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Evaluating the value of Bias Correction of High-Resolution Satellite Rainfall Product (CHIRP) to simulate Stream flow into Lake Ziway, Ethiopia

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Significant lowering has been observed in the Lake Ziway volume, which hinders the lake services for a wide variety of ecosystems. However, the contribution of water withdrawal, land cover change and climate change has not been quantified yet due to scarce data for rainfall-runoff modeling. Hydrological modeling for runoff simulation requires long-term accurate and consistence rainfall data both in space and time. Satellite hydro-meteorological estimate may serve as important inputs for modeling in an area of data scarce and poorly gauged region. In this study, we evaluated the runoff simulation from near-real time, Climate Hazards Group InfraRed Precipitation (CHIRP) satellite rainfall product at daily temporal and 0.05° X 0.05° spatial resolution for a period from 1984 to 2016. The study area is Lake Ziway watershed situated in Ethiopian Central Rift Valley lakes basin (CRV), Eastern Africa, the highest in a chain of four lakes. As evidenced from other studies, the bias of satellite rainfall estimate must be removed before estimates receive hydrological and water resources applications. We applied a non-linear power bias correction method to obtain bias corrected precipitation using in-situ rainfall data as references. The bias-corrected CHIRP data were used to calibrate and simulate rainfall-runoff using Hydrologiska Byråns Vattenbalansavdelning (HBV) model at Katar and Meki catchments, two major river inflows into the lake.

The HBV model revealed very good performance when evaluated using Nash-Sutcliffe model efficiency (NSE) and relative volume error (RVE) objective functions for the calibration and validation periods. For calibration period run 1986 to 1991, the value of NSE was 0.78 and 0.65, and the RVE was -2.49 and -4.45 for Katar and Meki catchments respectively. The verification of model performance revealed NSE values of 0.73 and 0.61, and RVE values of 1.93 and 5.56 for both catchments during a period from 1996 to 2000. Simulation result indicates that, Katar and Meki rivers contribute a runoff volume of 614.6MCM (61% for the Katar and 39% for the Meki) to Lake Ziway for the period from 1986 to 2016. On average a change of up to 9% annual Lake runoff volume reduction obtained during simulation over time. Our study shows that bias corrected CHIRP satellite rainfall estimates play a major role in estimating catchment runoff and lake inflows. Further study should incorporate lake level simulation and climate change impact assessment to assess the likely current and future behavior of lake.