World Applied Sciences Journal 22 (3): 307-312, 2013
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2013.22.03.2503

Investigation on the Effect of the Season in Determination of Manning Roughness Coefficient in Predicting Drought Hydraulic Behavior (Case Study: haraz River)

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Abstract: The season of determination of Manning roughness coefficient causes some changes in predicting drought hydraulic behavior, because of vegetation changes. There are different methods of controlling drought damages. One of them is drought zoning. In this method drought zones for different return periods are determined by simulating river hydraulic behavior and its drought plain. According to Manning formula: $V=1/n\ R^{2/3}\ I^{1/2}$ and $Q=A.V$, Manning roughness coefficient is one of the effective factors on water velocity, depth and zone. In this research a section of Haraz River (3250 m in upstream of Amol, northern Iran) was studied in to find the effect of the season in determination of Manning roughness coefficient in predicting drought hydraulic behavior because of vegetation changes. Geographical Information System (HEC-GeoRAS Extension), HEC-RAS software and river topographic maps of 1:500 scale were used in order to simulate Haraz River's hydraulic behavior and its drought plain.The Manning roughness coefficient was determined in winter and summer using Cowen method for corss sections separately.The result showed that season of the determination Manning coefficient causes changes on n values on left and right banks of the river and drought plain because of vegetation changes. Consecuently, that causes some changes in drought zones, water velocity and depth, shear stress and the distribution of the drought volume in river channel and its drought plain for different return periods.

Key words: Season on determination · Roughness coefficient · Hydraulic behavior · Haraz river

INTRODUCTION

In recent decades, drought occurrences result in large casualties in Iran. Drought plains include at risk fertile farm lands. Drought map can be very useful in drought plains management studies. Nowadays, these maps are considered as basic and vital information for civil plans and assessed carefully to avoid losses before any investments or execution of developing plans in drought plains. Several factors can be considered in speed, depth and force of water stress during drought is one of them. Since there is no simple theorem relation between water cutting stress, slope and speed, experimental equations can be useful [1]. Manning equation is used so much to calculate water speed as well as anticipate hydraulic behavior of rivers. There are various approaches to determine coefficient of n in Manning Method those dependent to river situation like grain of river-bed, plant coverage and river route curvature degree, obstructs and variations. Manning coefficient varies in a river section with plant coverage variation in different seasons. This variation may affect on water speed distribution, water height and drought area in different return periods. Also, inaccuracy in Manning coefficient estimation can result in incorrect answers [2]. Tite *et al.* proposed an approach to increase output accuracy of HEC-RAS software in geographic data system by matching land mapping data, river geometry and control structures with available land model in geographic data system [3]. Motiie *et al*. mapped Sefid-Roof river drought by HEC-GeoRAS and HEC-RAS [4]. Andem in his thesis named "comparison of jungle and non-jungle rivers regimes", used HEC-GeoRAS and HEC-RAS to study speed variations and descent numbers of the two types of rivers. Also, he compared effects of plant

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coverage on regimes and physical behavior of flow, finally he conclude that HEC-RAS can be useful in producing appropriate values to study regime and the other hydraulic characteristics of river [5]. Islam and Kimitro used remote sensing and GIS data to produce drought risk map of Bangladesh in 1988 [6]. Yazdandoost and Nasiri determined at risk regions of Islamshar with different return periods [7]. Safari mapped at risk areas of Neka river in east of Mazandaran province [8]. Various studies performed to determine drought areas in different return periods in Iran and other countries, but programming to overcome natural hazards should be based on the most acute situations to be effective. The present study is performed to assess Manning coeffiecint season effect on drought hydraulic behavior anticipation.

MATERIALS AND METHODS

Haraz river originate from Alborz mountains in north of Iran and passing Amol to Caspian Sea. This research is performed in a section of Haraz River and its drought plain at the entrance of Amol with 3250m length. The geographical condition is 52° 22 ´ of eastern longitude and 36 ° 23 ´to 36° 23´ northern latitude locate in Tarak-Kola, outskirt of Amol. Paddy plains of this section are fallow in cold seasons. In this paper, Cawon approach is used to determine the Manning coefficient in summer and winter for river-bed and left-right shores, separately to study the effects of season of Manning coefficient determination on drought hydrologic behavior anticipation. Also, GIS (the attached HEC-GeoRAS) and HEC-RAS software are used to simulate hydraulic behavior of the river for their high capability [9]. At first, 50 years maximum instant discharge records of Karesang, in Amol, are analyzed considering adequacy, relation and homogeny and the confirmed by sequence test with 0.05 reliability level [10]. Appropriate statistical distribution is determined by Smada software. In addition, maximum discharge with different return periods are specified by Pierson log, type III. In the other word, the estimated and observed graphs of each statistic distribution are planed and statistical distribution with maximum overlap considered as the best statistical distribution. Then, river-bed situations and drought plain of Haraz River in the studied section, such as main flow route, shores, drought paths and breadthways sections are simulated by HEC-GeoRAS in the platform of ARCView-GIS and river map with 1:500 scale. 84 sections are considered to represent river condition. Then, the considered section separated to 7 equal ranges to determine.. coefficient. This factor is calculated by Cawen method for river-bed and left-right shores in each 7 ranges in summer and winter, separately. Manning formula and Cawen approach to estimated. coefficient of Manning is presented in (1) and (2):

$$V = \frac{1}{n} R^{2/3} I^{1/2} \quad (1)$$

$$n = (n_0 + n_1 + n_2 + n_3 + n_4)m_5 \quad (2)$$

Where, n is Manning coefficient of Manning in Cawen approach and n_0 is Manning coefficient of river-bed substances. Corrective coefficients, n1, n_2, n3, n4 and m_5 are cross-section irregularity, cross-section variation, obstructs in river route, plant coverage and rote curvature degree, respectively [6]. Manning coefficients are determined by field study as well as GIS device for each 84 sections. Manning coefficient of left-right shores vary in summer at the contrary of winter for growing plants and paddy farming, but main channel of the river remain constant considering no plant growth. Geometric data are entered from GIS to HEC-RAS software to present model and simulate Haraz river hydraulic behavior. Complex regime and normal depth considered in this research and two simulated models with difference in Manning coefficients, because of plant coverage variations in summer and winter, are used to compare the results.

RESULTS AND DISCUSSION

River-bed and drought plain of Haraz River are simulated by using GIS, HEC-RAS software and field studies considering their high capability in rivers hydraulic behavior studies [11, 12]. Minimum discharge are determined by Pierson log type III (Table 1). Manning coefficient of main channel of Haraz and left-right shores of 84 sections are determined by Cawen approach in

Table 1: Minimum discharge with different return and appropriate statistical distribution (person log type III)

200	100	50	25	10	5	2	Return Period (Year)
54	46.5	38.5	31.3	23.7	17.1	10.5	ö) $\frac{m^3}{s}$)Discharge

Table 2: Manning coefficients of studies sections in winter

No. Sec.	Right	Main Channel	Left
1	0.049	0.095	0.049
2	0.053	0.095	0.078
3	0.053	0.045	0.078
4	0.053	0.05	0.06
5	0.053	0.095	0.06
6	0.049	0.051	0.066
7	0.049	0.095	0.053

Table 3: Manning coefficients of studies sections in summer

No. Sec.	Right	Main Channel	Left
1	0.097	0.095	0.086
2	0.07	0.095	0.12
3	0.085	0.045	0.12
4	0.085	0.05	0.109
5	0.085	0.095	0.097
6	0.086	0.051	0.103
7	0.069	0.095	0.07

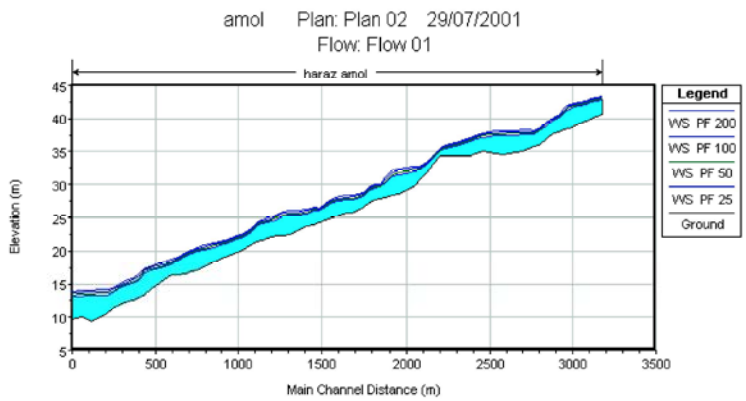

Fig. 1: River-bed longitudinal profile and flow level in 25, 50,100 and 200 years return period (Summer Manning coefficients)

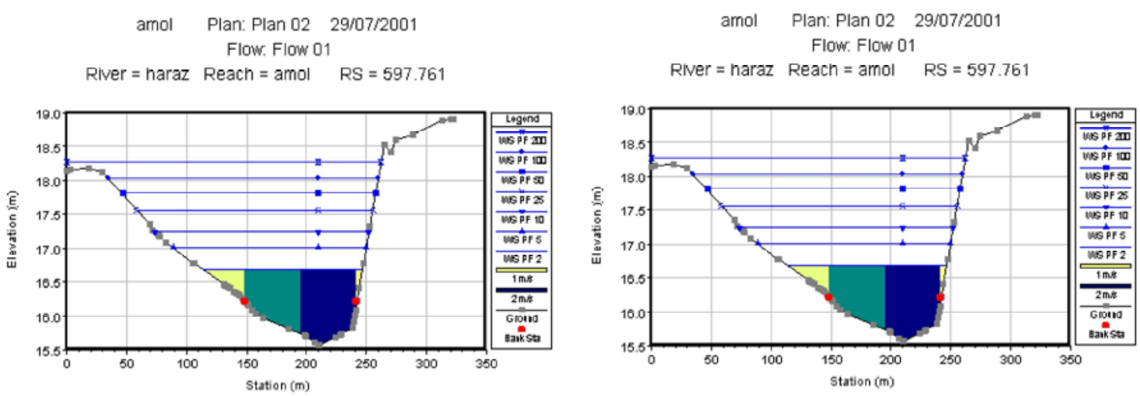

Fig. 2: Speed and water level profile distribution in various return periods, summer and winter coefficients in 70th section

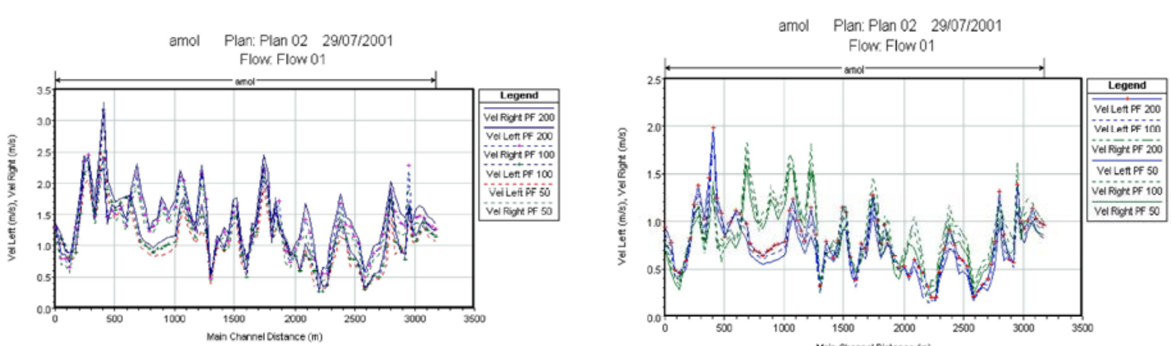

Fig. 3: Water speed variations in left-rights shores of Haraz River with various return periods, summer and winter coefficients

Table 4: Output results of HEC-RAS in 200 years return period, 61st section, summer and winter coefficients

Profile: PF 200 RS: 933.996 Plan: Plan 02

haraz amol RS: 933.996 Profile: PF 200

Element	Left OB	Channel	Right OB
Wt. n-Val.	0.078	0.095	0.053
Reach Len. (m)	33.82	31.42	37.68
Flow Area (m2)	66.73	275.25	34.79
Area (m2)	66.73	275.25	34.79
Flow (m3/s)	71.25	412.86	61.92
Top Width (m)	70.50	130.00	30.43
Avg. Vel. (m/s)	1.07	1.50	1.78
Hydr. Depth (m)	0.95	2.12	1.14
Conv. (m3/s)	824.4	4777.1	716.4
Wetted Per. (m)	70.55	130.01	30.51
Shear (N/m2)	69.28	155.07	83.52
Stream Power (N/m s)	73.97	232.60	148.63
Cum Volume (1000 m3)	78.85	212.67	34.00
Cum SA (1000 m2)	74.87	83.50	37.09

Profile: PF 200 RS: 933.996 Plan: Plan 02

haraz amol RS: 933.996 Profile: PF 200

Element	Left OB	Channel	Right OB
Wt. n-Val.	0.120	0.095	0.070
Reach Len. (m)	33.82	31.42	37.68
Flow Area (m2)	73.79	287.93	37.81
Area (m2)	73.79	287.93	37.81
Flow (m3/s)	52.44	441.39	52.20
Top Width (m)	74.32	130.00	31.50
Avg. Vel. (m/s)	0.71	1.53	1.38
Hydr. Depth (m)	0.99	2.21	1.20
Conv. (m3/s)	611.8	5149.3	608.9
Wetted Per. (m)	74.37	130.01	31.59
Shear (N/m2)	71.50	159.57	86.25
Stream Power (N/m s)	50.81	244.62	119.07
Cum Volume (1000 m3)	101.32	235.85	46.72
Cum SA (1000 m2)	86.02	83.50	47.12

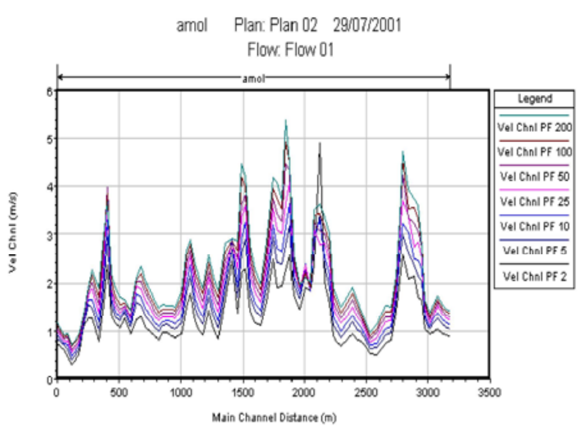

Fig. 4: Water speed variations in Haraz river main channel with various return periods, summer and winter coefficients

summer and winter separately (Table 2 and 3). It can be seen that the coefficients vary in summer and winter for plant coverage variations at the contrary of river main channel. Geometric data of River bed and drought plain are entered from GIS to HEC-RAS software platform. The longitudinal profile of river-bed of the studied section is shown in figure 1. then the two simulated models with different Manning coefficients to anticipate Haraz river hydraulic behavior in the considered section are presented. Speed distribution and water level profile in one of the breadth sections with summer and winter Manning coefficients are shown in figure 2 and 3, respectively. It can be seen that in summer Manning coefficient, drought height increase for Manning coefficient increment. According to the recent researches, high speed drought would be occurred in flat and impenetrable surfaces with artificial drainage [13]. Water speed variation during drought with various return periods in left-right shores is show in figure 4 and 5. It is obvious that Manning coefficient increment in summer result in significant reduction of shore speed compare to winter situation. Water speed variations during drought occurrence in main channel are shown in figure 6 and 7 as well as tables 4 and 5. It can be seen that water speed reduction in shores and drought plains because of plant coverage and Manning coefficient in summer, result in no significant variations in river main channel compare to winter except to few hundredth meter per second water speed. Data of 61st breadth section are shown in table 4 and 5 according to 200 years drought for the two summer and winter model.

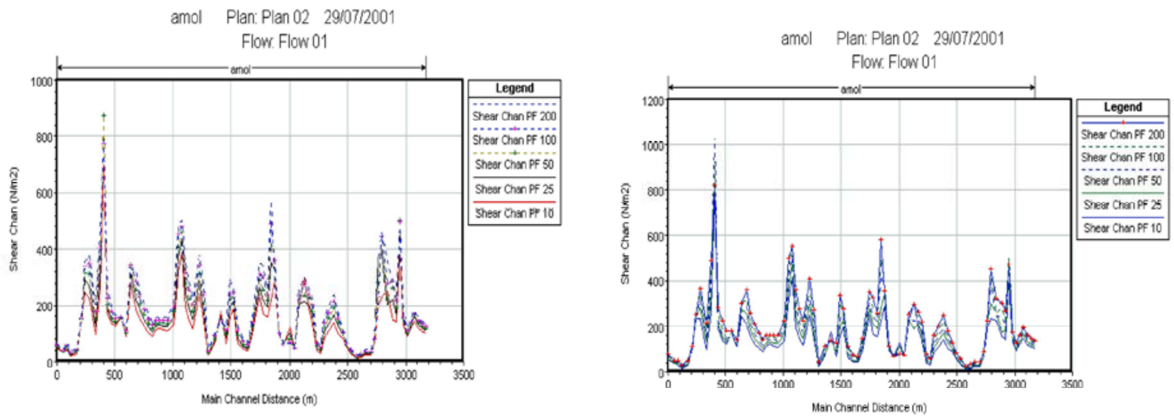

Fig. 5: Cutting stress variations in left-rights shores of Haraz River with various return periods, summer and winter coefficients

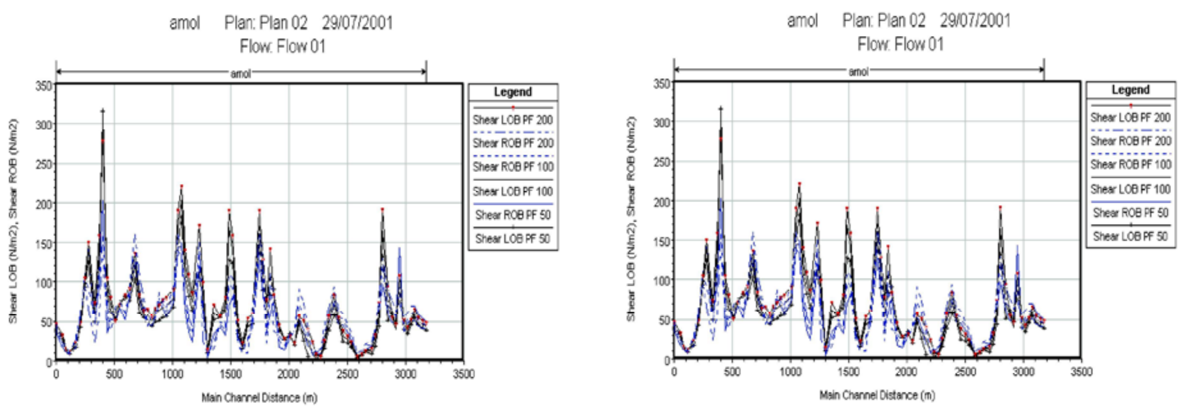

Fig. 6: Cutting stress variations in Haraz river main channel with various return periods, summer and winter coefficients

CONCLUSION

According to the results of this paper, determination time of Manning coefficient, affect significantly on hydraulic behavior anticipation results, speed, height and area of drought. Considering plant coverage results in summer, Manning coefficient increase according to plant coverage increment in Cawen method. This coefficient increment of drought plain and shore significantly reduce water speed as well as little speed water rate of main channel. Water sped reduction is accompanied by depth, height, area and cutting stress increment. In the other hand, Manning coefficient variation vary drought volume distribution of plain. Note that, most of remarkable droughts in north of Iran, such as Neka and Gorgan drought in 4-5-1999 and 27-2-1992, occurred in plant coverage growth season [14]. Considering the research aim to avoid drought damage as well as successful programming to control natural hazards, most acute situations should be concerned. It can be seen in the tables that plant coverage growth and Manning coefficient increment, increase drought area compare to winter. Cutting stress and Manning coefficient increment variations versus plant coverage growth are shown in figures 8,9,10 and 11. It is notable that plant coverage growth and Manning coefficient increment, increase cutting stress in river shores and main channel, specially in main channel. Also, according to table 4 and 5, water flow reduce notably by plant growth and Manning coefficient increment in shores and drought plain less than main channel. Therefore considering the above in studies such as drought mapping, Manning coefficient should be determined in plant growth season or at least knowing drought plain coverage, asking native habitants, Manning coefficients considered for each section.

ACKNOWLEDGMENTS

We wish to thank all the people to help us in this research.

REFERENCES

1. Chow, Ven Te, D.R. Maidment and Larry W. Mays, 1988. Applied Hydrology, Mc Graw Hill, International edition.
2. Islam, M.D. and K. Sado, 2000. Development of flood Hazard maps of Bangladesh Using NOAA-AVHRR Images with GIS, Hydrological Sciences Journal, 45(3).
3. Wilhite, D.A., 2000. Drought: A Global Assessment, Routledge, pp: 3-18.
4. Hisdal, H., Lena M. Tallaksen, 2003. Estimation of regional meteorological and hydrological drought characteristics: a case study for Denmark, Journal of Hydrology, 281: 230-247.
5. Lanen, Henny, A.J. van, Lena M. Tallaksen and Gwyn Rees, 2007. Droughts and climate change,Commission Staff Working Document Impact Assessment (SEC(2007)993), ccompanying document to Communication Addressing the challenge of water scarcity and droughts in the European Union (COM(2007)414), Commission of the European Communities, Brussels, Belgium.
6. Demuth, S., B. Lehner and K. Stahl, 2000. Assessment of vulnerability of a river system to drought. In: Drought and Drought Mitigation in Europe. Academic Publishers, Dordrecht, The Netherlands, pp: 209-219.
7. Laaha, G. and G. Blöschl, 2005. Low flow estimates from short stream flow records-a comparison of methods Original Research Article Journal of Hydrology, 306(1-4): 264-286.
8. Dracup, J.A., K.S. Lee and E.G. Paulson, 1980. On the definition of droughts. Water Resources Research, 16: 297-302.
9. Hill, M., 2001. Flood Plain Delineation Using the HEC-GeoRAS Extention for Arcview, Brigham Young University, pp: 514.
10. Hisdal, H., L.A. Roald and S. Beldring, 2006. Past and future changes in flood and drought in the Nordic countries. In: FRIEND 2006-Water Resource Variability: Processes, Analyses and Impacts, IAHS Publ., 308: 502-507.
11. Rodrigues, R., M.A. Santos and F.N. Correia, 1993. Appropriate time resolution for stochastic drought analysis. In: J.D. Salas, R. Haroe and J. Marco-Sgura, (Eds.), Stochastic Hydrology and its Use in Water Resources Systems Simulation and Optimisation, Netherlands: Kluwer, pp: 247-265.
12. Tallaksen, L.M. and Lanen, H.A.J. van, 2004. (Eds) Hydrological Drought-Processes and Estimation Methods for Streamflow and Groundwater. Developments in Water Sciences 48, Elsevier Science BV, Amsterdam,The Netherlands.
13. Barr, T., 2002. Application of Tools for Hydraulic Power Point Presentation. 105-Upper Gotv and Hydroelectric Power Project Feasibility Study. 1996. Reservior Operation Flood, pp: 14.
14. Andam, K., 2003. Comparing Physical Habitat Conditions in Forested and Non-Forested Streams. Thesis of Partial Fulfillment of the Requirements for the Degree of Master of Scince Specializing in Civil and Environmental Engineering.University of Vermont, pp: 136.