Desalination and Water Treatment
www.deswater.com
doi:10.5004/dwt.2018.22346

114 (2018) 109–119
May

Groundwater share quantification through flood hydrographs simulation using two temporal rainfall distributions

Khaled S. Balkhair[a,b,*], Amjad Masood[a,c], Mansour Almazroui[d], Khalil Ur Rahman[a,e], Omar A. Bamaga[b], Ahmed S. Kamis[a], Iqbal Ahmed[b], Mohammed I. Al-Zahrani[f], K. Hesham[g]

[a]*Department of Hydrology and Water Resources Management, King Abdulaziz University, Jeddah, Saudi Arabia, email: kbalkhair@kau.edu.sa (K.S. Balkhair)*
[b]*Center of Excellence in Desalination Technology, King Abdulaziz University, Jeddah, Saudi Arabia*
[c]*Global Change Impact Studies Centre, Islamabad, Pakistan*
[d]*Center of Excellence for Climate Change Research/Department of Meteorology, King Abdulaziz University, Jeddah, Saudi Arabia*
[e]*Department of Hydraulic Engineering, Tsinghua University, Beijing, China*
[f]*Saudi Geological Survey, Jeddah, Saudi Arabia*
[g]*Department of Geophysics, King Abdulaziz University, Jeddah, Saudi Arabia*

Received 7 November 2017; Accepted 4 February 2018

ABSTRACT

Due to the scarcity, randomness, and extremity of rainfall events in arid regions, planning and management of water resources are essential. Rainfall in many arid regions such as Saudi Arabia is characterized by high intensity and short duration during which flash floods occur and cause not only major loss in life and structures but also a huge loss of clean water. Understanding the relationship between rainfall and runoff is the key issue in the management and control of water resources. In this study, two approaches have been applied using Hydrologic Engineering Center's Hydraulic Modeling System model to simulate flood hydrographs of a mountainous watershed located on the west side of Saudi Arabia. The first approach was based on incorporating losses through the soil conservation service (SCS) curve number and SCS unit hydrograph. The second approach was based on effective rainfall in which excess rainfall was computed by Horton's infiltration method and the Phi index method. Results revealed that the performance of losses incorporation approach was poor in simulating runoff hydrographs in all studied storms. Its main drawback was the ineffective representation of flow mass conservation and the early generation of runoff due to rainfall input. In contrast, the effective rainfall approach simulated runoff hydrographs efficiently; moreover, results were comparable with many of those reported in the literature. The two critical hydrograph parameters of peak flow and time to peak were simulated accurately by Phi index method and Horton's infiltration method. The sensitivity analysis showed that the peak flow is directly proportional to the curve number and inversely proportional to the initial abstraction. From water management point of view, the simulated hydrographs added a valuable piece of information about the quantification of lost and stored rainwater. About 55%–70% of rainwater infiltrates through the soil profile and recharges the underlined groundwater reservoir, hence becomes a major source of water in the region.

Keywords: Arid regions; Excess rainfall; Floods hydrograph; Temporal distribution; HEC-HMS; Clean water

* Corresponding author.