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

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

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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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The above candidate has carried out research for the master's thesis under my supervision.

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Dr. R.L.H.L. Rajapakse

2019.09.25

Date

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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 km^2 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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