World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:11, No:05, 2017

Impact of Climate Change on Irrigation and Hydropower Potential: A Case of Upper Blue Nile Basin in Western Ethiopia

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Abstract : The Blue Nile River is an important shared resource of Ethiopia, Sudan and also, because it is the major contributor of water to the main Nile River, Egypt. Despite the potential benefits of regional cooperation and integrated joint basin management, all three countries continue to pursue unilateral plans for development. Besides, there is great uncertainty about the likely impacts of climate change in water availability for existing as well as proposed irrigation and hydropower projects in the Blue Nile Basin. The main objective of this study is to quantitatively assess the impact of climate change on the hydrological regime of the upper Blue Nile basin, western Ethiopia. Three models were combined, a dynamic Coordinated Regional Climate Downscaling Experiment (CORDEX) regional climate model (RCM) that is used to determine climate projections for the Upper Blue Nile basin for Representative Concentration Pathways (RCPs) 4.5 and 8.5 greenhouse gas emissions scenarios for the period 2021-2050. The outputs generated from multimodel ensemble of four (4) CORDEX-RCMs (i.e., rainfall and temperature) were used as input to a Soil and Water Assessment Tool (SWAT) hydrological model which was setup, calibrated and validated with observed climate and hydrological data. The outputs from the SWAT model (i.e., projections in river flow) were used as input to a Water Evaluation and Planning (WEAP) water resources model which was used to determine the water resources implications of the changes in climate. The WEAP model was set-up to simulate three development scenarios. Current Development scenario was the existing water resource development situation, Medium-term Development scenario was planned water resource development that is expected to be commissioned (i.e. before 2025) and Long-term full Development scenario were all planned water resource development likely to be commissioned (i.e. before 2050). The projected change of mean annual temperature for period (2021 – 2050) in most of the basin are warmer than the baseline (1982 -2005) average in the range of 1 to 1.4oC, implying that an increase in evapotranspiration loss. Subbasins which already distressed from drought may endure to face even greater challenges in the future. Projected mean annual precipitation varies from subbasin to subbasin; in the Eastern, North Eastern and South western highland of the basin a likely increase of mean annual precipitation up to 7% whereas in the western lowland part of the basin mean annual precipitation projected to decrease by 3%. The water use simulation indicates that currently irrigation demand in the basin is 1.29 Bm3y-1 for 122,765 ha of irrigation area. By 2025, with new schemes being developed, irrigation demand is estimated to increase to 2.5 Bm3y-1 for 277,779 ha. By 2050, irrigation demand in the basin is estimated to increase to 3.4 Bm3y-1 for 372,779 ha. The hydropower generation simulation indicates that 98 % of hydroelectricity potential could be produced if all planned dams are constructed.

Keywords : Blue Nile River, climate change, hydropower, SWAT, WEAP
Conference Title : ICEWW 2017 : International Conference on Environment, Water and Wetlands
Conference Location : Montreal, Canada
Conference Dates : May 11-12, 2017

Open Science Index, Environmental and Ecological Engineering Vol:11, No:05, 2017 publications.waset.org/abstracts/69153.pdf