeting on that, this study was conducted as a case study on the Deduru Oya reservoir, Sri Lanka.

The impacts of climate change on the Deduru Oya basin were reviewed and two main parameters of climate indices, rainfall and temperature were identified using the findings from the previous literature. The prediction of the future streamflow data was carried out using a rainfall-runoff based hydrological model developed in Hydrologic Engineering Centre's Hydrologic Modeling System, version 4.3 (HEC-HMS) software, with the aid of the identified climatic parameters. Furthermore, prediction of the reservoir operation data was accomplished using a water balance based hydrological model developed in Hydrologic Engineering Centre's Reservoir System Simulation, version 3.1 (HEC-ResSim) software, with further emphasis on reservoir hydrology and adaptation methods.

It has been observed that there is an increase in the total annual rainfall by 21% - 24% for the 20s (2011-2040) and 42% - 75% for the 50s (2041-2070) while the average annual temperature indicates 0.08% - 0.14% increase for the 20s and 0.28% - 0.43% increase for the 50s under IPCC emission scenarios A2 and B2. Annual streamflow has shown a 62% -77% increase for the 20s and it has increased further in the 50s while the reservoir releases also indicate increased amounts on an annual basis. On a monthly basis, the rainfall, streamflow and reservoir releases in wetter months will get increased further, but in drier months those amounts will get reduced slightly.

Because of the increased release rates from the reservoir, it is needed to exert more attention to the increased downstream basin vulnerability to floods. While increased release rates add pressure to reassure the safety of existing structures, the ability to produce energy, cope with the agricultural and drinking water demand and maintain the ecological flow can be ensured by better water management practices in the future.

Keywords: Climate prediction; hydrologic variations; vulnerability to floods; water supply-demand balance

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor, Dr. R. L. H. L. Rajapakse for his immense support, guidance and encouragement throughout this research. Because of his support, I was able to successfully complete my Masters, and I could gather more knowledge on the aspects like climate change impacts and water resource management.

Further, I would like to express my appreciation to the Research Coordinator of the Department of Civil Engineering, University of Moratuwa: Dr. J. C. P. H. Gamage who instructed me to improve my research work throughout the period.

Also, I would like to express my gratitude to Prof. S.A.S. Kulathilaka, who is the Head of the Department of Civil Engineering for creating a good atmosphere to work.

My special thanks should go to the Department Research Assistant System for providing me with financial support throughout the study period.

Finally, I would like to express my gratitude to all the senior professors, professors, senior lecturers and lecturers of the Department of Civil Engineering for their advises and support throughout this research project.

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LIST OF ABBREVIATIONS

Abbreviation	Description
AGHP	Annual Gross Hydropower Potential
DEM	Digital Elevation Model
ETP	Potential Evapotranspiration
GCM	General Circulation Model
GW	Ground Water
HEC-HMS	Hydrologic Engineering Centre - Hydrologic Modeling System
HEC-ResSim	Hydrologic Engineering Centre - Reservoir Simulation
IDW	Inverse Distance Weighting
IPCC	Intergovernmental Panel on Climate Change
MAR	Mean Annual Rainfall
MCM	Million Cubic Meters
MSL	Mean Sea Level
NSE	Nash-Sutcliffe Efficiency
RCM	Regional Climate Model
RVA	Range of Variability Approach
SDSM	Statistical DownScaling Model
SMA	Soil Moisture Accounting
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

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