Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 5 [1] December 2015: 46-56

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

ORIGINAL ARTICLE **OPEN ACCESS**

Flood Zoning; the appropriate solution to reduce the Environmental crisis using HEC-RAS model

Saeed Judi Sani[1], Edris Merufinia[2*]
[1]Department of Civil Engineering, Mahabad Branch, Islamic Azad University, Mahabad, Iran
[2*] Young Researchers and Elite Club, Mahabad Branch, Islamic Azad University, Mahabad, Iran
***Corresponding Author:** edris.marufynia@yahoo.com

ABSTRACT
The frequency of flood in recent decades causes that most parts of the country be exposed to destructive floods invasion and financial and life losses significantly be increased. Increase in population along with the lack of planning to exploit the land, destruction of forests and grasslands and also, development of impervious surfaces caused less water infiltration into the ground in water basins and flow faster to the downstream side. As a result, floods are more frequent, severe and sudden and inflict more damages. In this paper, a part of Barde Sur River in Urmia was selected and considering the importance of the above region, flood basins study and flood zoning in this area was selected as the necessity and objective of this study. In this study, flood capability of Barde Sur River basin in Urmia was evaluated using the techniques of GIS and HEC-HMS hydrologic model. Then, a reach of Barde Sur River in Urmia was hydraulically studied using the HEC-RAS hydraulic model and hydrographic maps were obtained for 2, 5, 10, 25, 50, 100 return periods that can be used in zoning Barde Sur Rive in term of structural construction.
***Keywords**: Environmental Crises, Flood zoning, HEC-RAS*

Received 01.10.2015 Revised 13.10.2015 Accepted 01.12.2015

INTRODUCTION

Although the human being is not capable of living without water but water can be the threatening factor of health and welfare of humans and even geographical areas as well. Near the great rivers there is always enough water for municipal, industrial and irrigation. Hence, a high proportion of advances in the developed urban centers, agriculture and industry are located along the rivers. Against the aforementioned benefits, massive flooding in the river is considered a threat to the facility located in its neighborhood [1]. One of the main issues raised during the watershed operation is to prioritize erosion control and reduce flooding measures in the sub-basins of a basin [2].

Shushtari *et al*. [3] simulated the flow in Kor and the Seyvan Rivers in using HEC - HMS the model. In this model methods were predicted to calculate the precipitation losses, runoff and basic discharge and flood routing. Jalalirad *et al*. [4], flood mapping using HEC – RAS software and Geographic System Information in watershed basin in Darabad city of Fars province. Abghari *et al*. [5] provided the application of hydraulic and GIS model in the optimal management of the flood plain. In this study they mapped the flood risk using various return periods. Randel *et al*. [6] in the United States Bureau of Land Development used the HEC - RAS mathematical model to simulate the hydraulic parameters such as water height, average flow rate and the water fluctuation in the Teton River in the Teton Dam upstream in the Idaho for four various intervals. Neshat and Sedghi [7] estimated the runoff using the SCS method and HEC – HMS model in the Gulalai drainage basin. In this study the results of estimating the rainfall conversion to the surplus rainfall under the title of CN as analyzed using two different methods. Radmanesh *et al*.[8] analyzed the calibration and the evaluation of model HEC – HMS in the Dez River watershed basin The results indicate a good fit of the observed hydrograph peak and simulated hydrographs. Time difference in reaching the peak of the hydrograph in all cases, was equal or less than an hour. Mohammadi et al. [9] in his study titled "Estimating average weekly Kor River discharge using the artificial neural network and HEC - HMS model" predicted the average discharge rate in Kor River- Fars Province. The results of this study determine the higher performance and facility of the artificial networks compared to the HEC – HMS model in predicting the weekly Kor River flood. Ashouri et al. [10] evaluated the effects of the urban development on the increased runoff in the watershed basin of Darabad using the HEC - HMS model. Then the rainfall-runoff events in the watershed before and after the urban development was simulated using the HEC – GEOHMS and HEC - HMS model and the flood peak discharge values obtained in different return periods. Kathol et al. [11] used the HEC - HMS model to determine the highest discharge in runoff volume in two agriculture basins in the South East State Dakota South. In order to estimate the losses in these basins they used SCS method and in order to determine the hydrograph they used the SCS Unit Hydrograph.

MATERIALS AND THE METHODS

ShaharChay River is one of the major independent rivers of the Urmia plain located in the south and south west of the city of Urmia. The River is known as the Barde Sur in the upstream and the Kakre, Kouse Lou and Mirabad rivers pour into it and it is fed by the precipitations received from the West to the East. ShaharChay River is located in the category of medium-sized rivers with the catchment area located in the central part of central Silvana which is also known as the Urmia River. The area under study is 575.59 square-kilometers located in the city of Urmia. It is in 470,000 to 520,000 E and 4,128,000 to 4,160,000N. The residential areas under study include Urmia, Noushinshahr, Silvane and Serve. The Lowest height of the area is 1267 m and the maximum catchment area is 3507 m above sea level. The study area circumference is equal to 47/156 km. The geographical map of the catchments under study is presented below. The range is located outside Urmia city and within the Urmia plain before reaching Lake Urmia. This range is about 100m below the Keshtiban Dam in coordinates 518, 274 and 4,156,881 and has a length of 1200 meters. Within this range the river passes through the Haspestan, Poshtgol and Darghalu villages.

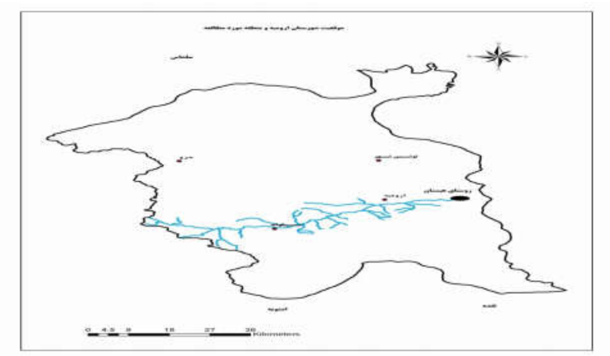

Figure 1. Location of the city of Urmia and study area

Table 1. Physical characteristics of the studied basins in the study area Shahre Chai

Row	Basin No	Area (Km)	Circumference (Km)	Main Channel length (Km)	Average slope (%)	Maximum Height (M)	Minimum Height (M)	Medium height (M)	Coefficient Compactness	Equivalent circle diameter (Km)	Time of concentration (H)	Equivalent rectangle Length (Km)	Equivalent rectangle width (Km)	Shape factor	x	Y
1	A1	12.86	15:06	4.59	40.8	3119	1801	2556	1.2	4.0	1.0	4.9	2.6	0.5	480644	4139022
2	A2	44.27	28.12	11.54	27.3	3126	1872	2543	1.2	7.5	2.5	9.3	4.8	0.5	478196	4136158

4142230	4141105	4142937	4143604	4146219	4138048	4145132	4148742	4147113	4148066	4150552	4153191	4152347	4156508	4155190
484669	492364	478165	494304	483660	469872	497039	504331	490935	499607	493964	512729	504224	513714	497981
0.3	0.7	0.7	0.3	0.3	0.3	0.3	0.9	0.3	0.3	0.3	0.3	0.2	0.3	0.5
3.1	4.1	3.0	2.2	3.6	5.1	2.9	4.8	2.8	2.8	2.6	3.0	2.4	2.9	5.8
10.6	5.6	4.2	7.8	10.8	16.5	9.5	5.6	9.5	8.3	7.9	10.1	13.5	9.0	10.9
2.2	2.0	1.2	1.4	2.9	2.9	2.1	1.8	2.2	2.1	1.9	2.3	3.0	4.2	3.5
6.4	5.4	4.0	4.6	7.1	10.3	5.9	5.8	5.8	5.5	5.1	6.2	6.5	5.8	9.0
1.3	1.1	1.1	1.4	1.3	1.3	1.3	1.1	1.3	1.3	1.3	1.3	1.6	1.3	1.2
1902	1669	2129	1800	1846	2632	1835	1578	1791	1700	1825	1362	1418	1307	1604
1575	1573	1774	1473	1577	1870	1453	1400	1570	1383	1450	1269	1332	1267	1352
2836	1855	2800	2202	2767	3507	2224	2129	2206	2208	2213	1675	1713	1360	2109
26.8	9.5	40.4	17.2	13.5	31.7	17.6	10.8	12.2	19.2	15.5	4.0	4.5	1.0	8.8
10:11	7.14	5.21	5.32	11.65	14.69	8.78	6.66	8.30	8.49	7.48	7.05	9.35	9.48	13:37
27.33	19:40	14:52	19.85	28.82	43.23	24.75	20.70	24.52	22:31	20.95	26.18	31.84	23.90	33.37
32.62	23:01	12.81	16.72	39.23	83.85	27.57	26.62	26.51	23:52	20.60	30.45	32.89	26.52	63.20
A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

In this paper first we obtained the topographic map of the area with 1: 50000 scales from the mapping organization of the country and then using the map the contour lines were drowned and the required revisions were made visually. Also the waterways and network of streams of the basins were formed and the GIS model was completed. The software can conduct physical calculations of the basin and the required parameters after the completion of the basin model. This is easily done on GIS. The following figure presents the basin model in the GIS software.

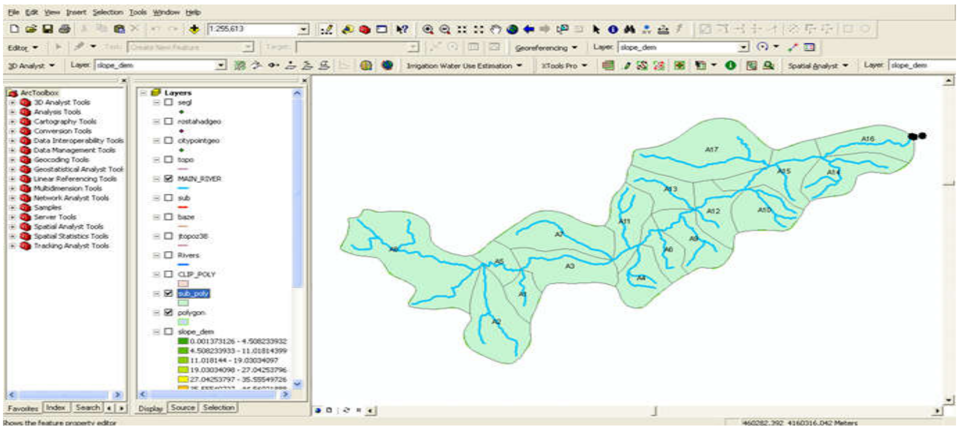

Figure 2. Formation of the basin and sub-basin operations in ARC GIS software

In this paper the elevation of the studied area was performed using the topographic map of the area with 1: 50000 scale and Arc GIS software. As it can be seen the largest catchment area of ShaharChay is within 1269-1533 and 1533-1839 range.

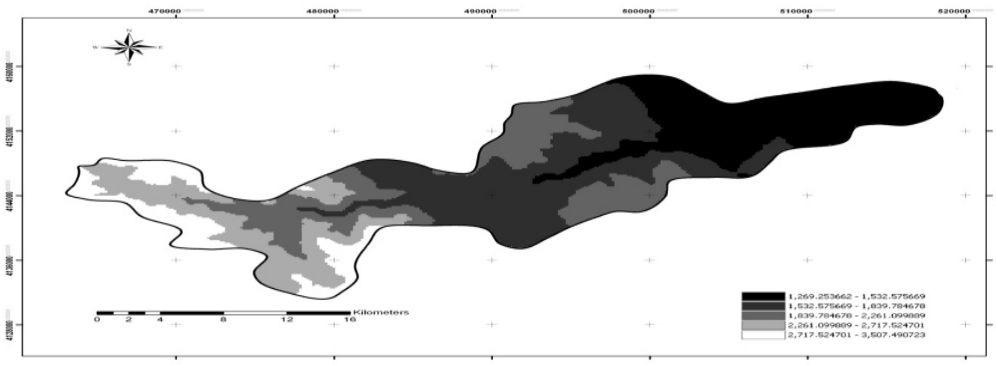

Figure 3. Elevation map of the studied area

To obtain every single slope of the waterways the drainage basin slope maps of the area produced by Arc GIS software are used. The upstream waterway have higher slope than the rest of areas indicating the mountainous basins in the area. From the maps of the slope it can be inferred that that the highest area is within the class of 0.02-8% slope.

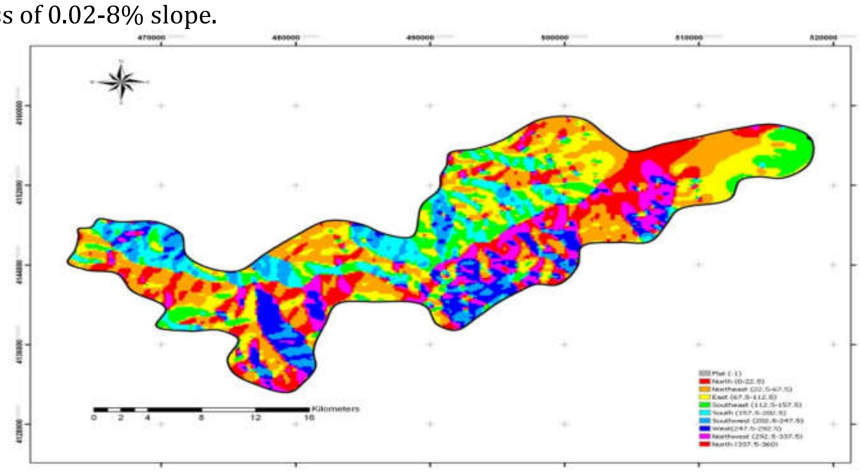

Figure 4. Map of the slope in the study area

In this study to estimate the intensity curve - time - frequency curves the prepared for the Western Azerbaijan province is used. This equation is calibrated based on the one-hour rainfall with 10 year return period that has 10-19 variables. This value varies 10.75-19 in Western Azerbaijan province. The Hesari-Movahed Danesh equation for the acceptable ranges is as follows:

$$P_T^t = [0.4548 + 0.2387 * Ln(T - 0.19)][-0.7685 + 0.847t^{0.1805}]P_{10}^{60} \quad (1)$$

$$2 \leq T \leq 100yr \quad , \quad 15 \leq t \leq 120min$$

$$P_T^t = [0.5806 + 0.1888 * Ln(T - 0.79)][0.3594 + 0.0934t^{0.4757}]P_{10}^{60} \quad (2)$$

$2 \leq T \leq 100yr \quad , \quad 15 \leq t \leq 120min$

DISCUSSION AND CONCLUSIONS

HEC-HMS software is used to estimate the discharge for the return periods of 2, 5, 10, 25, 50 and 100 years.

Table 2. Estimation of maximum instantaneous flow of Barde Sur basin

T return period	Maximum instantaneous flow (CMS)
2	59.2
5	113.5
10	175
25	225.6
50	277.8
100	331.5

Considering that the maximum instantaneous flow was estimated using HEC-HMS software for the mentioned basin, thus, flood hydrograph for different frequency can be achieved by having the unit hydrograph. For this purpose, it is necessary to multiply the dimensions of the unit hydrograph in the designed discharge rate on the maximum flow rate of the unit hydrograph.

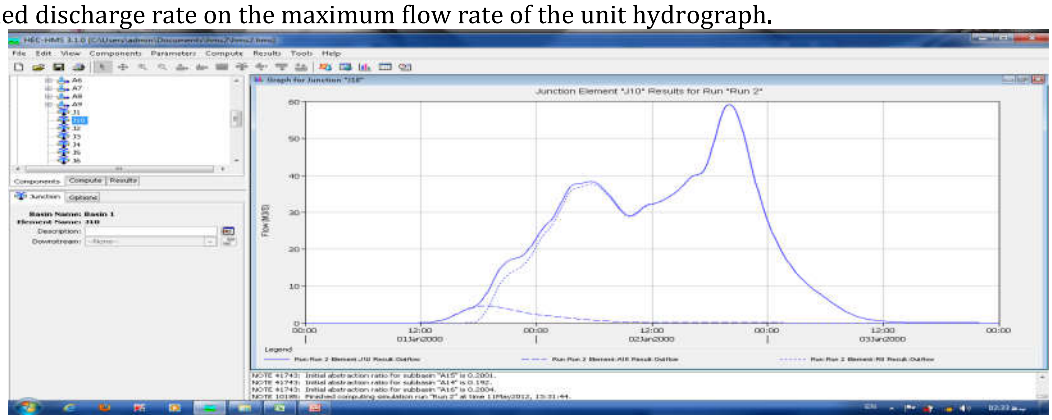

Figure 5. Flood hydrograph for a 2-year return period obtained from HEC-HMS software

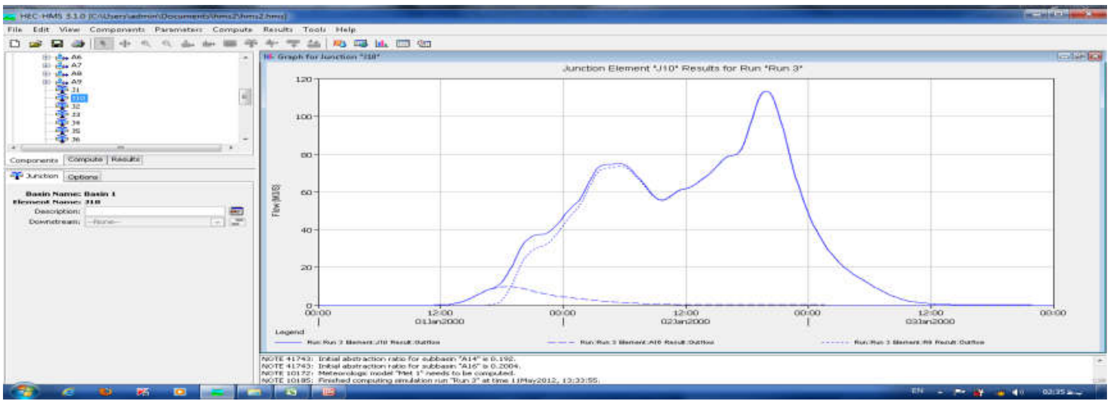

Figure 6. Flood hydrograph for a 5-year return period obtained from HEC-HMS software

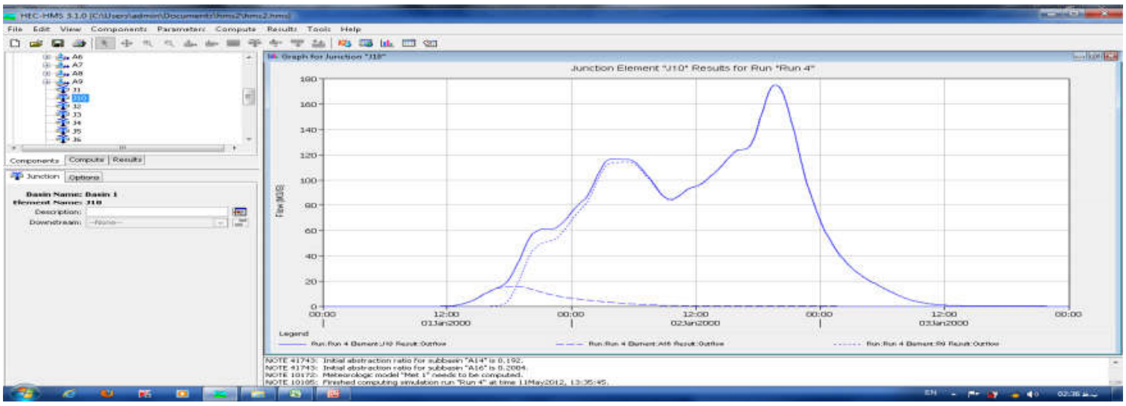

Figure 7. Flood hydrograph for a 10-year return period obtained from HEC-HMS software

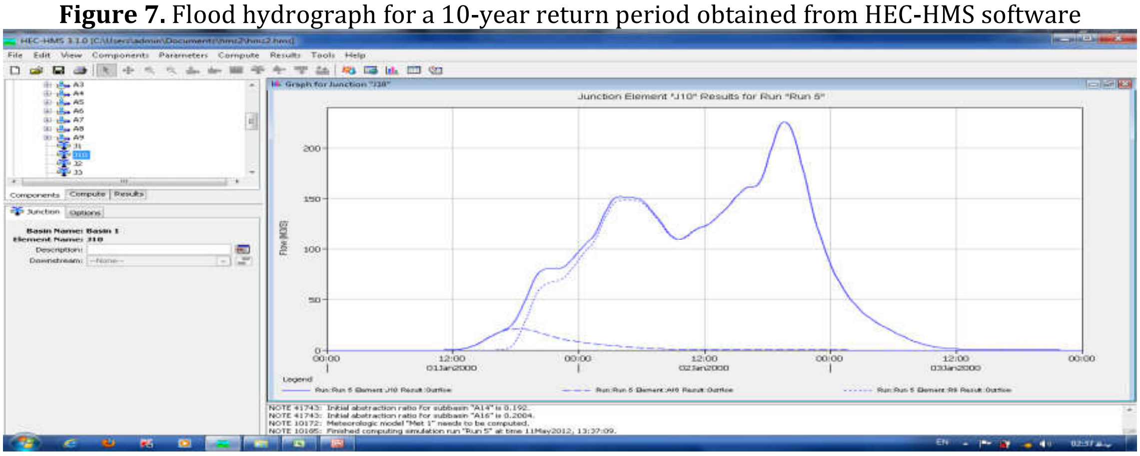

Figure 8. Flood hydrograph for a 25-year return period obtained from HEC-HMS software

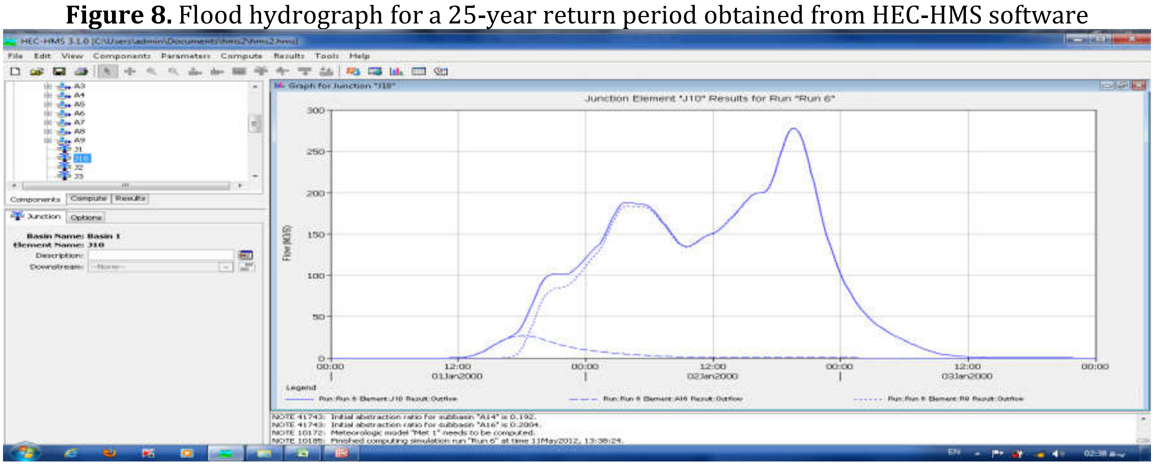

Figure 9. Flood hydrograph for a 50-year return period obtained from HEC-HMS software

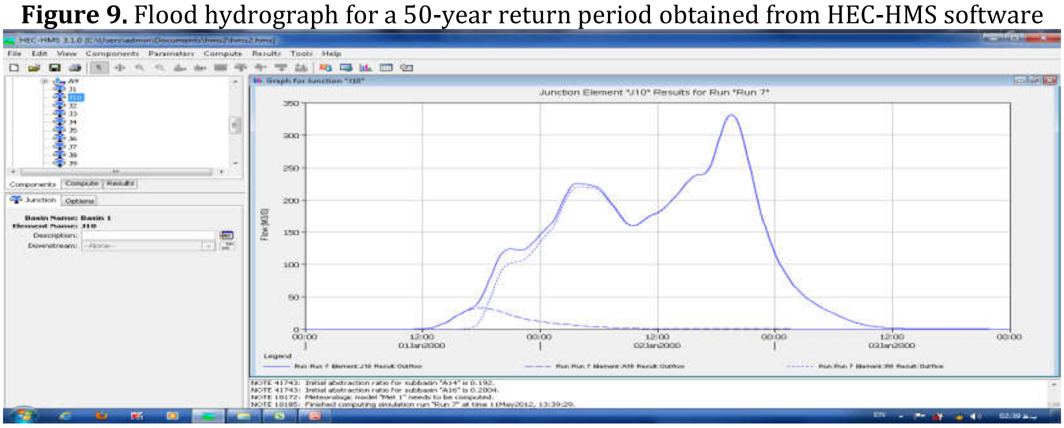

Figure 10. Flood hydrograph for a 100-year return period obtained from HEC-HMS software

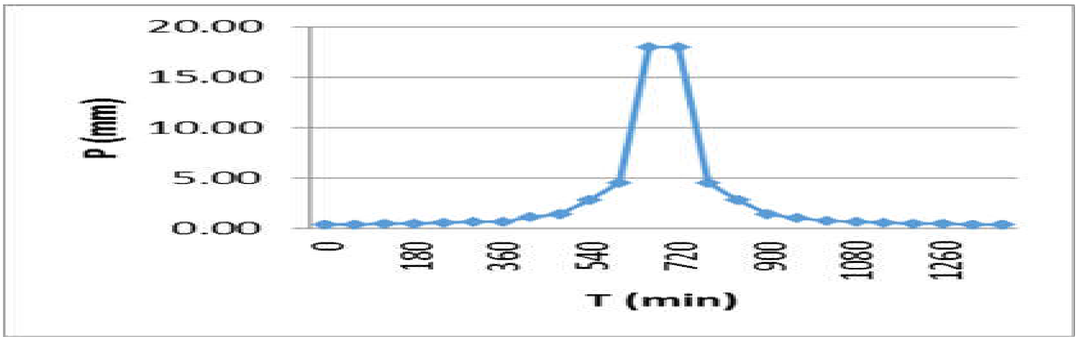

Figure 11. Designed hyetograph based on a 5-year return period flood

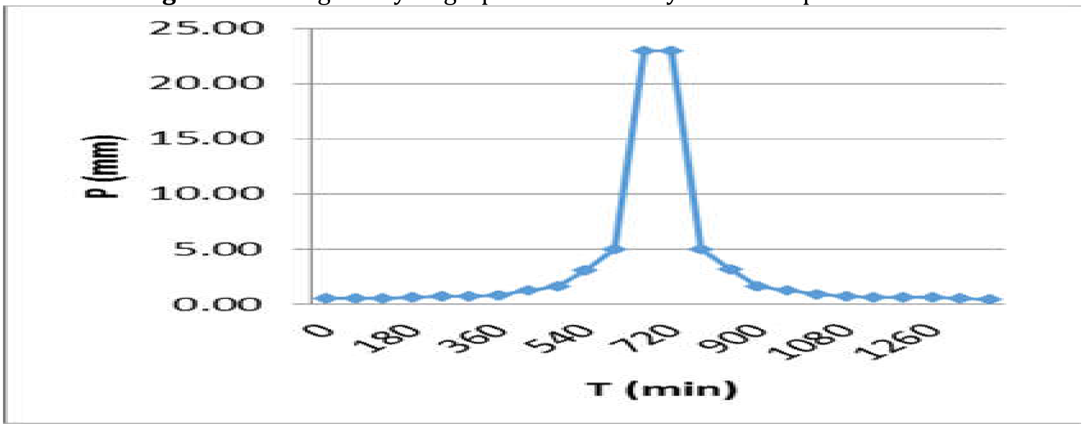

Figure 12. Designed hyetograph based on a 10-year return period flood

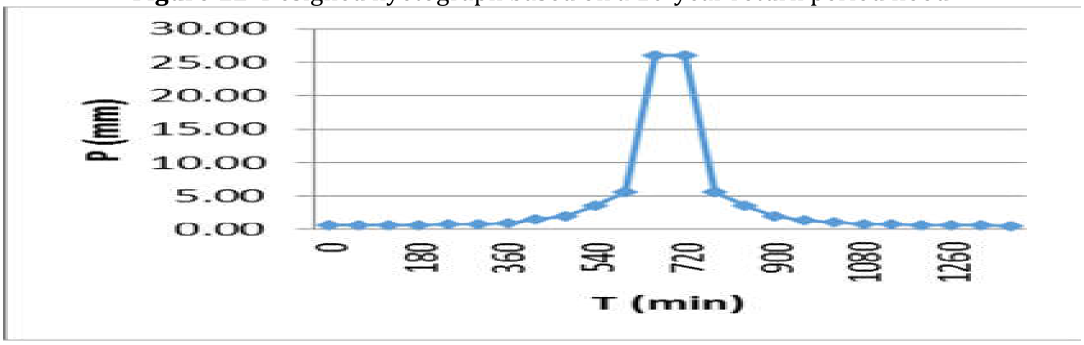

Figure 13. Designed hyetograph based on a 25-year return period flood

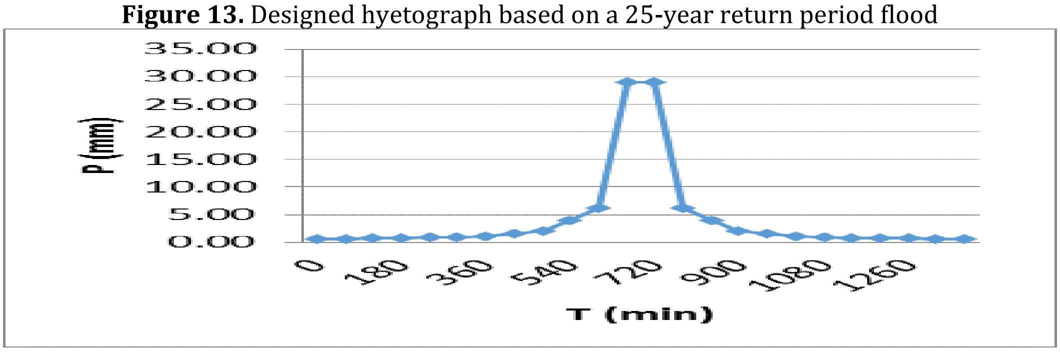

Figure 14. Designed hyetograph based on a 50-year return period flood

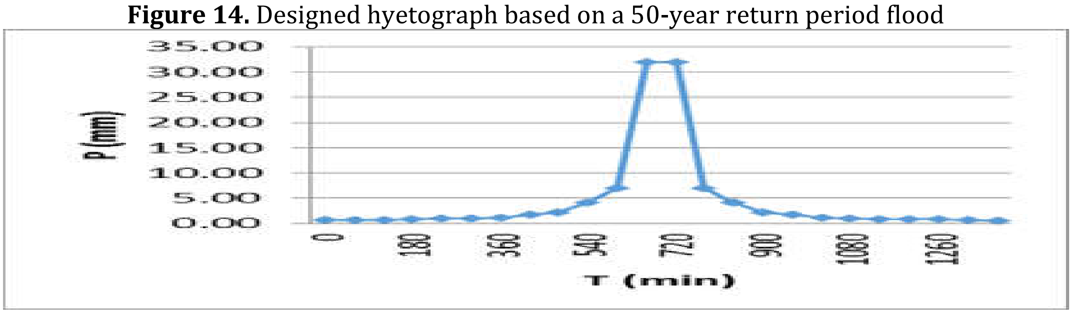

Figure 15. Designed hyetograph based on a 100-year return period flood

HEC-RAS hydraulic model and ARC GIS software were used for flood distribution. The calculated flood discharges were used as the available hydrological data from the river. The return periods of 2, 5, 10, 25, 50 and 100 were used to prepare zoning maps that the graph for a 2-year return period is presented as the sample.

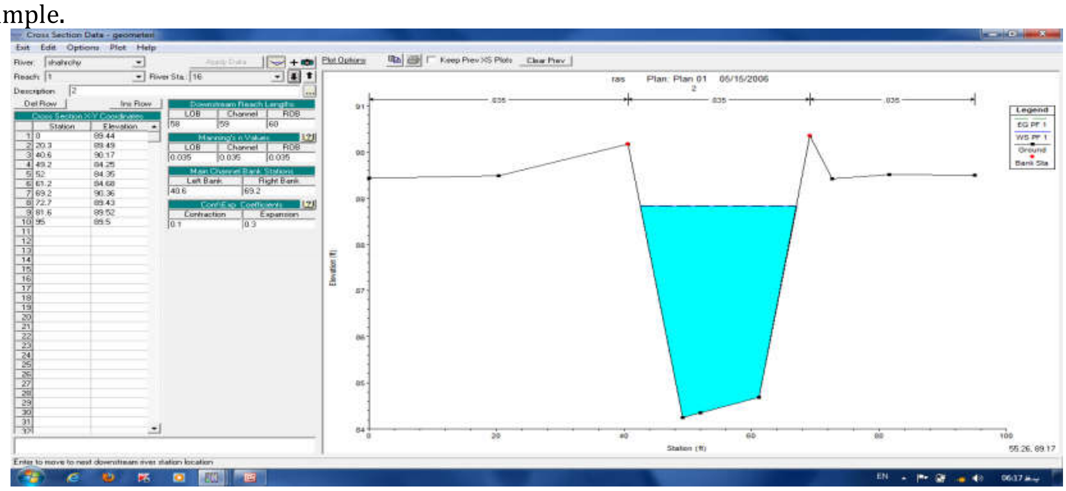

Figure 16. The water level position in reach 1 for a 2-year return period flood

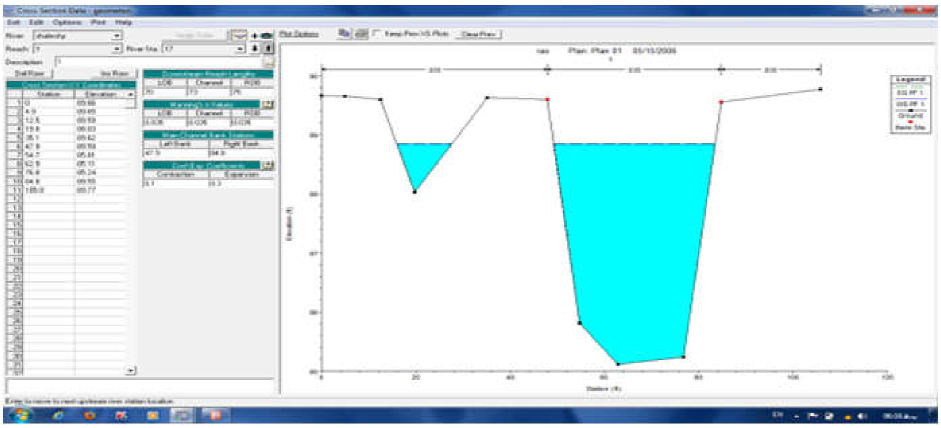

Figure 17. The water level position in reach 2 for a 2-year return period flood

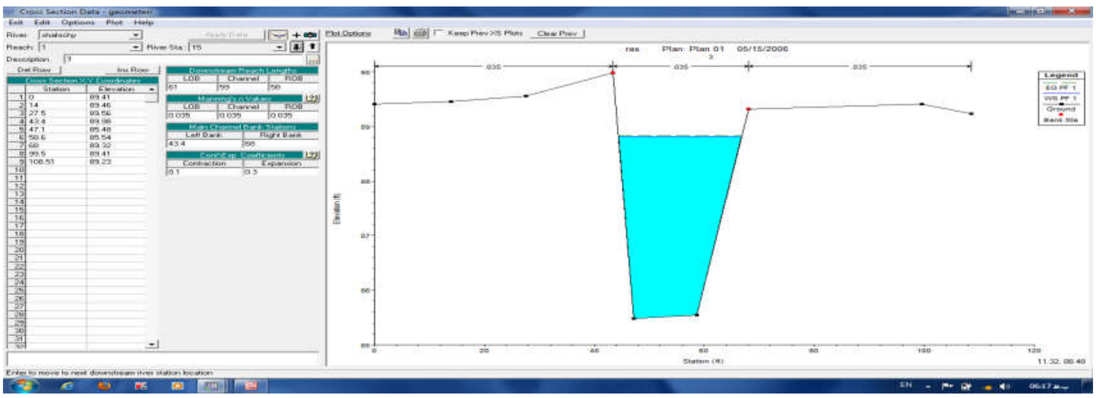

Figure 18. The water level position in reach 3 for a 2-year return period flood

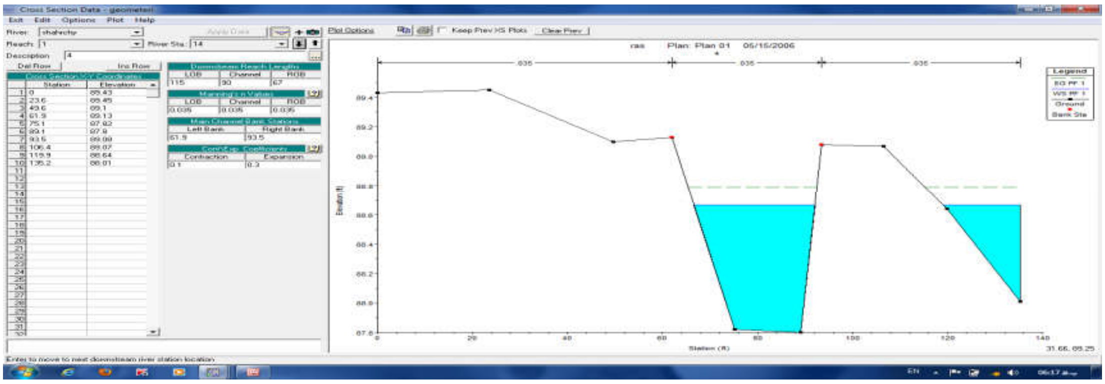

Figure 19. The water level position in reach 4 for a 2-year return period flood

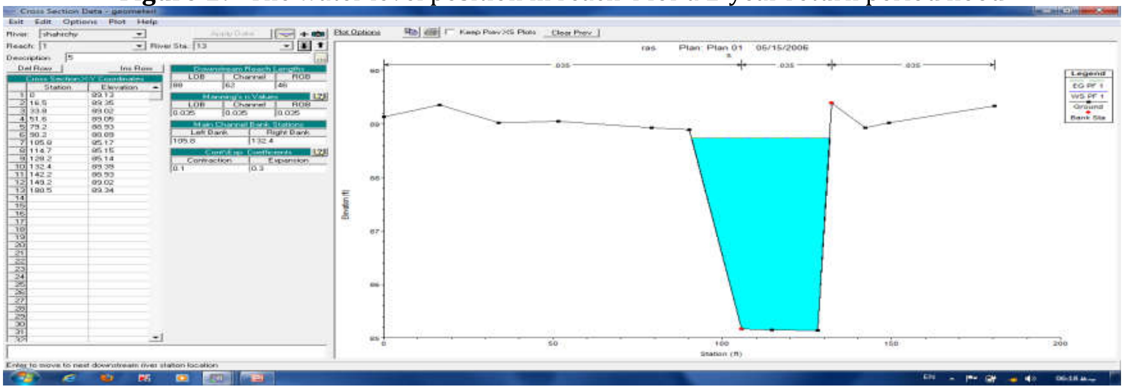

Figure 20. The water level position in reach 5 for a 2-year return period flood

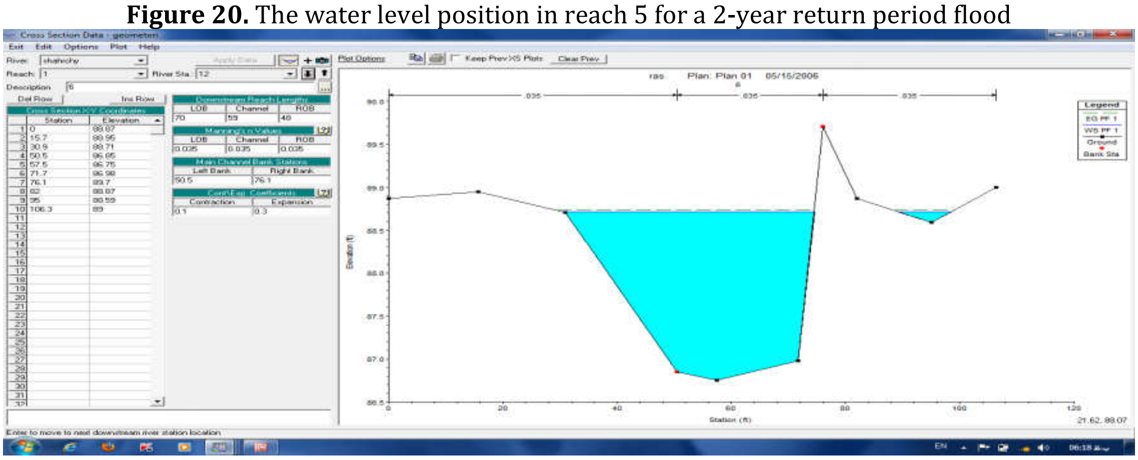

Figure 21. The water level position in reach 6 for a 2-year return period flood

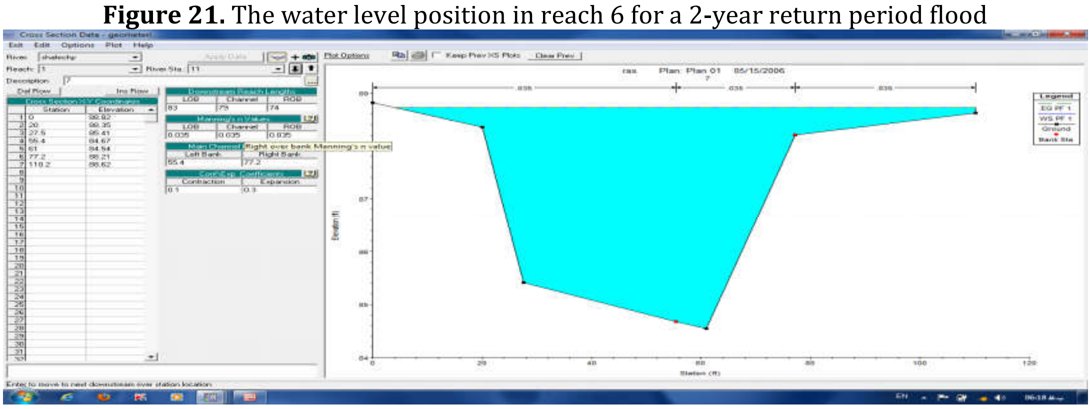

Figure 22. The water level position in reach 7 for a 2-year return period flood

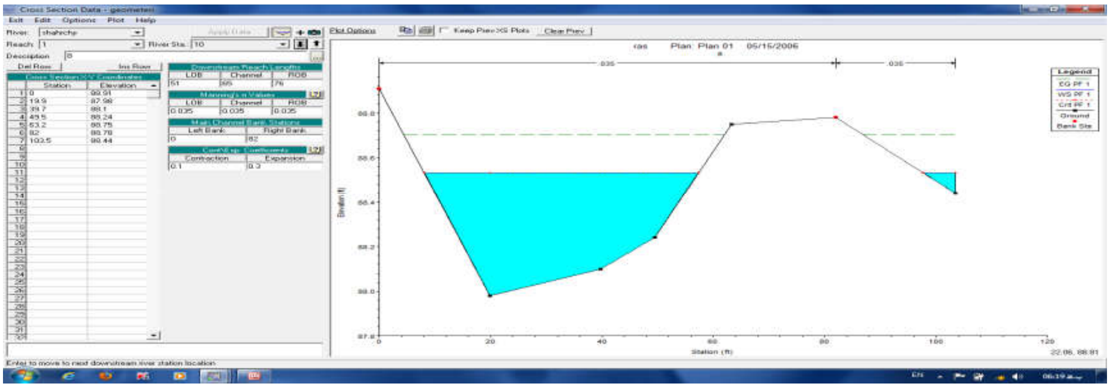

Figure 23. The water level position in reach 8 for a 2-year return period flood

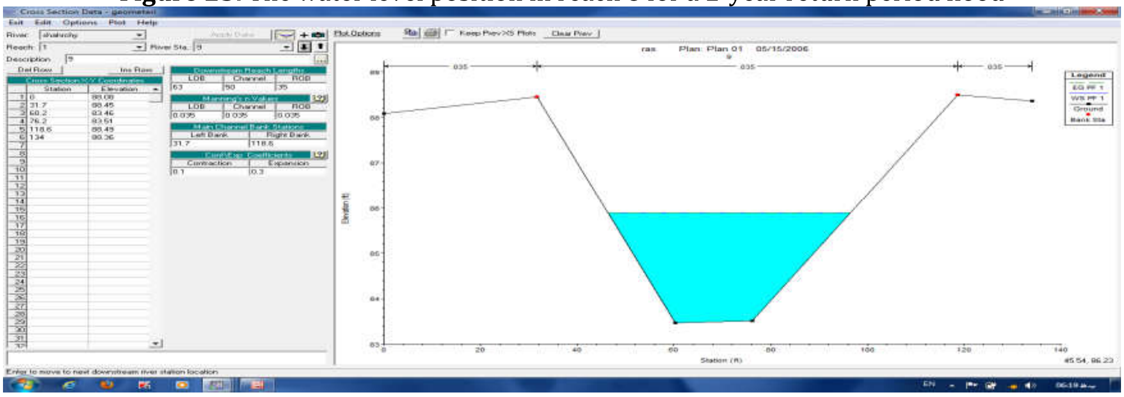

Figure 24. The water level position in reach 9 for a 2-year return period flood

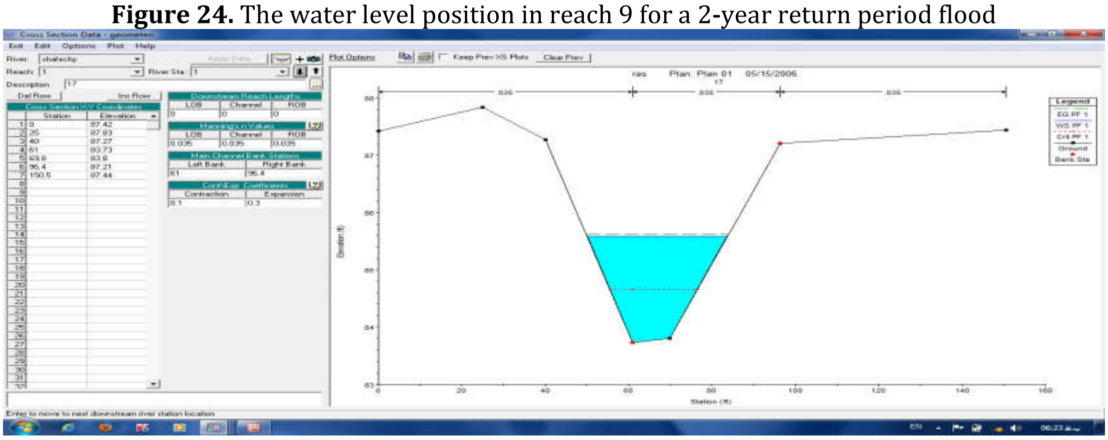

Figure 25. The water level position in reach 17 for a 2-year return period flood

These maps are provided in the form of flood zone maps for return periods of 2, 5, 10, 25, 50 and 100 years.

FINDINGS AND RECOMMENDATIONS

1. In this project, ARC GIS software was used to evaluate the sub-basins of Barde Sur River in Urmia overlooking the studied period. This software has a high capability to calculate the physical properties of the basin and the used parameters in HEC-HMS software. The studied area is divided into 17 sub-basins by this software.
2. HEC-HMS and SCS software were used to estimate discharge with different return periods. This model attempts to draw a flood hydrograph for each of its sub-basins using the physical characteristics of the study area and the rainfall data.
3. Two land use map and also soil groups' hydrologic map were integrated in ARC GIS software to estimate CN.
4. HEC-RAS software is used in order to flood zoning. In the way that the obtained cross sections were entered in this software by mapping operation and then, flood discharge values has been entered into this

software for different return periods obtained from HEC-HMS software and the results were presented in the form of water level in the reaches and also, zoning maps in ARC GIS.

RECOMMENDATION

1. It is recommended that the used method in this study be used in research projects and various organization experts.
2. It is recommended that the maximum instantaneous discharge data be used to estimate flood discharge for various return periods.
3. It is recommended that WMS software be used to estimate the physical parameters of the studied area.
4. It is recommended that a similar study be conducted using this set but with different DEMs and with different accuracy and the results be compared with these results.
5. It is recommended that simulation of flood zone in the studied intervals be conducted with other software and other sets such as WMS in order to select the appropriate model and evaluate the performance of other models.

REFERENCES

1. Hassanpour Kashani, M., (2006), “runoff simulation process using artificial neural network in the West and South Lake Basin of Urmia Lake", MS Thesis, University of Urmia, Iran.
2. Alizadeh, A, (2012), "Principles of Applied Hydrology", published by Astan Quds Razavi Khorasan, twenty-fourth offset, Mashhad, Iran
3. Shushtari, M, Bagheri,AR, Javan, M, (2002), "(HEC-HMS) Analysis and Application in Engineering River " Kor and Sivand Rivers in Fars Province” Sixth International Engineering Rivers Seminar University of Shahid Chamran Ahvaz, IranPp.1061 to1068
4. Jalali ,R , Rajabi, T, Netati, M, (2006), "The flood mapping of the Garmrud River using (HEC-RAS)model ",the seventh Seminar International Engineering River Conference, Ahvaz-Iran, pp. 1to6
5. Abghari , H, Rezaei, A, Mirzaei, S, (2006), "Application of hydraulic model ((GISIn the Optimized Management of Plain Flood ",the seventh International Engineering Rivers Seminar Ahvaz, Iran, pp. 1to6
6. Randel et.al (2000), "Geomorphology, and River Hydraulics of the TETON River
7. Neshat ,A, Sedghi, H, (2006), "Estimation of runoff water by SCSAnd theModel (HEC-HMS) in AbGulalai Basin ", the seventh International Engineering Rivers Seminar, Ahvaz, Iran
8. Mohammadi , M, Mohebi, A, Nazemi, S, (2006), "Estimating the average weekly rate of Kor river with an artificial neural network model (HEC-HMS)", the seventh International Engineering Rivers Seminar Ahvaz, Iran
9. Radmanesh , R, Roshan, P, Masruri, B, (2006), "Calibration and evaluation of (HEC-HMS) model in Dez Basin Catchment River ", Seventh Seminar International River Engineering, Ahvaz, Iran
10. Ashouri M,Kamju, L, Farzin, MR, (2006), "Effects of urban development on runoff increases", the fifth conference of the National Association of Hydraulic
11. Kathol, JP, Werner, HD, androoien, (2003), predicting Runoff Frequency Upstream of TET Dam,Idaho

CITATION OF THIS ARTICLE

Saeed Judi S, Edris M. Flood Zoning; the appropriate solution to reduce the Environmental crisis using HEC-RAS model. Bull. Env. Pharmacol. Life Sci., Vol 5 [1] December 2015: 46-56