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Evaluation of the GIUH, GCIUH and Nash Models for flood prediction in the Kangir (Eyvane Gharb) watershed, Iran

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Abstract

The Kangir catchment in Ilam province, Iran, has a drainage area 122.71 km2 and is located in the latitude range of 33o 41' to 33o 51' and longitude range of 46o 17' to 46o 27'. The altitude in the study watershed varies between 1175 m in northwest and 2650 m in southeast. The study area is upstream part of Kangir basin and drained by permanent Kangir river that flows from southeast to northwest. Geologically, Kangir catchment is part of the Zagros Fold Belt of the Zagros Mountains. The structures are composed of anticlines and synclines and trend in NW-SE direction. The linking of the geomorphological and climatic parameters with the hydrological characteristics of the basin can provide a simple way to understand the hydrologic behavior of different catchments, particularly the ungauged ones. In this study, geomorphological instantaneous unit hydrograph (GIUH) geomorphoclimatic instantaneous unit hydrograph (GCIUH) and Nash models were evaluated based on geomorphological characteristics, velocity, rainfall data and geometrical parameters of stream channel, in Kangir catchment. Results of this study shows that GIUH and GCIUH methods approximately estimated the observed peak discharges but underestimate the time to peak discharges. in Nash model, the calculated QP and TP values effectively differ from observed QP and TP values. also, in spite of relatively better performance of GIUH and GCIUH methods, error function (ERR)results represent that three mentioned methods failed to predict the complete shape of observed hydrographs. This study reveals that karstic landforms such as karren and doline and tectonic joints perpendicular to topographic slope reduce the velocity of runoff and increase the travel time and, hence, affect the QPs and TPs of GIUH, GCIUH and Nash models.

Keywords: GIUH, GCIUH, Nash, Kangir, geomorphologic characteristics, karstic landforms

1. Introduction

In many regions around the world the hydrologic data required to investigate the response of a basin to rainfall are not available. One of the most popular approaches to this problem is to link the hydrological response of the watershed to their geomorphological characteristics. Rodriguez-Iturbe and Valdes (1) introduced the concept pf GIUH(Geomorphological Instantaneous Unit hydrograph) by linking the IUH peak discharge (qp) and time to peak (tp) with the geomorphological parameters of the watershed and a dynamic parameters(velocity). Rodriguez-Iturbe et al. (2) rationalized that velocity must be a function of the effective rainfall intensity and duration and proceeded to eliminate velocity from the results. This led to the development of geomorphoclimatic instantaneous unit hydrograph (GCIUH). Rosso(3) related the Horton's order ratios to the parameters of Nash IUH model (1957) on the basis of geomorphologic parameters of Qp and Tp. Rosso derived the parameters of Nash IUH model through power regression. Recently, several studies have examined the GIUH, GCIUH and Nash models in different catchments (4, 5, 6, 7, 8, 9, 10). Morphometry, morphological landforms and climatic parameters have complex relationship with hydrology in karstic catchments. This complexity can produce differences between observed and estimated hydrographs in GIUH, GCIUH and Nash models. The objectives of the present study are (i) to derive GIUH, GCIUH and Nash models from geomorphological characteristics, climatic data and geometric parameters of channel (ii) to compare the observed and simulated flood events and to evaluate the coefficient of efficiency (iii) to evaluate the effect of karstic landforms on hydrographs for mentioned models in karstic Kangir catchment.

2. Data and approach

The GIS software in the present study is Integrated Land and Water Information System (ILWIS). The boundary of catchment and all the streams have been mapped at a scale of 1:50000 from Iranian National Geography Organization toposheets. For stream order, Strahler's ordering system has been followed (11). After digitizing the drainage area for each stream, the total stream areas, lengths and numbers of each order were calculated. Values of RB, RA and RL, then, were determined by plotting the logarithms of the numbers, areas and lengths of streams against orders. Parameters RB, RA and RL were estimated by taking antilog of