WATER RESOURCES AVAILABILITY AND LOW FLOW DISCHARGE ANALYSIS OF KELANI RIVER BASIN IN WET ZONE UNDER CHANGING CLIMATE CONDITIONS

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This study estimates the effects of climate change on water resources availability and low flow streamflow discharge in the wet zone Kelani Basin in Sri Lanka. Models are available for flood study purposes in the respective basin, but for the estimation of low flows, more precise hydrological models are required. Analysis of the water resources availability under low flow conditions is essential for future infrastructure projects, ongoing urbanization, irrigation releases, and hydropower generation as well as for proactive planning, decision making, and establishing alternative sources. The selected pilot areas for this study are Norwood and Deraniyagala sub-basins of Kelani river. This research further evaluates the future change in streamflow of Kelani river due to climate change using a climate scenario analysis based on predicted climate variations in the basin. Standard Precipitation Index (SPI) analysis was performed to identify meteorological drought conditions that occur in the study area. The cumulative SPI results of shorter periods were generated by using the 12-month timescale which is above or below the generally used normal value. Further, the SPI values for a longer period tend to zero if a typical wet or dry trend has not occurred for a considerable period.

The HEC-HMS rainfall-runoff model was used to simulate streamflow under different scenarios, based on the accessibility to data, data reliability, and flexibility of the model. The model results indicated the capability of HEC–HMS model to simulate streamflow in the basin with reasonably higher accuracy with Mean Ratio of Absolute Error (MRAE), Nash Sutcliff Efficiency (NASH), and R-squared correlation (R^2) as objective functions. The MRAE showed more sensitivity to low flow and medium flow regions and less sensitivity to high flow region while NASH showed more sensitivity to high flow region compared to low flow regions.

The non-parametric estimator (ε_p) was used to estimate the rainfall elasticity of streamflow which is an initial estimation of the impacts of climate change on runoff generation and subsequently on water resources availability. According to the rainfall elasticity of streamflow analysis, elasticity values of 0.75 and 1.00 were obtained for the Norwood and Deraniyagala subbasins, which indicate that a 1.00% change in rainfall results in a 0.75% and 1.00% change in streamflow discharge in two sub-basins, respectively. The data for synthetic climate change scenarios were generated by adjusting the historical time series of hydro-climate data. The HEC-HMS model was run for selected 18 combinations of evaporation and precipitation in order to simulate changes in the hydrological processes due to potential climate change while incorporating climate uncertainty. The synthetic climate change scenario analysis results indicate up to a 40% reduction in streamflow in the dry season due to the climate change for the 2016-2035 period. This model is a feasible tool for testing the impact of future water management plans and policymaking on low flow management, while the findings and outcome of the research will be useful for scenario analysis and implementation.

Keywords: climate scenarios; drought indices; HEC-HMS; sensitivity analysis

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