Geophysical Research Abstracts
Vol. 20, EGU2018-6407, 2018
EGU General Assembly 2018

Investigating the Adaptive Capacity measure of a reservoir system under the effect of Climate Change

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Water Stress is a serious issue in many areas in the world. Quantifying the availability of fresh water in these areas to protect the livelihood of people and ecosystem is one of the important challenges facing water managers. However, water stress does not only depend on water resources but also on the adaptive capability of societies to access to differing degrees of water availability. Today, population growth and climate change are two of the most influential factors causing water stress. This study sets out to measure water stress under the influence of climate change - defined as ‘adaptive capacity’ measure. To achieve this goal, two hypothetical dams are designed to respond to the needs of 20,000 and 100,000 people. These dams are then located on three randomly chosen streamflows in Iran and Australia. The operation of the dams is optimized considering two non-conflicting objectives, i.e. minimizing both water deficit and flooding around the reservoir considering the mass-balance equation of the system for monthly time steps of associated historical data. These optimized policies are then used to simulate the system for future Climate Change Pathways, introduced in IPCC Fifth Assessment Report (AR5), September 2013. The four Representative Concentration Pathways (RCPs), introduced in AR5, describe four possible future climate scenarios by considering the emissions concentration through out a period of 30+ years.

In this study, Climate Change Pathways data is obtained using MIROC5 (Model for Interdisciplinary Research on Climate, Version 5) which has been developed by the University of Tokyo Center for Climate System Research. Future precipitation, temperature and evaporation data obtained from MIROC5 are bias corrected using Kernel Density Distribution Mapping (KDDM). These bias-corrected data are then used as input for IHACRES, which is a ‘rainfall-runoff model that uses a non-linear loss module to calculate the effective rainfall and a linear routing module to convert effective rainfall into stream flow’ and acts as a catchment-scale lumped rainfall-runoff model to estimate future runoffs. Long time storage and release decisions of the dams are calculated by simulating the obtained streamflow through the hydrological model of the system. Future release decisions and projection of Human Development Index (HDI) are used to calculate Social Water Stress Index (SWSI). SWSI is considered as an adaptive capacity index expressing that ‘distributional equity’, ‘political participation’ and ‘access to education’ are good means to measure adaptive capability of societies to water stress.