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Topic: Impact of Climate Change on Hydropower Generation in Tehri Garhwal Region using Remotely Sensed Data

Keywords: ARIMA model, HEC-HMS, MIKE, Clirnate Change, Hydrological Modelling, RCP, Precipitation and Temperature Anomalies.

Outcomes:

The research work deals with investigating the effect of climate change on hydropower generation in Bhagirathi River basin by making use of remote sensing technology. Specific objectives of the research may be outlined as follows:

1. To analyse the impact of climate change on the cryosphere and the hydrological regime in the Bhagirathi river basin by the application of statistical techniques (ARIMA model).
2. To estimate water resources availability under current climate scenarios by the application of hydrological model (HEC-HMS) at Tehri Dam;
3. To estimate water availability under different future climate change scenarios using the hydrological model (HEC-HMS) for the Bhagirathi River Basin;
4. To conduct rainfall-runoff modelling in the basin using Mike 11 – a state-of-the art modelling software.

The first part of the thesis presents impact of climate change on the cryosphere, snow cover dynamics and the hydrological regime in the Bhagirathi river basin at Tehri Dam. This is done by conducting time series trend analysis of climate variables (precipitation and temperature) to find correlation between them by Pearson, Mann-Kendall and Spearman methods and forecasting is done by seasonal ARIMA model. The correlation analysis of annual and seasonal snow cover, precipitation and temperature shows a positive correlation which indicate that inflows at Tehri dam are affected by rainfall and snowfall in the study area which in turn are affected by the variations in temperatures (minimum and maximum) in the Bhagirathi basin. The seasonal ARIMA model forecast that the warmer locations at lower

elevations are becoming warmer while the colder locations at higher elevation are becoming colder.

The second part of the thesis describes the investigation of hydrological response of the basin to changing patterns of precipitation and temperature by applying HEC-HMS model. HEC-HMS hydrological model is used to estimate water resources availability at the study area outlet at Tehri Dam reservoir. The results obtained indicate that the availability of water resources on a daily temporal scale in the Bhagirathi River basin using remotely sensed data and data products can be modelled adequately using the HEC-HMS. The calibrated and validated model can be further applied to other watersheds in the region or to similar regions in other watersheds.

The third part of the thesis estimates the water availability at Tehri Dam reservoir by applying HEC-HMS hydrological model under different climate change scenarios to the Bhagirathi River Basin. The calibrated HEC-HMS model was successfully applied for RCP 4.5 and RCP 8.5 under bcc_csm1_1, ccsm4, csiro_mk3_6_0 and mri_cgcm3 models. The discharge in the study area has shown a similar increasing trend for both RCP 4.5 and RCP 8.5. There is a shift in peak discharge from August to September by the end of century. This in turn is going to affect the cropping pattern in the region and on the irrigation water supply. The results also indicate that there shall be more extreme events of rains and no-rains. There is an increase in discharge through the dam under climate change scenarios which might result in flooding of the surrounding areas.

The fourth part of the thesis investigates the performance, efficiency and suitability of applying Mike 11 NAM Rainfall-Runoff model in the Bhagirathi basin. It is a conceptual, lumped and deterministic rainfall-runoff model. The model is calibrated and validated for using the data for 2007-2010 and 2011-2016, respectively. This found suitable for simulating discharge in the basin with high degree of accuracy. The coefficient of determination (R2) is found to be 0.73 for calibration period and 0.76 for validation period. Sensitivity analysis is conducted to identify the most sensitive model parameter and maximum water content in surface storage (Umax) is found to be most sensitive model parameter. The coefficient of base flow (Ckbf) is found to be an important parameter in modelling as it was found to affect both high and low flows significantly affecting.