

**ANALYSIS OF HYDROCLIMATIC VARIABILITY AND
ADEQUACY OF CHANNEL FLOWS IN
AN ARID ZONE IN PAKISTAN**

Sidra Rashid

(189247H)

Degree of Master of Science

Department of Civil Engineering

University of Moratuwa

Sri Lanka

September 2019

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Sidra Rashid

(189247H)

Thesis submitted in partial fulfilment of the requirements for the degree of Master of
Science in Water Resource Engineering and Management

Supervised by

Dr. R. L. H. L. Rajapakse

Department of Civil Engineering

UNESCO Madanjeet Singh Centre for
South Asia Water Management (UMCSAWM)

University of Moratuwa

Sri Lanka

September 2019

DECLARATION

I declare that this is my own work and this thesis does not incorporate any material previously submitted for a Degree or Diploma in any other University or institute of higher learning without acknowledgement 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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✓
Dr. R.L.H.L. Rajapakse

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.....

Date

ACKNOWLEDGEMENT

Firstly, I would extend my heartiest gratitude to Dr. R.L.H. Lalith Rajapakse for his continuous supervision, encouragement, support and precious advices throughout the study. The objective of this study had been achieved with his great commitment and conviction within the study period. His immense knowledge and experience in guidance played a very valuable role for success.

I also express my gratitude to Professor N.T.S. Wijesekera for rendering support to study. My sincere thanks are extended to late Shri Madanjeet Singh for his vision and efforts which provided the scholarship to study Water Resource Management in South Asia at the UMCSAWM.

I would like to thank Mr. Wajira Kumarasinghe and all staff of UNESCO Madanjeet Singh Centre for South Asia Water Management as well. Mr. Muhammad Kamran is warmly appreciated for his friendship and assistance in data collection.

The author wishes to extend her gratitude to the Punjab Irrigation Department and Pakistan Meteorological Department for their unremitting support in data acquisition. I also wish to express our appreciation to anonymous reviewers for their valuable and constructive remarks.

My thanking list also includes the late Shri Madanjeet Singh and the University of Moratuwa for furnishing this outstanding opportunity to study towards a Master's Degree of Water Resource Engineering and Management, at UNESCO Madanjeet Singh Centre for South Asia Water Management, Department of Civil Engineering, University of Moratuwa, Sri Lanka.

ABSTRACT

ANALYSIS OF HYDROCLIMATIC ADEQUACY AND VARIABILITY OF CHANNEL FLOWS IN AN ARID ZONE OF PAKISTAN

Water is becoming progressively scarce and effective usage of accessible supplies is of major concern. Globally, 15% ~ 21% of the water allocated for irrigation is lost due to poor management and non-optimized conveyance practices. Pakistan is an agricultural country which hosts one of the world's largest irrigation networks, Indus Basin Irrigation System (IBIS). The system has been found to operate with an irrigation efficiency of a mere 35% ~ 50% which is abysmally low. It is thus vital to oversee the proper management of this scarce resource while limiting the losses within the system. The selected Hakra canal covers an irrigated area of 2031 km² with a 92 km of total length and lies in the semi-arid region in Punjab, Pakistan.

The aim of the present study is to evaluate the competence of the available irrigation channel flows to meet actual Crop Water Requirement (CWR) and variations in availability with climatic irregularities. For the detailed analysis of hydroclimatic variability and channel flow adequacy, data of daily channel flows and climatic parameters were obtained for the period of 2010~2017 while monthly rainfall data from 1978~2017 was used for long-term trend analysis. The CWR was estimated using CROPWAT 8.0. Observed deficit in supply is provided by groundwater abstraction and was estimated using root zone water balance approach. Mann-Kendall and the Sen's slope tests were used to detect the possible trend and its magnitude. An upstream rainfed basin is selected and used for the verification of observed climatic variations.

Trend analysis depicted an increase in annual rainfall from 1978~2017 over the region with the estimated contribution of 13% to irrigation supply. Irrigation supplies are the dominating source of water and highly fluctuating. The seasonal shortfall has shown a variation of 7%~26% in Rabi season and 71% ~78% in Kharif season. Further analysis of data revealed an increasing trend in the maximum and minimum temperature values especially in the months where rainfall has also shown an increase i.e. June and September.

The observed climatic variability in the downstream of IBIS is highly reliant on hydrological behaviour of upstream catchments. Four parameter '*abcd*' lumped model with incorporated snow parameter '*m*' for icy catchment is used to sensibly screen and verify the reaction of a catchment under the climate change scenario by evaluating the changes in hydrological processes. The better understanding of meteorological and hydrological conditions of the study area helped proper investigation and imitation of the actual situation. Unreliable supply of water in the irrigation system along with variability in climatic factors i.e. precipitation and temperature would disturb the dynamics of hydrological water cycle hampering crop yield. It would elevate the maximum soil moisture deficit that results in crop failure or low yield.

Keywords: Alternating crop pattern; Channel flow optimization; Crop water requirement; Hakra canal

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