Shahid Chamran University of Ahvaz

Irrigation Sciences and Engineering (JISE) **Vol. 42, No. 3, Fall 2019, p. 1-15**

EXTENDED ABSTRACT

Calibration and Evaluation of SCS Method for Estimating Flood Runoff in Pasekohak Watershed

M. Adeli[1] and Z. Mohammadi[2*]

1- Ph.D. Candidate of Hydrogeology, Department of Earth Science, Shiraz University.

2*- Corresponding Author, Associate Professor of Hydrogeology, Department Of Earth Science, Shiraz University *(zmohammadi@shirazu.ac.ir).*

Received: 6 February 2016 Revised: 19 April 2017 Accepted: 23 April 2017

Keywords: : Pasekohak Watershed, Runoff, SCS Method, Curve Number (CN), Remote Sensing.
DOI: 10.22055/jise.2017.16921.1233.

Introduction

The Curve Number (SCS-CN) method, one of the most widely used methods for estimating runoff in hydrology, has been developed by soil conservation services. The application of SCS equation in Iran may be mixed with considerable errors due to different climatological, geological, and hydrological characteristics. In addition, the other cause of error in this method is the relationship between Ia and S (Equation 2), which is experimental and has been taken from rainwater data in small laboratories (Anonymous, 1972). This relationship can be criticized in terms of the document and was examined in various studies of its accuracy and application (Bo et al., 2011, Shi et al., 2009, Baltas et al., 2007, Mishra et al ., 2006,2004, Hawkins et al., 2002), In order to calibrate the SCS equation and evaluation in empirical relations, Pasekohak catchment was selected. Pasekohak basin includes four sub-basins where flood runoff was gauged during five flood events. Curve Number (CN) for the sub-basins was estimated according to the remote sensing, geological maps, and field works. The real hydrograph for each event was compared with SCS hydrograph in HEC-HMS software, and the calibration and correction of SCS coefficients were conducted. The results suggest a correction coefficient of 0.92 for SCSLag, the average ratio of Ia/S is 0.044, which is completely different from 0.2 in SCS. The CN in the study area is 0.41 of CN provided by SCS.

Methodology

In this study, in order to investigate the validity of the relations in the SCS method, the watershed of Pascukhak with an area of about 72 square kilometers located in the west of Shiraz was studied. This basin has 4 sub-basins and 5 measuring stations. 5 rainfall events were used for direct runoff measurement. flood discharge measurements were carried out several times in different events at each station. The runoff depth was also taken at intervals of 2 to 4 hours in all rainfall events at each station (Rating curve). in this research, AutoCAD software (extraction of precipitation data from relevant graphs), ArcGIS (geological map and slope distribution), ENVI (land use differentiation), and finally, HEC-HMS (for the comparison and calibration of real hydrograph and hydrograph derived from SCS) have been used. Using field studies in the study area and according to the geology map (the genus of the rock formations in the region) and the permeability of the alluvium from each formation and the relevant tables, soil hydrological groups in the Pascourt basin and sub-basin were determined (table 1). In order to determine the land used in the studied area, TM satellite images (12 / June / 1998) and the ENVI 3.4 (2006) software were used.

Table 1- geological formations and related hydrological groups

Formation	Hydrologic group
Gachsaran	C
Bakhtiyari Conglomerate	C
Bakhtiyari Conglomerate	A
Alluvial	
Gachsaran Alluvial	B
Razak	C
Asmari	B
gorpeiy	C

Results and Discussion

Using the data above, the hydrologic groups of the soil and the percentage of each hydrological group were determined in the study area. Finally, the amount of CN in moisture conditions II was determined for the Peschuk basin and sub-basin (table 2). The calibration of the SCS method was performed based on the calculated and observed hydrographs for each rainfall event using the HEC-HMS software. Possible sources of error in the SCS method can be referred to as the IA / S ratio. This ratio is ascertained experimentally and equals to 0.2. Also, in the SCS method, the time factor does not play an important role. This means that the precipitation intensity is not considered. Thus, in this research, the IA / S ratios for the basin and sub-basins were determined and we tried to investigate the role of time (rainfall intensity) by drawing different factors in comparison with rainfall intensity. Therefore, changes in CN, SCS Lag, and Ia values have been studied and compared with rainfall intensity.

Table 2- Estimated CN (humidity condition II) for Pasekohak basin and sub basins

Basin /sub basin	CN
Pasekohak basin	70
Pasekohak sub basin	60
Maroon sub basin	72
Gazdan-Maroon sub basin	72
Maroon-Maroon sub basin	70

The results obtained in this study indicate that the calibrated SCS Lag values vary at different stations, and the average value obtained from the SCS Lag calibrated to SCS Lag from SCS is 0.92. thus, we can use Equation 1 to obtain the actual SCS Lag value

$$\mathrm{SCSLag}_{O} = \mathrm{SCSLag}_{SCS} \times 0.92 \qquad (1)$$

The amount of initial abstraction in this study was lower than those predicted by the SCS method in all sub-basins. The average Ia / S value obtained in this study is 0.44, according to 2:

$$\mathrm{I}_{a} = 0.044 \times S \qquad (2)$$

This equation can be used instead of the SCS experimental relationship. Given the CN estimated by the SCS method, and the average of actual CN obtained for each sub-basin, the correction coefficient as equation 3 will be used for converting the estimated to the observation CN

$$\mathrm{CN}_{O} = \mathrm{CN}_{SCS} \times 0.41 \qquad (3)$$

Conclusions

The results showed that the calibrated SCS Lag values vary at different stations, and the average value obtained from the SCS Lag calibrated to SCS Lag from SCS is 0.92. The amount of initial abstraction in this study was lower than those predicted by the SCS method in all sub-basins. The

average Ia / S value obtained in this study is 0.44. Given the CN estimated by the SCS method and the average of actual CN obtained for each sub-basin, the correction coefficient could be 0.41 for converting the estimated to the observation CN. This research was carried out in the Pesekohak watershed and its results are valid for this basin. It is suggested that similar research be carried out in the same climatic conditions in order to ascertain the accuracy of the relationships, and then the results obtained from this study could be used in similar basins in terms of lithology, soil type, and physiography characteristics.

References

1- Baltas, E.A., Dervos, N.A. and Mimikou, M.A., 2007. Determination of the SCS initial abstraction ratio in an experimental watershed in Greece. *Hydrology and Earth System Sciences Discussions*, *11*(6), pp.1825-1829.

2- Bo, X.I.A.O., Qing-Hai, W.A.N.G., Jun, F.A.N., Feng-Peng, H.A.N. and Quan-Hou, D.A.I., 2011. Application of the SCS-CN model to runoff estimation in a small watershed with high spatial heterogeneity. *Pedosphere*, *21*(6), pp.738-749.

3- Hawkins, R.H., Jiang, R., Woodward, D.E., Hjelmfelt, A.T., Van Mullem, J.A., and Quan, Q.D., 2002, July. Runoff curve number method: examination of the initial abstraction ratio. In *Proceedings of the Second Federal Interagency Hydrologic Modeling Conference, Las Vegas, US Geological Survey, Lakewood, Colorado*.

4- Jain, M.K., Mishra, S.K., Suresh Babu, P. and Venugopal, K., 2006. On the Ia–S relation of the SCS-CN method. *Hydrology Research*, *37*(3), pp.261-275.

5- Mishra, S.K., Jain, M.K. and Singh, V.P., 2004. Evaluation of the SCS-CN-based model incorporating antecedent moisture. *Water resources management*, *18*(6), pp.567-589.

6- Mishra, S.K., Sahu, R.K., Eldho, T.I. and Jain, M.K., 2006. An improved I a S relation incorporating antecedent moisture in SCS-CN methodology. *Water Resources Management*, 20(5), pp.643-660.

7- SCS, U., 1972. National engineering handbook. *Hydrology Section*, *4*.

8- Shi, Z.H., Chen, L.D., Fang, N.F., Qin, D.F. and Cai, C.F., 2009. Research on the SCS-CN initial abstraction ratio using rainfall-runoff event analysis in the Three Gorges Area, China. *Catena*, *77*(1), pp.1-7.

9- Woodward, D.E., Hawkins, R.H., Jiang, R., Hjelmfelt, A.T.J. and Van Mullem, J., 2003, June. Runoff curve number method: examination of the initial abstraction ratio. In *World Water & Environmental Resources Congress 2003 and Related Symposia*.