Comparison of some empirical relations in the estimated time of Concentration Ivar Watershed

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Abstract: Time parameters, including parameters which are of them used the most hydrologic and hydraulic models. Most commonly time parameters used in hydrology is time Concentration. Time Concentration it is duration that the water farthest point watershed reach to the outlet or point from Way River. Time concentration is required on the design of spillways, estimating flood volume, preparation flood hydrograph and many other hydrologic analysis. Until now is presented many methods for estimating time of concentration that the purpose of this study select the best method of techniques estimating the time concentration is in ivar watershed. Direction estimated time concentration on this watershed were used of five experimental method kirpich, chaw, Jianduty, Williams and California. Based on the results of the maximum and minimum time Concentration on the sub watershed I08 and I10 was obtained for method chaw 1.75 and 0.55, method California 1.88 and 0.52, method Williams 3.41 and 0.55, method kirpich 1.82 and 0.52 and Jianduty 4.78 and 0.55 h. Time concentration also watershed using any method was obtained (Kirpich, Chaw, Jianduty, williams and california), respectively, 2.01, 2.01, 4.82, 3.85 and 2.15 hours. With considering various parameters such as main water way length, subwatershed and watershed area and water way slope for kidney watershed units, the suitable concentration will be kirpich..

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1. Introduction

Temporal parameters that are used on most models including hydrological and hydraulic parameters. The most common parameter on hydrology used when it is time of concentration. Concentration time is the period during water from the basin to the point farthest exit or reaches the point of the river (Najmaii, 1989). In other words, concentration time period that is the focus farthest point drop compared to the concentration required to its own course and to reach that point. The farthest concentration point drop compared to their physical distance but are may be considered hydraulic (Alizadeh, 1995). Time of concentration is required in the spillway design, estimation of flood hydrograph floods and many other hydrological analysis (Keramat Khani, 1996). With regard to the physiographic and climatic conditions determine the time concentration on the basin, and have design concentration used to estimate time across the globe formulas and equations. However, Iran has different climates and cannot be arbitrary and taking into account some of the parameters of this formula and used ties. Therefore, it is necessary that these formulas and relationships basin tested different country to select the best method (Motamed Vaziri, 2004). Abbasi (1991) for Kasilian basin in northern Alborz introduced Bransby Williams's formula about the best way to estimate time of concentration. Moghaddamnia (1997) in two basins Amameh and Kasilian northern Alborz, the concentration achieved by injecting salt and empirical relationship Bransby Williams concluded that the best way to estimate time of concentration in this region. Motamed Vaziri (2004) to compare some empirical equations to estimate time of concentration measured in the basin began Shahrestanak and results in a slope of less than 3% did not provide an adequate answer focus of empirical equations to estimate time, In the slope of 3 -7% relatively acceptable answer offered to Chow, Krpych, California Basu and on slopes of more than 7%, provides the best answer delay equation SCS. Goitom (1989) in one of the basins of Arizona study showed that the relationship Krpych is a good relationship for time of concentration in the study area. The aim of this study was to estimate the time of concentration and select the best method is in the basin.

2. Materials and methods

Ivar watershed with an area of about 5,500 hectares, located in North Khorasan province, Jajarm city and with longitude 56 degrees 8 minutes and 58 seconds to 56 degrees, 15 minutes, 53 seconds width and longitude 36 degrees 58 minutes and 3 seconds up to 37 degrees and 4 minutes and 26 seconds. The climate classification will be assessed Domarten climate arid regions. Minimum and maximum altitude of 1031 and 1603 meters, the annual average rainfall of 168 mm. The average annual temperature 14.1, the average annual minimum temperature 7.8, 22.1 average annual maximum temperature, absolute annual minimum -8.1 and the absolute maximum annual 40.1 ° C. Prevailing wind are east winds and the amount of 17.3 of the total. In this study, the boundary of the study area using aerial photos, satellite images and was used field visits to the watershed on a topographic map 1: 50000. And all the main branches of permanent water basins, specific and regional digital mapping software after Ilwis3.2 topography within each of the identified main branches and sub-basins were obtained in this way. Further studies and measurements were concentrated in the sub-basins. Using the physical characteristics of the basin and a number of empirical equations to estimate time of concentration was calculated. Numerous empirical formulas and relationships have been proposed by experts in hydrology in that study, is used some of the most important this relationship.

Williams's equation:

$$TC = 0.96L^{1.2} / H^{0.2} \times A^{0.1} \quad (1)$$

In this formula: TC = concentration time in hours, L = length of the main stream (km), H = main channel height difference (m), A = area in square kilometers, this method is recommended for large areas.

Jyanduti equation:

$$Tc = \frac{4A^{0.5} + 1.5L}{0.8H^{0.5}} \quad (2)$$

Tc = time of concentration (hr), A = area (Km2), L = length of the main stream (km), H = average height difference between the field and the exit point (m).

Krpych method:

This time concentration will be calculated as follows. This method is recommended for areas with smaller land area.

$$Tc = 0.949 \times \left(\frac{L^3}{H}\right)^{0.385} \quad (3)$$

Tc = time of concentration (hr), L = length of main stream (Km), H = difference height in area (m)

CHAV method:

$$Tc = 0.00013 \times \frac{\left(L^{0.77}\right)}{S^{0.385}} \quad (4)$$

Tc: Concentration time (hr), L: Water flow length of the longest string (Foot), S: Main River slope (%).

California Method:

In this method, used the following formula:

$$Tc = \left(0.885 \times \frac{L^3}{H}\right)^{0.385} \quad (5)$$

Tc = time of concentration (hr), L = length of main stream (Km), H = difference height in area (m).

3. Results and discussion:

Due to factors affecting the classification of areas such as topography, the river, the location townships, hydrological issues, and with the help of aerial photographs and topographic maps according to a survey, the region was divided on smaller areas. As a result of this classification, Ivar than include 11 sub-watershed Hydrologic, 10 sub non-hydrological and 9 sub hybrid formation.

With regard to the processing of data in GIS environment and the use of specialized software and office and field studies was determined watershed physical parameters such as area, perimeter, shape, drainage density, slope, channel length, shape factor, time of concentration, height.

The results of the calculation of these factors for each subdivisions is specified in Table 2.

Table 1. Different sub-basin watershed Ivar

Type	Perimeter (KM)	Area (KM2)	Sub basin	No
Hydrologic	10.18	2.07	I1	1
	14.16	7.80	I2	2
	10.43	2.95	I3	3
	11.59	5.14	I4	4
	18.86	5.36	I5	5
	7.61	1.90	I6	6
	14.49	5.36	I7	7
	7.67	1.75	I8	8
	14.98	2.99	I9	9
	10.26	4.58	I10	10
	8.93	1.85	I11	11
Non-hydrological	1.91	0.10	I'1	12
	8.21	1.72	I'2	13
	8.21	1.72	I'3	14
	6.60	1.05	I'4	15
	0.68	0.03	I'5	16
	2.88	0.37	I'6	17
	5.15	1.05	I'7	18
	15.21	5.18	I'8	19
	4.81	1.04	I'9	20
	6.02	1.61	I'10	21
Hybrid	15.46	10.84	I01=I3+I2+I'1	22
	19.09	19.77	I02=I01+I1+I4+I'2	23
	27.17	26.23	I03=I02+I5+I'3	24
	28.60	23.19	I04=I03+I6+I'4	25
	28.05	34.57	I05=I04+I7+I'5	26
	28.63	36.69	I06=I05+I8+I'6	27
	30.57	40.74	I07=I06+I9+I'7	28
	40.11	51.53	I08=I07+I10+I'8+I'9	29
	42.72	55.00	Ivar =I08+I11+I'10	30

Table 2. The physical properties of sub-basins

Minimum height (m)	Maximum height (m)	Height (m)			Diameter flat (Km)	Equivalent width (Km)	Equivalent rectangle length (Km)	Compression ratio Gravilious	Form Factor	Length (Km)	Environment (Km)	Area (Km^2)	Sub basin
		Facade	Middle	Weighted Average									
1129	1214	1150	1150	12/1150	62/1	45/0	65/4	98/1	11/0	42/4	18/10	07/2	I1
1134	1440	1150	1170	88/1193	15/3	36/1	71/5	42/1	43/0	24/4	16/14	80/7	I2
1134	1480	1150	1180	94/1209	94/1	64/0	57/4	70/1	14/0	64/4	43/10	95/2	I3
1130	1480	1150	1215	41/1229	56/2	09/1	70/4	43/1	23/0	68/4	59/11	14/5	I4
1123	1500	1350	1320	82/1308	61/2	16/0	82/8	28/2	16/0	77/5	86/18	36/5	I5
1119	1203	1150	1145	29/1150	56/1	59/0	21/3	54/1	15/0	58/3	61/7	90/1	I6
1109	1460	1150	1170	01/1195	61/2	84/0	41/6	75/1	16/0	80/5	49/14	36/5	I7
1107	1193	1150	1150	1150	49/1	53/0	31/3	62/1	13/0	68/3	67/7	75/1	I8
1102	1490	1250	1240	8/1248	95/1	42/0	07/7	43/2	07/0	49/6	98/14	99/2	I9
1233	1603	1350	1350	07/1361	42/2	15/1	97/3	34/1	51/0	00/3	26/10	58/4	I10
1059	1130	1055	1085	2/1059	54/1	46/0	00/4	84/1	12/0	91/3	93/8	85/1	I11
1130	1480	1150	1170	85/1197	72/3	84/1	89/5	31/1	48/0	76/4	46/15	84/10	I01
1125	1480	1150	1170	91/1196	02/5	04/3	51/6	20/1	71/0	29/5	09/19	77/19	I02
1119	1500	1150	1185	79/1217	78/5	33/2	26/11	49/1	79/0	75/5	17/27	23/26	I03
1109	1500	1150	1185	94/1210	10/6	47/2	84/11	48/1	79/0	09/6	60/28	19/29	I04
1107	1500	1150	1185	42/1208	64/6	19/3	84/10	34/1	92/0	13/6	05/28	57/34	I05
1103	1500	1150	1175	05/1205	84/6	34/3	97/10	32/1	83/0	64/6	63/28	69/36	I06
1085	1500	1150	1180	74/1205	20/7	44/3	85/11	34/1	65/0	89/7	57/30	74/40	I07
1059	1603	1150	1175	83/1210	10/8	03/3	03/17	56/1	64/0	58/10	11/40	53/51	I08
1031	1603	1150	1175	42/1202	37/8	99/2	37/18	61/1	40/0	72/11	72/42	00/55	Iϖαρ

Table 3. The physical properties of sub-basins

Branch ratio	Drainage density (Km/Km^2)	Watershed average slope (%)	Gross slope of the main stream (m/m)	Diameter flat (Km)	Main stream length (m)	Main stream length (Km)	Gross slope (%)	Pure Slop (%)	Total length of rivers (Km)	Sub basin
00/4	64/3	99/1	01/0	62/1	19/4245	25/4	06/1	02/1	53/7	I1
64/3	27/6	03/5	05/0	15/3	93/5333	33/5	15/5	76/2	88/48	I2
50/4	28/6	93/6	05/0	94/1	52/5176	18/5	78/4	67/3	51/18	I3
83/3	11/8	43/8	07/0	56/2	73/5009	01/5	05/7	61/3	70/41	I4
83/4	83/7	83/13	04/0	61/2	43/8221	22/8	30/4	84/2	96/41	I5
75/3	00/7	91/1	02/0	56/1	14/3714	71/3	27/2	13/2	33/13	I6
80/3	78/7	12/6	06/0	61/2	17/6287	29/6	60/5	60/2	70/41	I7
17/3	83/8	83/1	02/0	49/1	88/3472	47/3	15/2	02/2	45/15	I8
17/3	95/7	99/1	06/0	95/1	23/6792	79/6	61/5	80/2	76/23	I9
16/4	66/7	69/17	08/0	42/2	88/4114	11/4	53/7	61/4	13/35	I10
33/3	78/5	14/2	02/0	54/1	95/3887	89/3	91/1	82/1	72/10	I11
06/4	24/6	52/5	05/0	72/3	66/5666	67/5	97/4	75/2	70/67	I01
51/3	39/6	58/5	04/0	02/5	00/6538	54/6	25/4	80/2	23/126	I02
84/3	60/6	11/7	04/0	78/5	85/7470	47/7	81/3	91/1	01/173	I03
86/3	56/6	58/6	03/0	10/6	24/8181	18/8	31/3	56/1	48/191	I04
04/4	70/6	50/6	03/0	64/6	37/8379	38/8	31/3	56/1	51/231	I05
09/4	79/6	24/6	03/0	84/6	24/89	99/8	31/3	65/1	30/249	I06
23/4	87/6	29/6	03/0	20/7	95/10581	58/10	89/2	41/1	85/279	I07
68/4	96/6	81/6	03/0	10/8	77/12280	28/12	68/2	48/1	58/358	I08
84/4	03/7	58/6	03/0	37/8	36/13848	85/13	62/2	56/1	90/386	Iϖαρ

Table 4. Time of concentration in Ivar Watershed and sub-watershed using experimental method

Time of concentration Jyanduti methods (h)	Time of concentration Krpych methods (h)	Time of concentration Williams methods (h)	Time of concentration California methods (h)	Time of concentration Chow methods (h)	Sub basin
22/1	15/1	22/1	15/1	22/1	I1
81/0	76/0	81/0	76/0	81/0	I2
70/0	66/0	70/0	66/0	70/0	I3
68/0	64/0/0	68/0	64/0	68/0	I4
17/1	09/1	17/1	09/1	17/1	I5
85/0	79/0	85/0	79/0	85/0	I6
85/0	79/0	85/0	79/0	85/0	I7
78/0	74/0	78/0	74/0	78/0	I8
92/0	87/0	92/0	87/0	92/0	I9
55/0	52/0	55/0	52/0	55/0	I10
89/0	84/0	89/0	84/0	89/0	I11
89/0	79/0	92/1	89/0	83/0	I01
07/4	94/0	08/2	03/1	96/0	I02
99/3	08/1	20/2	18/1	10/1	I03
19/4	22/1	42/2	29/1	21/1	I04
48/4	25/1	45/2	33/1	24/1	I05
67/4	32/1	63/2	44/1	35/1	I06
71/4	57/1	06/3	69/1	58/1	I07
78/4	82/1	41/3	88/1	75/1	I08
82/4	01/2	85/3	15/2	01/2	Iϖαρ

4. Conclusion

There is empirical methods for obtain of basin concentration time. In this study, tried to make be measurable the required parameters of equations presented that exist or simply. For this purpose were selected five common methods (Krpych, chav, Bransby Williams, Jyanduty and California). To measure the concentration time in each of the sub-basins, evaluated the main stream carefully and based on parameters such as slope, flow depth, speed was divided into equal intervals. Then the concentration time accordance with the procedures described in the section Methodology, obtained in each interval. From total of time concentrate obtained in each interval is achieved of sub-basins, sub-basins time concentration. The results showed that the highest and lowest sub-basin of time concentration in I08 and I10, for Chow method is 1.75 and 0.55, California method is 1.88 and 0.52, Williams's method is 3.41 and 0.55, Krpych method is 1.82 and 0.52 and Jyanduti method is 4.78 and 0.55 hours was obtained. Time of concentration basin is also using any method (Krpych, chow, Jyanduty, Williams, California) was obtained respectively 2.01, 2.01, 4.82, 3.85 and 2.15 hour. Taking into account various parameters such as main stream length, basin area and sub- basin and slope of stream for all field units Krpych will be the right Time of concentration.

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