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Review paper

Impact of climate change on water resource in Upper Blue Nile basin: A Review

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Climate change impact influence the water resource planning choice. The upper Blue Nile river basin is the part of the Nile river basin found in Ethiopia has an important role in the hydrology of the Nile river basin. About 60% of the streamflow source of Nile River comes from this basin. Effects of change climate indicate that rise in maximum temperature and mean annual streamflow. Hydrological Byråns Vattenbalansavdelning (HBV) and SWAT hydrological models were used for assessment of the impact of climate change on streamflow, water resource and water resource. The models show good performance quality in calibrations and validation. The investigation indicates Upper Blue Nile basin was significantly and sensitive to climate change and affected due to climate change in all analysis.

Keywords: *Calibration, GCM, HBV, SWAT, Validation*

1. Introduction

The IPCC report indicated Africa as one of the most susceptible continents to climate alteration and climate changeability [1]. Water resources planning involves making assumptions about future plausible hydro-climatic conditions like temperature, precipitation, and river flows. Climate change affects the choice of information supporting these assumptions [2]. [3] Explain that a great number of studies have examined potential trends in measures of river discharge during the

20th century. Some have sensed important trends in indicators of flow, and some have demonstrated statistically significant relations with trends in temperature or precipitation. Increased water demand due to increased populations in Africa is expected to experience water stress before 2025. Climate change is expected to exacerbate this condition. In some analysis, the population at danger of increased water stress in Africa, for the full range of SRES scenarios, is projected to be 75–250 million and 350–600 million people by the 2020s and 2050s, respectively [4]. Abay which is part of the Blue Nile basin in Highlands of Ethiopia is characterized by significant internal climate variability, the topography is complex and associated local climate contrasts, [5]. The upper part of Blue Nile Basin which is a portion of the Nile River known and found in the Central Highlands of Ethiopia has an important role in the hydrology of the region. Over 60% of the total Nile River streamflow flow toward Sudan and Egypt is generated from the upper Blue Nile basin [6]. The hydrology and water resources availability of the upper Blue Nile River is affected by Climate change. Because of the increase in flow volume in the basin have significant causes for the sustainability of water development projects. The Upper Blue Nile River catchments and their water resources are a significant input for the different water development projects. [7].

2. Literature review

climate change influence on streamflow

[8] Investigate the impression change in climate to streamflow on upper Gilgel Abay catchment. The study was done in a period from 1961 to 1990 using SWAT hydrological model and HadCM3 global climate model with two emission scenarios. (A2 and B2). Based on the research in the catchment, the analysis in climate variables direct in A2 scenario increase means annual streamflow by 7.1, 9.7, and 10.1 % for the by 6.8, 7.9, and 6.4 % for the B2 scenario for the 2020s, 2050s, and 2080s. Effect of climate change to streamflow in river basins Awash, Baro, Genale, and Tekeze situated in Ethiopia using HSPF (Hydrologic Simulation Program FORTRAN) from 1971 to 2000 years. The climate model used in this investigation was spatial resolution data of CORDEX. Results of the study show that a 3% (6%) escalation in Awash, Baro, and Tekeze rivers, while the annual streamflow in Genale river was projected to increase over 18% (33%), is projected annual streamflow of the 2050s and 2080 projection years [9]. [10] use the SWAT model and RGM for a climatic model for inspection and results presented that the change in climate causes for the reduction in mean monthly flow volume that varies from −1.6% to −33% in the 2020s and 2080s scenario periods.[11] Use FORTRAN (HSPF) for assessment of potential evapotranspiration effect on streamflow estimations under changing climatic conditions and get result increase in precipitation from 6.2 to 7.2% and an increase in temperature from 1.8 to 2.7 ∘C.

3. Impact on hydrology

The main factors in determining a change in the hydrological process are land-use changes in the catchment. Several studies have been carried out to assess the impacts of change in land use and climate change on water resources [12]. An assessment of climate change impacts on hydrology by the HBV-96 hydrologic model and HadCM3 GCM with A2 and B2 scenarios used in different researchers. GCM (Genera climatic model) is coarse so statistical downscaling has several advantages as compared was used. The model is a semi-distributed conceptual model that allows separating the catchment into sub-basins and then sub-basins further divided into elevation and vegetation zones. Nash–Sutcliffe efficiency and correlation coefficient of 0.76 and 0.9 [13],[14],[15] and [16], use SWAT for hydrological model and GCM with the downscaling technique for climate change analysis in a basin. The influence of alteration in climate on hydrology shows that increasing maximum temperature in the watershed. [17] Investigate the impact of evaluating the impacts of climate and land use/land cover (LU/ LC) dynamics on the Hydrological Responses by the hydrological model SWAT for 40 years (1973–2015). The study showed increasing stream flow because of LULC change in the watershed. This increase was 8.49% and 14.50% during short rainy and wet season respectively.

4. Impact on water resource

[18] Investigate the Water Resources situation under changed climate on Megech River Catchment by HBV-Light hydrologic model. For this assessment three performances of Nash and Sutcliffe efficiency (NSE), efficient of determination (R2), and Relative volume error (RVE) were used. The performance of the model in calibration and validation show NSE = 0.91, R^2 = 0.92 and during calibration and R^2 = 0.87, NSE = 0.86). The results show that the HBV-Light model accuracy can simulate daily discharge. Results show that a reduction of the peak discharge in August and September in HBV-Light model simulation. According to [19] study on Impact of climate change on surface water availability and crop water demand for the sub watershed of Abbay Basin using the Hydrologiska Byråns Vattenbalansavdelning (HBV) model. The model showed the performance during calibration (R^2 = 0.89) and validation (R^2 = 0.85) and future water availability was simulated by climate change scenarios. The forthcoming expected streamflow indicates that minimum flow might decrease in RCP4.5 and RCP8.5 scenarios, in the 2035 and 2055 projected years [20] [21]. Examine change in climate impact on water by using Soil and Water Assessment Tool (SWAT) hydrological model. Through Streamflow measured data from four gauging stations SWAT model calibration and validation was perform. The performance model was assessed by the Nash-Sutcliffe coefficient efficiency (NSE) and the coefficient of determination (R^2). To distinguish the model accuracy to the catchment on stream flow impact induced by climate change the observed and simulated result difference should be minimum. During the model validation period, the SWAT model demonstrated good to very good performance (R2 from 0.58 to 0.84 and NSE from 0.57 to 0.80). Surface runoff is projected to increase by up to 14%. The result shows that the total water yield of the Basin is estimated to decrease by -1.7 to -6.5% and -10.7 to -22.7%, for simulations forced using RCP4.5 and RCP8.5 scenarios, respectively.

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