# FORECASTING DRY WEATHER FLOW TO ASSESS FUTURE WATER EXTRACTION CAPACITIES AT KOLEIMODARA INTAKE IN KUDA GANGA, KALU GANGA

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

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Mr A. H. R. Ratnasooriya

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# ABSTRACT


## Forecasting Dry Weather Flow to Assess Future Water Extraction Capacities at Koleimodara Intake in Kuda Ganga, Kalu Ganga

Kalu Ganga is the primary source of potable water supply in the greater Colombo area and total Kalutara District. Kethhena water treatment is supposed to cover the water demand in the middle and southern parts of the Kalutara district, which is estimated as 1.5 $m^3/s$, including the subsequent explanation to covet 2030 to 2060 design horizon. The new intake at Koleimodara in Kuda Ganga is supposed to extract water during the dry weather period the as the old intake at Thebuwana is impacted by salinity intrusion. Therefore, this study was formulated to assess the possibility of extracting water from the Koleimodara intake during the subsequent design horizon.

A hydrological model was developed using Hydrologic Engineering Centre's Hydrologic Modelling System (HEC HMS) to estimate river discharge at Koleimodara with Deficit and Constant loss method, linear reservoir baseflow method, Snyder Unit Hydrograph transform method, and Muskingum routing method. The calibration and validation events were selected as the water cycle having prolonged dry spells i.e.,2006/2007 and 2011/2012 for calibration and 2008/2009, 2009/2010, 2013/2014 and, the continuous stimulation from 2005 to 2015 for validation. Kukule Ganga run-off-the-river plant operations were included for the model with elevation-capacity-discharge relationship considering environmental flow (0.5 $m^3/s$) and maximum turbine discharge. The objective functions, Relative Nash-Sutcliff ($NSE_{rel}$), Mean Ratio of Absolute Error (MRAE), Root mean square error (RMSE), and Percent bias (PBIAS) were used to evaluate model performance. Future precipitation projections were derived from Regional Climate Model (RCM) ICTP-RegCM4-7 based on NCC-NORESM1-M Global Climate Model (GCM) under Coupled Model Intercomparison Project Phase 5 (CMIP5) project. Two future scenarios of Representative Concentration Pathways (RCP) 2.6 and 8.5 were used to assess the future precipitation in the basin and streamflow at the intake location. The Standard Precipitation Index (SPI) and low flow indices i.e., Probability exceedance flow of $90^{th}$ percent ($Q_{90}$) and $50^{th}$ percent ($Q_{50}$), Mean 7-day annual minima (MAM7) and Mean 30-day annual minima (MAM30), Baseflow index (BFI), deficit duration, deficit volume, and intensity were applied to assess the future (2030-2060) climatic and low flow conditions of the project area relative to the observed data simulations of the 2005 to 2020 period.

The SPI indicated a possibility of the dry months becoming drier (June, July, and August under RCP 2.6 and July and August under RCP 8.5) or prevail the same dry conditions (January and February under both RCPs), and the wet month May receives more precipitation (under RCP 8.5). All indices indicated a possibility of low flows decreasing with deficit durations becoming more prolonged under both RCPs particularly during 2030-2040. Deficit analysis results and MAM7, MAM30 results indicated that the first inter-monsoon and Northwest monsoon periods continue to be the dry period. The intake is projected as facing a maximum deficit volume of 4.9 MCM for 47 days with the intensity of 105 thousand $m^3$/day and with a deficit volume of 4.4 MCM for 42 days with the intensity of 105 thousand $m^3$/day respectively, under RCP 2.6 and 8.5 during 2030 to 2040. Deficit events are projected as two during the base period (2005-2020) and nine and twelve respectively, under RCP 2.6 and 8.5 from 2030 to 2060. Based on the results of this study, it is recommended to select another water source for the next design horizon extractions or maintain storage of about 4.9 MCM to cater to the dry period water deficit to provide an uninterrupted water supply.


**Keywords: Climate change, HEC HMS, Kukule Ganga, low flow, RCM, water intake**

# DEDICATION

I would like to dedicate this study to my parents for all the efforts and dedications they made, and the encouragement and support given which no words can express to make me and my sister who we are today.

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AMF: Absolute Minimum Flow, ..... 10
AOGCM: Atmosphere-Ocean coupled General Circulation Model, ..... 34
AR 5: Fifth Assessment Report, ..... 32
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