STREAMFLOW VARIABILITY UNDER CLIMATE CHANGE SCENARIOS IN KELANI RIVER BASIN, SRI LANKA

Farid Farhat

208350M

Degree of Master of Science

Department of Civil Engineering

University of Moratuwa
Sri Lanka

February 2022

STREAMFLOW VARIABILITY UNDER CLIMATE CHANGE SCENARIOS IN KELANI RIVER BASIN, SRI LANKA

Farid Farhat

208350M

Supervised by

Dr R. M. J. Bamunawala

and

Dr T. M. N. Wijayaratna

Thesis submitted in partial fulfillment of the requirements for the degree Master of Science in Civil Engineering

UNESCO Madanjeet Singh Centre for

South Asia Water Management (UMCSAWM)

Department of Civil Engineering

University of Moratuwa

Sri Lanka

February 2022

DECLARATION OF THE CANDIDATE AND SUPERVISOR

"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".

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

UOM Verified Signature

29-Apr-2022

Farid Farhat — Date

The above candidate has carried out research for the Masters thesis under my supervision

UOM Verified Signature

29-Apr-2022

Dr R. M. J. Bamunawala — Date

UOM Verified Signature

29-Apr-2022

Dr T. M. N. Wijayaratna — Date

ABSTRACT

Streamflow Variability under Climate Change Scenarios in Kelani River Basin, Sri Lanka

In recent years, the downstream floodplain of the Kelani River Basin has been suffering from frequent floods. With the current climate change trend, flood-related damages are expected to amplify in future. Therefore, understanding how such extreme events behave in the future is quite essential for the basin planners and managers. Using the output from three global climate models (CNRM-CM6-1, MRI-ESM2-0, EC-Earth3-CC, and their ensemble) from the Sixth Phase of Coupled Model Intercomparison Project (CMIP6), variation of streamflow was evaluated from historical (1985-2014) to mid-century (2030-2059) and late-century (2070-2100) periods under Shared Socioeconomic Pathways (SSPs 2-4.5 and 5-8.5). Bias-corrected precipitation and temperature through linear scaling and power transformation, respectively were fed into the HEC-HMS model to project future river discharge. Based on the ensemble model, changes in average annual discharge indicates an increasing trend in future periods under both scenarios considered. Significantly high changes were projected in the late century (25-40 m^3/s) compared to the mid-century (15-25 m^3/s) under both scenarios. Projected changes in monthly streamflow indicate an increasing trend for wet months (June-December) while a decreasing trend for dry months (January-May). Further, the highest changes in streamflow were identified in the monthly changes (-5 to 60 and -5 to 100 m^3/s under SSP2-4.5 and SSP5-8.5, respectively). Comparison of seasonal changes shows the highest increase for Southwest Monsoon (40-60 m^3/s under both scenarios and future periods) while the highest decrease for First-Inter monsoon (<-10 m^3/s under both scenarios and future periods). Moreover, changes in high, median, and low flows (5%, 50%, and 95% percentiles of flow duration curve, respectively) indicate significant changes in high flows compared to the median and low flows. The findings of this study suggest a significant increase in high flows during the Southwest Monsoon that can further threaten the basin with the devastating floods. The results provide important insight for planners and other stakeholders dealing with water resources management in the basin.

Keywords: Streamflow Changes, Climate Change Impact, Shared Socioeconomic Pathway

DEDICATION

My work is dedicated to my dear

Mother and Uncles

Whose affection, love, encouragement, and financial support of each day and night allowed me to accomplish my dreaming master's degree. With my best wishes, I hope a successful and happy life for you all

ACKNOWLEDGEMENT

Herewith, I would like to convey my sincere gratitude to Dr. R. M. J. Bamunawala, who supervised my work and guided me during the entire process. Working with him was a once-in-life-time opportunity for me. Dr. Bamunawala was not only supportive for the academic workload at any time, but he was also an outstanding motivator in my personal life. His friendly, flexible, and collaborative attitude were among the many of his assets that makes working with him truly enjoyable. The success of this research is mainly attributed to his valuable contribution.

The author also would like to extend his gratitude to the UMCSAWM Director, Professor R. L. H. Rajapakse for his invaluable feedback and many other supports. He was a rich and insightful academic source for me and all my fellows that shaped our research. It was his hard work and time management that lead to the completion of our program during the challenging time of the COVID pandemic.

I would like to thank my mentor, Mr. H.W. Kumarasinghe for his kind assistance during my stay in Sri Lanka. Frankly speaking, he was always there when we had any problem, which made him like a real father. Additionally, I feel honoured to extend my gratitude to all members of the UMCSAWM and Department of Civil Engineering for their support through any means. Finally, my sincere thanks go to the South Asia Foundation for providing me with a fully funded scholarship to achieve my master's degree.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AR	Assessment Report
CDS	Climate Data Store
CMIP	Coupled Model Intercomparison Project
CMhyd	Climate Model for Hydrologic Modelling
ESGF	Earth System Grid Federation
GCM	Global Climate Model
IAM	Integrated Assessment Model
IAV	Impact Adaption Vulnerability
IPCC	Intergovernmental Panel on Climate Change
KRB	Kelani River Basin
RCM	Regional Climate Model
RCP	Representative Concentration Pathway
SSP	Shared Socioeconomic Pathway
WGCM	Working Group of Coupled Modelling
WRCP	World Climate Research Program