INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student :JEFFREY DENZIL K. MARAK

Roll Number :166104105

Programme of Study : Ph.D.

Thesis Title: Climate Change Impacts in a River Basin having Flow Regulating Structures

Name of Thesis Supervisor(s) : Prof. Arup Kumar Sarma & Prof Rajib Kumar Bhattacharjya

Thesis Submitted to the Department/ Center : Department of Civil Engineering

Date of completion of Thesis Viva-Voce Exam : 14/03/2022

Key words for description of Thesis Work : Hydrological modeling, climate change, SWAT model, Hydrological Alteration

SHORT ABSTRACT

The hydraulic structures constructed for the benefits of society can cause perturbations in the streamflow. Such perturbations to natural conditions may affect the river ecosystem. The assessment of the changes in the hydrological regime due to man-made structures requires a comparison between the existing and the counterfactual scenario. It is a challenging task to carry out such assessments when pre-impact condition data do not exist. In this paper, a methodological framework is proposed and applied to Umiam watershed to generate natural streamflow by using the post-impact data when pre-impact data is not available. The Soil and Water Assessment Tool (SWAT) model is applied for simulating streamflow under the presence of reservoir and water transfer out of the watershed. The Indicators of Hydrologic Alteration (IHA) method was used for the analysis of changes in streamflow. The results reveal a reduction in the monthly median flow rate by at least 21% in all the months during the five-decade period. The large floods and small floods are found to be reduced in the presence of the reservoir, whereas it also causes more frequent low flows which last for longer durations. The extreme annual minimum flow conditions (1-day, 3-day, 7-day, 30-day, 90-day minima) shows low alteration while the corresponding annual maximum flow conditions show medium alteration. The frequency and duration of high and low pulses are greatly affected by the reservoir. The rising-rate, falling-rate, and the number of reversals show a significantly decreasing trend. The results indicate a high overall degree of alteration in streamflow. The analysis of individual reservoir effects revealed increase in monthly flows due to Kyrdemkulai, Nongmahir, Umiam Stage IV and Umtru Reservoirs. The individual effect of Umtru Reservoir was found to be highest among the four. The second highest effect was due to Nongmahir Reservoir. The cumulative effect of all reservoirs could increase the yearly median flows by 38.49% as compared to unaltered flow without IBWT and reservoirs. The change in yearly median flows were 95.43% in Umtru Basin if no water was transferred from Umiam Basin. Since rainfall plays a significant role in hydrologic response of a watershed, the spatial and temporal trends in rainfall over Umiam and

Umtru watersheds were analyzed. The analysis used the gridded rainfall data from the Indian Meteorological Department from 1901 to 2018. The Innovative Trend Analysis (ITA) method was used to identify the trends in low, medium, and high-intensity rainfall. The results indicated a decreasing trend in low and medium intensity rainfall while high-intensity rainfall is increasing across annual and seasonal time scales. For the assessment of climate and landuse change CORDEX data of IITM_RegCM4, MPI-CSC-REMO2009 and SMHI-RCA4 were considered. Under dammed condition, highest flow in January to March occurs in S3 and S4 (RCP 8.5). In April, June highest flow occurs in S3 and S4 (RCP 4.5). Under undammed scenario, the timing of highest flow shifts to September for S3 and S4 scenarios under RCP 8.5. In all the scenarios, sub-basin 4 is found to have the highest change in flow due to climate and landuse change.