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EXTENDED ABSTRACT

Assessment of Developed 1-parameter Mishra-Singh Model for Flood Hydrograph Estimation

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Introduction

There are various models for flood prediction that are based on different conceptual basis. The current SCS-CN model is a well-known model in this field that is widely used in Iran and other countries. Recent researches focuses on improvement of this model and improve its efficiency but it is necessary to evaluate the improved models for catchments of Iran. The objective of this study is the comparison of current SCS-CN and developed Mishra-Singh (One Parameter) models for flood hydrograph and peak estimation using data of five catchments in Golestan province.

Methodology

Study Area and Used Data

Five catchments (including Galikesh, Tamer, Kechik, Vatana and Nodeh) located in Golestan province were considered to evaluate different models for flood hydrograph estimation. The characteristics of the selected basins are presented in Table. (1). Details of land use and soil hydrologic groups of catchments presented in Table 2.

Table 1- Characteristics of studied catchments

Catchment name	Area (Km^2)	Perimeter (Km)	Medium Height (m)	Average slope (Percent)	Main Floepath length (Km)	Events
Tamer	1527	287.87	1131.5	19.5	94	10
Galikesh	401.45	138.54	1358.5	27.5	57.8	13
Kechik	36	25.81	928	18.75	9.6	3
Nodeh	789.65	207.77	1540.7	28	65.69	9
Vatana	10.77	20.35	898.5	32.78	7.8	4

Table 2- Land use and soil hydrologic groups of the studied catchments

Catchment name	Land use(Percent)					Hydrological group				
	Cultivated-Straight Row	Cultivated-Close Seeded	Forest	Grassland	Residential	A	B	C	D	CN
Kechik	58.58	-	17.09	23.97	1.36	-	58.5	28.1	13.5	74
Vatana	0.05	-	99.95	-	-	-	99.3	0.7	-	72
Galikesh	2.9	37.86	51.31	7.93	-	-	9.24	90.8	-	75
Nodeh	1.21	-	28.96	69.54	0.29	14.5	32.6	44.8	7.7	73
Tamer	0.17	34.44	26.85	38.44	0.08	-	16.2	83.5	0.3	76

Descriptions of Models

The Standard curve number (SCS-CN) model presented is based on following basic equations:

$$Q = \frac{(P-I_a)^2}{(P-I_a)+S} \quad P \geq I_a \tag{1}$$

$$Q = 0 \quad P \leq I_a$$

$$S = \frac{24500}{CN} - 254 \tag{2}$$

$$I_a = \lambda S \quad \lambda = 0.2 \tag{3}$$

Where P is total rainfall, Q is excess rainfall, CN is curve number, Ia is initial abstraction, S is maximum retention. Using the concept of the degree of saturation (C=Sr), where C is the runoff coefficient (=$Q/(P-Ia)$), Mishra and Singh (2002) and Mishra et al. (2006) modified the original SCS-CN model after the introduction of antecedent moisture M as:

$$Q = \frac{(P-Ia)(P-Ia+M)}{P-Ia+M+S} \tag{4}$$

Relationships developed by Mishra et al. (2006) for M are as follows:

$$M = \alpha\sqrt{S\,P_5} \quad (4)$$

$$M = 0.72\sqrt{S\,P_5} \tag{6}$$

P_5 is prior 5-day rainfall depth.

Three model accuracy criteria including root mean square error (RMSE), Nash-Sutcliff efficiency (NSE) and percentage error in peak (PEP) were applied to compare the results of the models (Adib et al., 2010-2011).

Results and Discussion

There were 39 rainfall-runoff events that 25 and 14 events were selected for calibration and validation steps, respectively. The parameters of investigated models for different events and catchments and related model accuracy criteria presented in Tables 3 and 4. These results showed that the developed Mishra-Singh (One Parameter) model improved accuracy of flood hydrograph and peak estimation relative to standard SCS-CN model for 13 events and the difference between two models for 1 remaining event was presumably negligible. In addition, the standard SCS-CN model tend to overestimation for 64% of cases while the developed Mishra-Singh (One Parameter) model led to overestimation for 35% of investigated events.

Table 3- SCS curve number and optimized parameters for the studied catchments

Galikesh	SCS-CN		MS(1P)			Vatana	SCS-CN		MS(1P)		
	CN	λ	CN	λ	α		CN	λ	CN	λ	α
2013/4/25			60			2011/8/27			57		
2005/1/7			31			2012/9/2	72	0.2	67	0.08	0.72
2014/03/13			61			2012/10/13			41		
2012/7/20	75	0.2	42	0.08	0.72	Median	72	0/2	57	0.08	0.72
2011/10/21			54			Kechik					
2013/2/3			30			2012/9/2	74	0.2	78	0.08	0.72
2005/1/11			44			2014/8/14			40		
Median	75	0.2	44	0.08	0.72	Median	74	0.2	59	0.08	0.72
Tamer	SCS-CN		MS(1P)			Nodeh	SCS-CN		MS(1P)		
	CN	λ	CN	λ	α		CN	λ	CN	λ	α
2013/1/30			40			2009/11/4			50		
2010/6/22			53			2012/3/31			67		
2012/8/23			82			2010/6/22	73	0.2	70		
2012/5/16	76	0.2	55	0/08	0/72	2011/10/22			66	0.08	0.72
2011/8/26			78			2009/11/22			61		
2013/2/3			25			-	-	-	-		
Median	76	0.2	54	0/08	0/72	Median	73	0.2	66	0.08	0.72

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Table 4- RMSE, NSE and PEP in validation steps for the studied catchments

event	Galikesh						event	Nodeh					
	MS(1P)			SCS-CN				MS(1P)			SCS-CN		
	RMSE	NSE	PEP	RMSE	NSE	PEP		RMSE	NSE	PEP	RMSE	NSE	PEP
2010/2/22	16.24	-0.94	0.58	17.94	-1.37	0.24	2012/3/28	7	-1.2	0.8	11.83	-5.31	-1
2013/2/13	7.95	-43.31	-0.7	14	-138	-2.11	2012/9/6	16	-0.71	0.22	22.74	-2.46	-2.4
2009/2/18	2.28	-0.29	0.68	6.56	-9.7	-1.39	2007/8/4	84.5	-0.32	0.93	88.96	-0.46	0.99
2013/2/1	7.3	-1.7	0.12	13.56	-8.4	-0.62	2011/8/26	50.6	-35.9	-1.65	69.92	-69.5	-2.57
event	Tamer						event	Vatana					
	MS(1P)			SCS-CN				MS(1P)			SCS-CN		
	RMSE	NSE	PEP	RMSE	NSE	PEP		RMSE	NSE	PEP	RMSE	NSE	PEP
2011/8/27	13.52	-1.06	0.4	12.04	-0.73	0.62	2014/6/14	1.9	0.71	0.4	4.8	-0.82	0.95
2011/8/25	38	-41.8	-1.7	92.62	-252.5	-5.14	event	Kechik					
2011/3/31	3.03	-0.58	0.09	5.26	-3.75	-0.74		MS(1P)			SCS-CN		
2010/2/23	14.44	0.35	-0.1	48.81	-6.37	-1.09	2012/7/16	2.55	-2	-0.19	2.91	-2.93	0.6

Conclusions

In this study, the accuracy of standard SCS-CN and developed Mishra-Singh (One Parameter) models compared in terms of flood hydrograph and peak estimation considering data of five catchments in the Golestan province. Investigation of model accuracy criteria revealed that the developed model led to considerable improvement of flood estimation in the studied catchments.

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