Journal of River Engineering
Volume 2, Issue 4, 2014
http://www.scijour.com/jre
SCIJOUR

Determination of the Best Model for Flood Flows in the Western Basin of Lake Urmia

Mohammad Salarian[1,*], Zahra Shokri [2] and Mohammad Heydari[1]

[1] Master Student of Irrigation and Drainage, Ferdowsi University, Mashhad, Iran
[2] Graduated Student from Sari University of Agricultural Sciences and Natural Resources, Sari, Iran
[3] PhD Student, Department of Civil Engineering, University Malaya; Kuala Lumpur, Malaysia

ABSTRACT

Today, the management of water resources has been taken into consideration based on sustainable development in the world. Natural events such as floods have been among human problems in the past and present and hydrologists have always given lot attentions to this issue. Determination of the amount of the flood in drainage basins depends on hydrologic and hydraulic parameters of the basin. The purpose of this study is to provide the best model of the flood flow of drainage basin of West Lake Urmia. For this reason, after preparing the required statistics during two statistic periods for the 34-year, several equations were developed for estimating flood flow that in these relationships, flood flow parameter has been estimated as the dependent variable by using independent variables such as rainfall, the annual average temperature and physical characteristics of the basin. Finally, 4 models out of 112 models were selected as the best models to predict the area flood and the respective relationships were presented

KEYWORD

Flood, modelling, overflow, Urmia Lake

INTRODUCTION

Today, the management of water resources has been taken into consideration based on sustainable development in the world. The first requirement in the study of water resources projects in an area is knowledge of water resources and ability to estimate it in the region. Surface water hydrology studies will be needed for recognition the factors and surface water resources in order to plan, design and management of irrigation schemes. Estimation of design flood is one of the important elements in hydrological studies of water resources projects especially dam construction projects. About 91 million hectares of the country's area has been estimated flood-oriented. In other words, 55% of the country's area has involved in producing direct and immediately runoff y which approximately 42 million hectares of it has moderate to very high intensity are flood-oriented [1] . Drainage basin of Urmia Lake is located in the mountainous area of North West and the area of the basin is of 52,700 square kilometers [2], and its average altitude is about 1800 meters [3]. According to the characteristics of topography, geology and climate, basin of Lake Urmia is divided into three sub-basins; West, South and East. West Sub-basin of Urmia Lake is stretched in the form of a parallelogram in the West part of the lake; the length of the parallelogram is about 150 km; its Eastern side is West shore of the Lake and its Western side is the ridge of the mountain ranges which is separated the country from Turkey. This sub-basin includes drainage basins of four permanent and seasonal rivers which are .Zolachay, Shahrechay, Barandaezchay and Nazloochay. Annual gains in the rivers which have water measurement stations are not a very difficult to job, but it is relatively difficult to estimate for the basins without station [4]. Due to the heavy costs of installation, maintenance and operation is impossible to equip hydrometric stations for all rivers, therefore, for estimation annual discharge of the basins, two ways are used: 1) the flow data analysis and 2) mathematical models. Theoretical solutions to hydrological problems have been largely replaced the more complex methods since 1950 and advances in scientific understandings have provided a possibility allowing a better understanding of the physical principles of hydrology correlations [5]. There are different methods for determining the amount of the flood of design in the basins without stations for measuring discharge. In some of these methods, maximum flood levels are determined by empirical relations established between maximum flood and basin characteristics such as area and meteorological parameters and in some other cases, the values of maximum flood are estimated by specified return period by statistics and data from other stations similar to the mentioned region [6]. The purpose of this paper is modeling the flood flow in West drainage basin of Lake Urmia; it means that the amount of generated flood can be predicted by using physiographic and meteorological characteristics of the area under study.

---

*Corresponding Author: Mohammad Salarian
E-mail : salarian_mohammad@yahoo.com
Telephone Number: +98-938-4060199 Fax. Numbe r:

MATERIALS AND METHODS

Regional analysis has been widely used in such as flood volume, annual average discharge, monthly average discharge and …. And the place decision can be made by using it [7]. Regional analysis method expands point analysis in the whole region (information can be transferred from the points which don't have statistic by doing this job). Multivariate regression method is used to estimate the desired parameter and to extend it to the areas without statistic because all sampling stations participated in regional analysis. Modeling is done between variables in order to provide the relationships between the flood flow and basin characteristics and meteorological parameters. In modeling, the variables must be entered into the model which has the major role in producing floods and there is minimum relationship between them. And also, the model should be carefully selected that the selected model could provide the best estimate from reported data and above all, it must be very simple. In this study, the following two models are used:

$$Q=mnXn+mn-1Xn-1+\ldots+m0 \qquad (1)$$

$$Q=mnLnXn+mn-1LnXn-1+\ldots+m0 \qquad (2)$$

Where Q is the values of predicted floods, Xi, i = 1,2, ..., n is independent variables and mj, j = 1,2, ..., n is constant coefficients of regression equation. The most important model has been chosen among the mentioned models by using statistical analysis and the following conditions are considered for selecting the model:

1-The values of modified explanation coefficient are closer to one.

2- Significant assumption of regression coefficients will be made achievable that this work has been done by calculated Fisher's F from the model and obtained F Fisher from the table.

3- Standard error is less.

4- The model should be simple and have the lowest number of independent variables.

In this study, the number of independent variables have been 6 and X1 represents (basin area), X2 (average slope of the basin), X3 (average height of basin), X4 (average rainfall of basin), X5 (average annual temperature of basin), X6 (compactness coefficient basin) and m0 is constant coefficient of the model and m6, m5, m4, m3, m2 and m1 are variable coefficients of X6, X5, X4, X3, X2, and X1 ,respectively and Q will be the amount of estimated flooding. Totally, among 13 hydrometric stations in the basins under study, 7 hydrometric stations were selected for modeling and 6 other stations were removed due to short period of statistical years or because of lacking available hydrometric statistics. In general, it is stated no logical limit to the length of statistical period and different researchers have considered different length of period while analyzing frequencies. For example, Linsley et al [8] suggested the minimum statistical period of 20 years for analyzing frequencies of flood with the purpose using in maximum annual flood and also, Campbell and colleagues [9] and Waylen & Woo [10] used 10-year base period for frequency analysis in their study. In this study, the 34-year statistical period (1972 to 2005) was considered as the base period and the modeling was done by available independent variables and the best models were selected among the models tested.

RESULTS AND DISCUSSION

Several combinations of physiographic and meteorological parameters were obtained as independent variable to estimate the flood. Totally, 112 models were obtained. In these models, physiographic features of basins such as area, average slope, average height and compactness coefficient (Gravelios coefficient) and also meteorological characteristics such as average rainfall and average temperature have been entered into the model as independent variables and the station data was used. Tables 1 to 4 indicate the results obtained from the models such as the value of Fisher's F and the value of R^2 and its square root, that is, the correlation coefficient.

Tab.1. The results of the two-parameter models (df=4)

The model parameters	F	R^2	R
X1X2	11.3055	0.8496	0.921737
X1X3	0.5561	0.2176	0.466476
X1X4	0.9847	0.3299	0.574369
X1X5	0.7446	0.2713	0.520865
X1X6	0.983	0.3295	0.574021
X2X3	7.9692	0.799	0.893868
X2X4	8.475	0.809	0.899444
X2X5	15.591	0.8863	0.941435
X2X6	8.4694	0.809	0.899444
X3X4	0.6331	0.2404	0.490306
X3X5	0.1675	0.077	0.277489
X3X6	0.24	0.6316	0.794733
X4X5	0.2867	0.1254	0.354119
X5X6	0.2862	0.1252	0.3538
LnX1LnX2	18.2333	0.9012	0.9493
LnX1LnX3	0.5073	0.2023	0.4497
LnX1LnX4	0.9027	0.311	0.5576
LnX1LnX5	0.6596	0.248	0.4979
LnX1LnX6	0.9657	0.3256	0.5706
LnX2LnX3	16.9436	0.8944	0.9457
LnX2LnX4	20.1696	0.9098	0.9538
LnX2LnX5	20.5822	0.9114	0.9546
LnX2LnX6	19.8016	0.9083	0.953
LnX3LnX4	0.618	0.2361	0.4859
LnX3LnX5	0.1707	0.0787	0.2805
LnX3LnX6	0.6845	0.255	0.5049
LnX4LnX5	0.2465	0.1097	0.3312
LnX4LnX6	1.1322	0.3615	0.6012
LnX5LnX6	0.3811	0.1601	0.4001

Tab.2. The results of the three-parameter models (df=3)

The model parameters	F	R^2	R
X1X2X3	10.7767	0.9151	0.9566
X1X2X4	5.7958	0.8529	0.9235
X1X2X5	12.3309	0.925	0.9617
X1X2X6	5.7941	0.8528	0.9234
X1X3X4	0.5015	0.334	0.5779
X1X3X5	0.5925	0.3721	0.61
X1X3X6	0.5006	0.3336	0.5775
X1X4X5	0.5418	0.3514	0.5927
X1X4X6	0.9248	0.4805	0.6931
X1X5X6	0.5409	0.351	0.5924
X2X3X4	4.4029	0.8149	0.9027
X2X3X5	6.4658	0.9045	0.951
X2X3X6	4.399	0.8148	0.9026
X3X4X5	0.3648	0.2673	0.517
X3X4X6	0.5852	0.3692	0.6076
X4X5X6	0.1877	0.1581	0.3976
X2X4X5	7.8054	0.8846	0.9405
X2X4X6	8.2717	0.8921	0.9445
X3X5X6	0.3637	0.2667	0.5164
X2X5X6	7.8045	0.8864	0.9414
LnX1LnX2LnX3	13.3084	0.9301	0.9644
LnX1LnX2LnX4	14.5663	0.9358	0.9673
LnX1LnX2LnX5	10.8881	0.9159	0.957
LnX1LnX2LnX6	12.9011	0.9281	0.9633
LnX1LnX3LnX4	0.4583	0.3143	0.5606
LnX1LnX3LnX5	0.5063	0.3361	0.5797
LnX1LnX3LnX6	0.4851	0.3267	0.5715
LnX1LnX4LnX5	0.4887	0.3283	0.5729
LnX1LnX4LnX6	0.5893	0.3708	0.6089
LnX1LnX5LnX6	0.5063	0.3361	0.5797
LnX2LnX3LnX4	10.087	0.9098	0.9538
LnX2LnX3LnX5	10.2912	0.9114	0.9546
LnX2LnX3LnX6	9.9735	0.9089	0.9533
LnX3LnX4LnX5	0.3501	0.2593	0.5092
LnX3LnX4LnX6	1.2873	0.5628	0.7502
LnX4LnX5LnX6	0.6135	0.3802	0.6166
LnX2LnX4LnX5	18.2003	0.9479	0.9736
LnX2LnX4LnX6	10.1892	0.9106	0.9542
LnX3LnX5LnX6	0.3851	0.278	0.5272
LnX2LnX5LnX6	19.587	0.9514	0.9753

Tab.3. The results of the four-parameter models (df=2)

The model parameters	F	R^2	R
X1X2X3X4	6.0713	0.9239	0.9611
X1X2X3X5	6.489	0.9285	0.9635
X1X2X3X6	6.0645	0.9238	0.9611
X1X3X4X5	0.3021	0.3767	0.6137
X1X3X4X6	0.5074	0.515	0.7176
X2X3X4X5	5.0506	0.9099	0.9538
X2X3X4X6	7.4801	0.9373	0.9681
X2X3X5X6	5.0549	0.91	0.9539
X2X4X5X6	23.7277	0.9794	0.9896
X1X4X5X6	0.5378	0.5182	0.7198
X3X4X5X6	0.3952	0.4415	0.6644
X1X2X4X5	6.252	0.9259	0.9622
X1X2X4X6	4.5416	0.9008	0.9491
X1X2X5X6	6.2542	0.926	0.9622
X1X3X5X6	0.302	0.3766	0.6136
LnX1LnX2LnX3LnX4	10.6417	0.9551	0.9772
LnX1LnX2LnX3LnX5	6.7136	0.9307	0.9647
LnX1LnX2LnX3LnX6	10.202	0.9533	0.9763
LnX1LnX3LnX4LnX5	0.2628	0.3446	0.587
LnX1LnX3LnX4LnX6	0.6436	0.5628	0.7502
LnX2LnX3LnX4LnX5	14.421	0.9665	0.9831
LnX2LnX3LnX4LnX6	5.6384	0.9185	0.9583
LnX2LnX3LnX5LnX6	12.8775	0.9626	0.9811
LnX2LnX4LnX5LnX6	10.379	0.954	0.9767
LnX1LnX4LnX5LnX6	0.307	0.3805	0.6168
LnX3LnX4LnX5LnX6	0.7126	0.5877	0.7666
LnX1LnX2LnX4LnX5	14.298	0.9662	0.9829
LnX1LnX2LnX4LnX6	15.4707	0.9687	0.9842
LnX1LnX2LnX5LnX6	13.2478	0.9636	0.9816
LnX1LnX3LnX5LnX6	0.27	0.3507	0.5921

According to the above tables, if the correlation coefficient obtained from regression is greater than or equal to the number in Table 5 which is a part of the table is provided by Fisher, it is in the desired confidence level, correlation is significant at the confidence level, but actually the higher correlation coefficient, the more accurate and reliable estimated values [11].

Tab.4. The results of the five-parameter models (df=1)

The model parameters	F	R^2	R
X1X2X3X4X5	2.6036	0.9287	0.9636
X1X2X3X4X6	2405.424	0.9999	0.9999
X2X3X4X5X6	9.4911	0.9794	0.9896
X1X3X4X5X6	0.2159	0.5191	0.7204
X1X2X4X5X6	12.8103	0.9846	0.9922
X1X2X3X5X6	2.6029	0.9286	0.9639
LnX1LnX2LnX3LnX4LnX5	5.9252	0.9673	0.9835
LnX1LnX2LnX3LnX4LnX6	8.5218	0.9771	0.9884
LnX2LnX3LnX4LnX5LnX6	663.3189	0.9997	0.9998
LnX1LnX3LnX4LnX5LnX6	0.3476	0.6348	0.7967
LnX1LnX2LnX4LnX5LnX6	6.7419	0.9712	0.9854
LnX1LnX2LnX3LnX5LnX6	5.3284	0.9638	0.9817

Tab.5. Significant correlation coefficient values at 1% and 5% confidence level

%5	%1	Degrees of freedom
997.0	1	1
95.0	99.0	2
878.0	959.0	3
811.0	917.0	4

First, according to Table 5, among all the models, the ones were selected which were at the confidence level 1% and 5% and then the acceptable level of their F has been investigated in both confidence levels and the points beyond the scope have been excluded. "Colorful boxes" in Tables 1 to 4 show the respective models. Finally, in order to provide the best models, the model was chosen with the highest correlation coefficients in the motioned group with having had the initial conditions. Four following models are the best descriptive models for the flood of basins of West Lake Urmia:

$$Y= 300.187\ \mathrm{LnA} + 103.184\ \mathrm{LnS} - 1810.445 \tag{3}$$

$$Y= 341.637\ \mathrm{LnA} + 721..082\ \mathrm{LnH} + 384.544\ \mathrm{LnP} - 9507.52 \tag{4}$$

$$Y= 0.389\ A - 280.148\ H + 1.848\ P - 41773.236\ T + 860786.812 \tag{5}$$

$$Y= 328.855\ \mathrm{LnA} - 1852.451\ \mathrm{LnS} + 19910.775\ \mathrm{LnH} + 734.521\ \mathrm{LnP} + 7461.984\ \mathrm{LnT} - 166445.002 \tag{6}$$

Where A is the area of mentioned part (square kilometers), S is the average slope of the area, H is the average height of the area (m), P is the average annual precipitation (mm) and T is the annual average temperature (° C). According to the above equations, it is determined that the area and coefficients average rainfall are always positive, which means that by increasing rainfall and being large area of the basin , the amount of produced flood will be increased. In Equation 4, using two parameters nearly related to the average height and average slope causes the produced flood is inversely related to gradient and directly related to height. The reason for providing the models with fewer parameters and thus low correlation coefficient is "flood estimation in regions with few parameters" in the area under study.

CONCLUSIONS

One of the important factors in understanding the hydrological behavior of catchments is studying the outflows from the basin at different time stages such as daily, monthly, yearly, etc. Meteorological parameters (precipitation and annual average temperature) and physiographic characteristics of the basins (area, average height, average slope, and compactness coefficient) are suitable for flood flows modeling. Flood flow can be estimated even in the basin areas without statistics by modeling and developing of relations between physiographic properties and meteorological parameters of the basin. Therefore, appropriate modeling can lead to establish flood warning system.

REFERENCES

[1] ***Ilkhchi, A., M. Haj Abbasi, A. , and A. Jalalian****, The effect of land usage changes from Pasture lands to dry farming on runoff production. Journal of Science and Technology of Agriculture and Natural Resources, 2002. 6 (4).*

[2] ***Movahed Danesh, A., E.*** *, Surface Water Hydrology of Iran. 1995, Tehran: Organization of Studying and editing the social sciences books of Universities.*

[3] ***JihadSazandegi,*** *Preliminary Report of Meteorology and Hydrology Studies of Uremia Lake Basin. 1997, Committee on Water Affairs of Jihad Sazandegi East Azerbaijan: East Azerbaijan.*

[4] ***Alizadeh, A.,*** *Principles of Applied Hydrology. Fifteenth Edition ed. 1989: Astan Ghods Razavi Publications.*

[5] ***Newton, D. and J. Herrin,*** *Assessment of commonly used methods of estimating flood frequency. Transportation Research Record, 1982(896).*

[6] ***Sangal, B.,*** *ESTIMATING PEAK FLOWS. Encyclopedia of Fluid Mechanics: Dynamics of single-fluid flows and mixing, 1986. 2: p. 258.*

[7] ***Kite, G.W.,*** *Frequency and Risk Analyses in Hydrology. 1991: Astan Ghods Razavi Press.*

[8] ***Linsley Jr, R., M. Kohler, and J. Paulhus,*** *Hydrology for Engineers, 3rd. Edtition Mc Graw Hill Book Co., New York, l982, 1982.*

[9] ***Campbell, A.J.,*** *Prediction of peak flows for culvert design on small watersheds in Oregon. 1982.*

[10] ***Waylen, P. and M.k. Woo,*** *Prediction of annual floods generated by mixed processes. Water Resources Research, 1982. 18(4): p. 1283-1286.*

[11] ***Remenieras, G.,*** *Hydrologic Engineering Fundamentals. Vol. Volume I. 1973: Shahid Chamran University Press.*