**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI**
**SHORT ABSTRACT OF THESIS**

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Thesis Title: Hydrological Assessment of LULC and Climate Change within the Water Resource Development Scenarios of Omo Gibe Basin, Ethiopia

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## SHORT ABSTRACT


The hydrological functions of river catchments are affected by numerous natural and man-made changes. Climate change is also one among them that has a complex effect on river basins. The river basins are vulnerable to natural and anthropogenic disruptions, changes in land use and land cover, and changes in hydrological characteristics because of water resources developments. The present study utilized hydrological modelling and remote sensing methods to determine the catchment response due to LULC changes at spatial and temporal scales for a river basin in Ethiopia. The study envisages hydrological assessment of LULC and climate change within the water resources development scenarios of the Omo Gibe Basin in Ethiopia.

Soil and Water Assessment Tool (SWAT) software was provided with inputs related to precipitation, topography, elevations, and soil types for hydrological modelling of the basin. Surface runoff, streamflow, and groundwater yield are some of the important outputs from SWAT for the basin. The precipitation inputs were provided with forecasts from climate models using different Representative Concentration Pathway (RCP) emission scenarios. The seasonal variation of precipitation in Gibe III dam site catchment during the summer precipitation season forecasted an increasing trend from 12.63 % in the midterm (during 2050s) to 13.95 % in the long-term (during 2080s) using RCP2.6. A similar trend exists for the RCP8.5 scenarios as well. However, the RCP4.5 scenario shows a decreasing trend from 3.61% in the midterm to 3.11% in the long-term prediction for this catchment. These trend analyses have shown the future shift of precipitations from summer to the winter and from the winter to spring seasons. The mean annual maximum temperatures in the mid-term are projected to increase by 1.34°C, 1.58°C, and 1.47°C for the RCP2.6, RCP4.5, and RCP8.5 scenarios, respectively, whereas the mean annual minimum temperatures in future long-term increase by 0.98°C, 1.03°C, and 1.35°C, respectively.

Further, SWAT was calibrated using the basin data from 1995 to 2007 and validated from 2008 to 2015 with 3 year's warm-up period. As there is an increase in percentage change in the future for precipitation in the basin, the corresponding increase in runoff is also witnessed. However, the evapotranspiration rates decreased in the futuristic scenarios for the basin. The mean annual maximum temperatures in the mid-term year (i.e., the 2050s) are projected to increase by 1.34°C, 1.58°C, and 1.47°C for the RCP2.6, RCP4.5, and RCP8.5 scenarios, respectively, whereas the mean annual minimum temperatures in future long-term 2080s increase by 0.98°C, 1.03°C, and 1.35°C, respectively. In this portion on temperature forecasts, the geo-statistical analysis shows that Root Mean Square Standardized Error (RMSSE) is nearly 0.98 for both the ordinary kriging and Inverse Distance Weighted (IDW) interpolation method.

The statistical parameters Nash and Sutcliffe efficiency (NSE) criteria, the coefficient of determination (R2), and Percent Bias (PBIAS) for both SWAT simulated and measured streamflow were estimated during calibration as 0.83, 0.76, and −3.37, and during validation as 0.856, 0.825, and −11.42, respectively. This shows that simulations have a very good correlation with the monthly observed and simulated streamflow in the lower Omo-Gibe basin. Climatic situations that influence evapotranspiration and precipitation processes, directly affect the basin's surface runoff, and soil moisture. Precipitation, evapotranspiration, and streamflow indicated increasing trends. The analysis revealed the impact of climate change on future annual streamflow to be directly correlated with an annual change of precipitation and indirectly correlated with evaporation.

The Land-use/Land-cover (LULC) classifications are some major inputs in SWAT model. The LULC classifications of Omo-Gibe for different periods were deduced from satellite images using the normalized difference indices on areas on vegetation, water bodies, and built-ups. The results indicate that LULC changes from 1987 to 2017 are significant for the region. The land-cover changes revealed an increase in the proportion of agricultural land and human settlement. The SWAT model assessed the impact of LULC dynamics on hydrological components. The calibrated and validated SWAT model simulations reveal that the percentage differences in surface runoffs show increasing trends while comparing the LULC changes between 1987, 2002, and 2017. Similarly, evapotranspiration values also increased from 1987 to 2017. However, other processes like groundwater flow, soil moisture, lateral flow, and water yield decreased in the basin from 1987 to 2017. Satisfactory comparison between the observed sediment yield from the basin and SWAT output justified the model's capability to use in different land-use scenarios.

Best management practices (BMPs) like – filter strips, terracing, and reforestation were artificially introduced in SWAT simulations of relevant sub-basins of Omo-Gibe. The simulations revealed reforestation as the BMP in reducing the sediment yield. Reforestation scenario simulation suggested a decrease in sediment output by 49.25%, 34.55%, and 40.84% for the years 1987, 2002, and 2017, respectively. The revelation is essential for stakeholders and policymakers in managing surface-water projects using the LULC scenario.