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Simulating Climate Change Impacts on Wadi-Flow Variation in Al-Khoud Watershed

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Abstract

Impact of climate change is one of the most important concerns nowadays since it will directly affects various sectors such as agriculture, economy, environment and human life. This study investigated the possible future climate change effects on precipitation pattern and resulting changes in stream flow regimes in Al-Khoud watershed in Oman. Al-Khoud watershed was delineated using HEC-GeoHMS tool in ArcGIS software. Wadi-flow simulation model was developed using Hydrological Engineering Center-Hydrologic Modeling System (HEC-HMS) software. In HEC-HMS, Soil Moisture Accounting (SMA) algorithm and User Specified Unit Hydrograph (USUH) technique were used for calculating precipitation losses and direct runoff generation, respectively. Parameters of the SMA method and USUH were calibrated and verified using historical rainfall and wadi-flow records. In climate prediction, historical precipitation data from 6 rain gage stations were used with LARS-WG6 to downscale future daily rainfall data from two general circulation models (GCMs) (EC-EARTH and MIROC5) and two representative concentration pathway (RCP) scenarios (RCPs 4.5 and 8.5). Predicted daily data were disaggregated to hourly time scale using K-Nearest Neighbor method (K-NN). These rainfall predictions were then used with the calibrated hydrological model to simulate wadi-flow variations in the future. The parameter analysis of HEC-HMS and SMA model show that the soil percentage, infiltration and soil percolation parameters are the most sensitive parameters for wadi-flow simulations. The simulated wadi-flows agree with the observed ones with the Nash-Sutcliffe efficiency value of 0.93. The model performance can potentially be improved by calibrating the parameters seasonally. Predicted rainfall by two RCPs and two GCMs indicate potential increases in annual total rainfall in two future periods: 2021-2040 and 2041-2060 compared to baseline period. Simulated wadi-flow events in the future show that the peak-flow rate can be significantly higher compared to the Gonu event in 2007 due to potential increases in rainfall intensity. Results further indicated that the base-flow amount increases as the duration of the rainfall event extends. Moreover, higher antecedent moisture content tends to increase the peak-flow rate and volume of the hydrograph.