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Application of Linear Moment Theory in Flood Alternation Analysis in Central Watersheds of Iran

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ABSTRACT

There are many ways to investigate the flood watersheds, which one can refer to the regional flood analysis. The regional flood analysis approach relies on the physical, climatic and ecological characteristics of the watersheds; it uses statistical methods to study current observation data. This approach has many ways. Husking and Wallis with the expansion of the probability weighted moment method, linear moment statistics were presented as a new index in the analysis of watershed flood alternation variation. The theory of linear moments is the basis of the present study. In this study, 27 hydrometric stations located in the central region of Iran were investigated.

Using linear moment diagrams, the linear skew curve was determined against the linear elongation and the most appropriate fitting distributions for each study station. Then, in order to remove the impossible stations, homogeneity tests were performed based on heterogeneity and heterogeneity parameters and finally two stations Barez and Gabr abad were identified as heterogeneous stations. In the next step, good fit test is performed to determine the most appropriate distribution function of the region, and respectively, generalized logistic distribution, generic limit values, normalized general, Pearson type 3 and General Pareto were the most appropriate distribution for areas. Eventually, estimated values of discharge with different frequency in the region were determined, and the selected distribution regional parameters were presented.

Keywords: *Linear moment, Probability Weight moment, Analysis of Regional Flood.*

INTRODUCTION

Regional flood analysis is perhaps one of the most controversial topics in the flood hydrology, and for years, it has attracted the attention of many scholars. Due to the widespread economic and environment impacts, regional flood analysis is one of particular importance. Therefore, research on the improvement of flood estimation methods is still ongoing. In seventies and eighties, most efforts were devoted to the development of work methods for flood frequency analysis at hydrometric stations. New statistical distributions and more efficient estimation methods are introduced in various hydrologic resources, some of which are specific to flood alternation analysis. It seems that this trend has been somewhat apparent at the beginning of the 1990s. Regional analysis is perhaps the most sustainable method for improving flood estimation, and it seems that efforts have been taken into consideration by researchers.

The purpose of regional flood analysis is to estimate the amount of flow and its occurrence in a given area. The return period, which is called probable distances, depending on the nature of the project and the runoff of the flood. For example, dams and flood restraint systems designed to withstand floods with a return period of 10,000 and 50 years, are constructed along useful structures. The existing relationship between the magnitude of the flood and its occurrence is known as the flood alternation curve, and can be used for engineering purposes, such as bridges, dams, water diversion and flood control structures.

Adamovsky in a research compares the non-parametric procedures and linear moment method in regional flood analysis in the provinces of Ontario and Quebec, Canada. In his research, he used the maximum annual data and partial flood series, in the first step, the domains were divided into 9 homogeneous regions based on the shape of the density function and the time of occurrence of the flood, so that the neighboring areas had some flood mechanism. The result of this research are the ineffectiveness of non-parametric models in separating various flood mechanisms, and the consequent weakness in determining homogeneous regions.

Vogel et al. used the theory of linear moments to study the flood alternation of Australian watersheds, and surveyed 61 hydrometric stations throughout the country. Based on the results of this research, distributions of the general extreme-value and the wake by are the best approximated to flow data in areas of Australia where the main rain full is due to winter rainfall, for other Australian waters, generalized Pareto and wake by distributions are the best fitted with observational data.

The hydrologic application of probability weighted moments was first proposed by Greenwood et al. and Landor et al. and then expanded by Husking and colleagues and Wallis. With the development of probability weighted moments, Husking and Wallis presented the linear moments for the first time. Husking showed that the linear moment of the first and second types, the linear moment ratios of the third to the second, and the linear moment of the fourth to the second, you will find useful data from random samples of statistical data. Linear moment ratios provided by Wallis and Husking are a good tool for hydrologic grouping in the watersheds.

Pearson used a linear moment charts to group 275 stations in New Zealand. The stations examined had at least 10 years' observational data, so that the average length of observation statistic in the region is 21 years. The application of the theory of linear momentum in the New Zealand flood survey shows that annual flood seasons of area South Canterbury are better fitted with distribution of extreme value type 2, while the results of previous studies revealed the distribution of extreme value type 1 as the best distribution for this region.

The purpose of this study was to investigate the linear moment method in determining the flood frequency in the central region of Iran. The shortage of water flow metering stations, the lack of statistical period, the lack of data in the observation period, due to the rare flood events in the region, and the existence of years without flow in the existing statistical period is the most important problem in investigating the flood alternate in the region, which makes use of regional methods inevitable.

Materials and Methods

Regional Flood Alternate Models

Most regional approaches to flood diversion analysis are based on the use of peak annual floods with annual series, while in some other methods, minor series are used. At the moment, regression and flooding methods are more common than other methods. While the regression methods widely used in the United states, Australia and other parts of the world is used, index flood method also of note scholar is located.

Generally, analysis regional flood five stages the following, so that the three first function is on personal judgement:

- Preparation of data observations
- Determine the homogeneous regions
- Select a distribution regional frequency
- Estimated parameters distribution regional frequency
- Estimated flood in areas without station

Like any statistical analysis, the first step in analyzing the flood alternate is to carefully study observational data and to solve large errors and heterogeneity. Here, external information can be helpful, especially on measuring and collecting data, as well as any changes in land use that have affected flood flow in the watersheds.

The next step in the regional analysis of the flood is to assign the stations to be homogeneous. A homogeneous area is a collection of watersheds which has roughly identical flood alternate distribution; it is recognized as a unit of regional flood diversion analysis. In this case, insists on the geographical proximity of watersheds, instead, the regions should consist of areas where are the same in terms of characteristics affecting the flood behavior. These features include latitude, annual average monthly, surface area, soil holdings and swamp storage capacity. Of course latitude and longitude are also features of watersheds, and may be a substitute for other features have been gradually changed and not measured by the changes.

After determining the homogeneous region, selecting a flood alternate distribution is appropriate. This is a general statistical problem that is usually solved by calculating the distribution statistics of observational data. This approach can also be used for flood diversion, provided that the following considerations are considered. First, available data is not a unique random sample, but also a bunch of samples collected from different stations. Second, it is not enough that the chosen distribution with good observation data, it should also be able to provide flood-based estimates that is not susceptible to distortion of the regional hydrological distortion of the regional distribution of the regional flood distribution. The regional flood alternate distribution estimate can be estimated by estimating the distribution of each station separately and combining station's estimates to regional average determination. One of the effective ways to achieve this goal is the moment method of the region, which will come below.

Linear Moments

Linear moments are linear combinations of order statistics that is not sensitive to outlier data and the small samples are non-inertial observational data. Therefore, their application is suitable for analyzing the flood period (determining proper distribution and estimating distribution parameters).

Linear moments have theoretical advantages in conventional moments, including those that can specify wider range of distribution functions, and when estimated from an observation sample, they are not sensitive to the outlier data in that sample. In other words, Estimators moments conventional like variance and coefficient skewness sample data observations in order to be 2 or 3 carry, that thus more weight to the outlier data is given, and ultimately lead cross and variance much they are.

Against, Estimators moments linear are linear functions of the values of the sample observations, and hence is the non-cross, compared to the outlier data is not sensitive. Also, excellence of linear moments to weight moment probability, their ability in summary a distribution statistical way is more meaningful.

In general, the most important application of linear moment can be solved problems related to estimate the parameter distribution, summarizing distribution statistical area are named. Moment of linear combinations of weight moment are likely:

$$\beta_r = E\{X[F(x)]^r\}$$

That $F_{(X)}$ is the cumulative distribution function of x. Non-skew sample estimates are obtained from PWM:

$$\beta_0 = \frac{1}{n}\sum_{j=1}^{n} x_j$$

$$\beta_1 = \sum_{j=1}^{n-1}\left[\frac{(n-j)}{n(n-1)}\right]x_j$$

$$\beta_2 = \sum_{j=1}^{n-2}\left[\frac{(n-j)(n-j-1)}{n(n-1)(n-2)}\right]x_j$$

$$\beta_3 = \sum_{j=1}^{n-3}\left[\frac{(n-j)(n-j-1)(n-j-2)}{n(n-1)(n-2)(n-3)}\right]x_j$$

That x_i is the ordered data stream with x_1 as the largest observational data, and x_n is the smallest data. The first four linear moment that are expressed as linear constituents of the probability-weighted moment are:

$$\lambda_1 = \beta_0$$

$$\lambda_2 = 2\beta_1 - \beta_0$$

$$\lambda_3 = 6\beta_2 - 6\beta_1 + \beta_0$$

$$\lambda_4 = 20\beta_3 - 30\beta_2 + 12\beta_1 - \beta_0$$

In the above relations, the average linear moment or λ_1, the center of inclination, and linear moment deviation or λ_2, is a measure of dispersion. The ratio λ_2 to λ_1 or τ_2 as the L-coefficient variation moment, the ratio of λ_3 to λ_2 or τ_3 as the L-skewness (L skew)moment, the ratio λ_4 to λ_3 or τ_4 is referred to as L-kurtosis (L kurt) moment.

Using linear moment, homogeneity test and heterogeneity test of the stations were performed.

Choosing the right distribution using linear moment charts

The theoretical relationships between τ_3 and τ_4 are obtained for various distribution. Choosing a suitable parametric particle for describing the data of the stations examined is based on the proximity of the average values of the parameters τ_3

and τ_4 of the region with the theoretical point or line of each distribution, as well as their variability around the corresponding average values.

Inconsistency test

If a single station does not occur in the linear moment curve within the two-dimensional (τ_3 and τ_4) space, a linear hub moment-based inconsistency test is performed to determine the need to remove the station from the test or stations under investigation.

This test is done by calculating D statistics. Assume that the U_i vector function contains linear moment ratios for station I, so:

$$U_i = \left[Lcv_i, \tau_{3i}, \tau_{4i}\right]^T$$

The average of the group ($\bar{U}$) and the matrix of the covariance of the sample are defined as:

$$\bar{U} = \frac{1}{N}\sum_{i=1}^{N} U_i$$

$$S = \left(\frac{1}{N-1}\right)\sum_{i=1}^{N}\left(U_i - \bar{U}\right)\left(U_i - \bar{U}\right)^T$$

$$D_i = \frac{1}{3}\left(U_i - \bar{U}\right)^T S^{-1}\left(U_i - \bar{U}\right)$$

So that N is the total number of stations. It is worth nothing that the average D_i total station equal one. If the D statistics for a station is more than 3, observation data of that station is considered to be inconsistent with other stations in the region and two probabilities are checked: Whether or there is an error in the observation data, or the station is not homogeneous in this area.

Homogeneity test

If the station's changeability or station spacing is large, the probability that these stations belong to a single unit can be checked by the homogeneity test of linear moment.

The linear moment homogeneity test is fitted with a four-parameter kappa distribution to fit the observational data series of the region, by numerical simulation (mathematics), it produces a 500-bit series of regional data, then, the linear momentum variability of the real area is compared with the linear momentum of the simulation series. Three heterogeneous statistics are used to examine the variability of three different statistics:

Statistics H_1 of linear coefficient of variation, statistics H_2 for the combination of the linear coefficient of variation and the linear skewness coefficient, and H_3 for the combination of the linear skewness coefficient and the linear kurtosis coefficient of each of the H statistics has the following general form:

$$H = \left(V_{obs} - \mu v\right)/\sigma v$$

So that μv and σv respectively average and standard deviation of values simulated variable desired, and parameter V_{abs} is values calculated variable using data area, and based on a statistics V, which for each statistics H (respectively, H_1, H_2 and H_3) for the following definition is:

$$V_1 = \sum_{i=1}^{N}\left(n_i (Lcv_i - \overline{Lcv})^2\right) \Big/ \sum_{i=1}^{N} n_i \qquad [۱۵]$$

$$V_2 = \sum_{i=1}^{N}\left(n_i\left[(Lcv_i - \overline{Lcv})^2 + (\tau_{3i} - \bar{\tau}_3)^2\right]^{1/2}\right) \Big/ \sum_{i=1}^{N} n_i \qquad [۱۶]$$

$$V_3 = \sum_{i=1}^{N}\left(n_i\left[(\tau_{3i} - \bar{\tau}_3)^2 + (\tau_{4i} - \bar{\tau}_4)^2\right]^{1/2}\right) \Big/ \sum_{i=1}^{N} n_i$$

According to the definition, if the H<1 AREA HOMOGENEOUS, WHEN $1 \le H < 2$ is area probably heterogeneous, and when $H \ge 2$ is area non-homogeneous. Therefore, a collection of stations investigated must parameter H less than 2 as an area probably homogeneous be considered.

Goodness of Fit Test for Determine the Primary Distribution

When the data in an area homogeneous and belonging to a distributed parameter single, test fitness-based moment linear done to one of the distribution of popular choice and parameters estimated. The alternate of flood in an area on the basis of regional distribution is determined. Criteria fitness for any distribution on the basis of moment linear is determined and statistics Z called.

$$Z^{DIST} = \left(\tau_4^{DIST} - \bar{\tau}_4 + \beta_4\right)\sigma_4$$

That DIST referring to the distribution. β_4 and σ_4 respectively are amount of cross and standard deviation τ_4 coefficient elongation linear and as follows defined:

$$\beta_4 = 1 \Big/ N_{sim} \sum_{m=1}^{N_{sim}} \left(\bar{\tau}_{4m} - \bar{\tau}_4\right)$$

$$\sigma_4 = \sqrt{\left[1/(N_{sim} - 1)\right]\sum_{m=1}^{N_{sim}}\left(\bar{\tau}_{4m} - \bar{\tau}_4\right)^2 - N_{sim}\beta_4^2}$$

That N_{sim} number of series data regional simulated, which using the distribution of kappa like method statistics homogeneous has been produced. Letter m is referring to the simulated area number m that this method obtained.

Software Used

To do all the research, software XFIT has been used (The original text of this program is provided by Husking in FORTRAN but the authors have been edited this article and has become applicable to the software). This program is applicable of examining 10 common statistical distributions, Gamma, generalized limit values, generalized logistics, Normal, Pareto-Generalized, Gamble, Wake by, Generalized normal, kappa and Pearson type III.

The program input includes information on the stations under study, such as station names and codes, statistical years, and water flow observations during the statistical period, which is provided in a special format.

Area Reviewed

The study area includes three major areas in the center of Iran called Zayandehroud, North Karoun and Qom (Figures 1 to 3). Of the 36 hydrometric stations in the area, 27 stations have been surveyed; their specifications are given in Table 1.

Zayandehroud Watershed

Zayandehroud watershed is located in the central part of Iran's central plateau , and is located in the geographical coordinates 50˚2' to 53˚24' in the east and 31˚12' to 33˚42' in the north latitude. The area is 41,347 Km^2, most of it is located in Isfahan province and a small part of it is located in Chaharmahal va Bakhtiari and Fars province.

This area starts from Koohrang and ends in the Gavkhooni swamp, and from the north to the central watershed (Salt Lake), from the east to the Ardestan watershed and the Black Sea desert of koreh, to the south to the Abarghoo-Sirjan desert and to the west and southwest to the Karoun river basin (Figure 2).

Qom Watershed

This area is on the northwest to the west of the great central area and the deserts of Qom, Arak, Kashan to the Salt Lake in the east. The Qom area is limited to the north by the southern slopes of the Alborz and south to the northern and northeast slopes of Zagros. The area is 94.000 Km^2, which consists

Table1. *Hydrometric station examined*

Row	Lake	Station	Longitude	Latitude
1	Plasjan	Eskandari	50˚ 25'	32˚ 48'
2	Zayandehroud	Ghaleshahrokh	50˚ 27'	32˚ 40'
3	Savaran	Savaran	50˚ 23'	32˚ 52'
4	Samandegan	Mandarjan	50˚ 39'	32˚ 47'
5	Zarcheshmeh	Tang Asfarjan	50˚ 45'	31˚ 38'
6	Abvanak	Tang Zardaloo	51˚ 26'	31˚ 38'
7	Abvanak	Tang Soolegan	51˚ 16'	31˚ 39'
8	Beheshtabad	Beheshtabad	50˚ 38'	32˚ 2'
9	Golpayegan	Vaneshan	50˚ 21'	33˚ 21'
10	Karoun	Armand	50˚ 45'	31˚ 40'
11	Jooneghan	Tang Darkesh	50˚ 39'	32˚ 6'
12	Koohrang	Chelgerd	50˚ 7'	32˚ 28'
13	Abvanak	Godar Kabk	51˚ 14'	31˚ 43'
14	Marbar	Kata	51˚ 15'	31˚ 11'
15	Marbar	Marbaran	50˚ 12'	32˚ 20'
16	Hana	Hana	51˚ 46'	31˚ 13'
17	Golpayegan	Sarab Hende	50˚	33˚ 21'
18	Bazoft	Morghak	50˚ 28'	31˚ 42'
19	Khersan	Barez	50˚ 25'	31˚ 31'
20	Lordegan	Lordegan	50˚ 50'	31˚ 28'
21	Ghahrood	Gabrabad	51˚ 30'	33˚ 46'
22	Bonrood	Ghamsar	51˚ 25'	33˚ 43'
23	Barzrood	Pol Hanjen	51˚ 47'	33˚ 37'
24	Shoor	Hastijan	50˚ 49'	33˚ 51'
25	Sazar	Tang Panj	48˚ 45'	32˚ 56'
26	Zayandehroud	Pol Zamankhan	50˚ 54'	32˚ 30'
27	Golpayegan	Sad Golpayegan	50˚ 17'	32˚ 20'

Figure1. *The study area in central Iran*

Figure2. *The stations studied in Zayandehroud and Qom watersheds of five areas called Shoor, Qomrood, Gharehchay, Arak and Mighan desert, Kashan and Qom desert and Salt Lake (Figure 2).*

North Karoun Watershed

North Karoun watershed is part of Karoun's great basin, and with an area of 14,476 Km^2 in the geographical range , 39˚34' to 51˚47' is the eastern length and 31˚18' to 32˚40' is the northern latitude.This area bounded north and northeast to the Zayandehroud dambasin, northwest to the Dez River basin, south to the watershed of the Khersaan River, and to the south and west to parts of the great Karoun basin (Figure 3).

RESULTS AND DISCUSSION

The observational values of peak water flow and peak momentum are collected during the research and are used in the framework of the input file of the XFIT program.Table 2 and 3 show the output of the above program.

Figure3. *The Stations Examined in the Northern Karoun Watershed*

As can be seen in Table 2, the first column is the station number; the third column is the statistical years and the subsequent columns of the first to fourth degree moment of the observed hub station. Also, the average regional linear moment ratios are given at the end of the table. The moment values of the second, third, and fourth type linear stations are used to plot linear moment curve (generally linear skew coefficient curve versus linear elongation coefficient).

Linear moment curve is a suitable tool for determining the appropriate statistical distributions for each hydrometric station. Figure 1 shows the values of linear torques of type three and four of the study stations as dispersed points. In this chart, the curves for each of the statistical distributions analyzed are plotted. It should be recalled that the statistical distribution has one or two parameters such as Gamble, Normal, Limit values of the first type and uniform in the form of a point, and distributions with three parameters in the form of curves, and distribution with four or five parameters such as Wakeby as a region it has been shown (Table 4).

Inconsistency Test

In order to determine the stations that are interspersed with τ_3 and τ_4 in relation to other stations, Inconsistent statistics provided by Husking and Wallis.

For all the stations examined, the results are shown in Table 5. According to the definition, stations with more than 3 coordinate statistics, it is known as the futile station and excluded from the collection of study stations.

Thus, stations 4 and 24, namely Barez and Gabrabad, were futile stations and were excluded from other stages of the research.

Homogeneity Test

As noted earlier, if the variability of space τ_3 and τ_4 is high, the moment homogeneity test can be checked for the probability that the set of stations examined does not belong to a single population.

The three test used are H_1 for Lev, H_2 for a combination of Lev and Lskew, and H_3 for combination of Lkurt and Lskew, by definition, if each of theH parameters is less than one, the area can be considered homogeneous. Table 6 shows the results of each H tests. In this table, the parameters H_1, H_2 and H_3 in this region are 0.25, 0.66 and 1.14, respectively, which in total represents the homogeneity of the area.

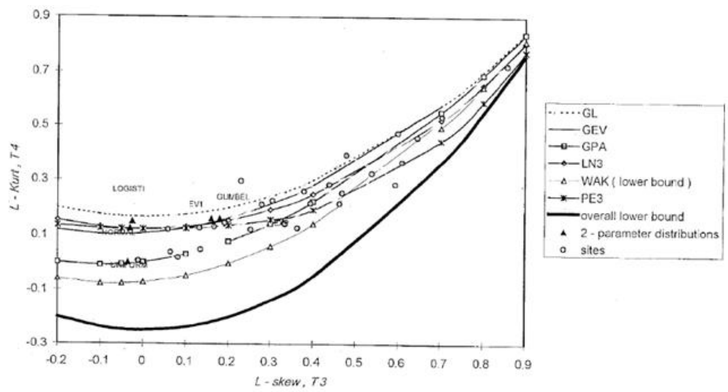
Table2. *Linear moment type one to four stations examined*

z	Station	Number of statistical year	LI	Lev	L skew	L kurt
1	Godar Kabk	5	54.4	16.28	0.167	0.131
2	Tang Soolegan	14	264.77	175.969	0.598	0.474
3	Tang Zardaloo	11	94.48	50.013	0.363	0.128
4	Barez	29	1019.42	386.78	0.135	0.048
5	Marbaran	14	10.91	1.69	0.191	0.146
6	Morghak	36	882.58	179.657	0.305	0.226
7	Armand	36	673.97	233.899	0.438	0.285
8	Lordegan	36	45.79	10.032	0.379	0.26
9	Kata	27	269.84	72.361	0.082	0.019
10	Tang Panj	19	1110.68	272.717	0.133	0.127
11	Hana	11	10.65	2.887	0.253	0.122
12	Tang Asfarjan	12	7.42	4.349	0.462	0.216
13	Savaran	8	12.86	7.199	0.537	0.325
14	Eskandari	22	32.3	13.264	0.477	0.392
15	Mandarjan	13	6.59	4.953	0.593	0.286
16	Pol Zamankhan	45	125.96	40.945	0.394	0.217
17	Sarab Hende	30	64.5	34.234	0.467	0.255
18	Sad Golpayegan	8	53.49	17.804	0.23	0.297
19	Tang Darkesh	9	116.78	28.821	0.058	0.121
20	Vaneshan	9	19.32	16.259	0.608	0.366
21	Beheshtabad	6	191.92	55.643	-0.011	0.006
22	Chelgerd	17	13.92	4.039	0.064	0.037
23	Ghaleshahrokh	18	269.83	82.34	0.28	0.214
24	Gabrabad	15	1.37	1.096	0.857	0.723
25	Ghamsar	15	0.53	0.337	0.644	0.457
26	Pol Hanjen	10	0.7	0.613	0.702	0.534
27	Hastijan	9	3.75	2.111	0.334	0.142
Regional average linear moment ratios			1.000	0.401	0.354	0.2451

Table3. *Estimated instantaneous water flow rates of stations and area in the period under review (m^3/s)*

Station number	Probability									
	0.1	0.2	0.5	0.8	0.9	0.95	0.98	0.99	0.999	0.9999
1	15.91	22.8	41.86	103.76	136.97	19.65	240.62	240.62	491.06	954.34
2	77.44	110.96	203.72	505.01	666.66	927.91	1171.13	1171.13	2390.06	3444.88
3	27.63	39.6	72.7	180.21	237.89	331.12	417.91	417.91	852.88	1657.5
4	298.16	427.23	784.36	1944.4	2566.77	3572.66	4509.1	4509.1	9202.23	17883.8

5	3.19	4.57	8.39	20.8	27.46	38.22	48.24	48.24	98.45	191.34
6	258.13	369.88	679.07	1683.38	2222.22	3093.07	3903.8	3903.8	7966.94	15483.1
7	197.12	282.46	518.57	1285.5	1696.97	2362	2981.1	2981.1	6083.88	11823.5
8	13.39	19.19	35.23	87.33	115.28	160.46	202.52	202.52	413.31	803.23
9	78.92	113.09	207.62	514.67	679.41	945.67	1193.54	1193.54	2435.79	4733.76
10	324.85	465.48	854.58	2117.46	2796.55	3892.49	4912.76	4912.76	10026	19484.8
11	3.12	4047	8.2	20.32	26.83	37.34	47.13	47.13	96.18	168.91
12	2.17	3.11	5.71	14.14	18.67	25.99	32.8	32.8	66.93	130.08
13	3.76	5.39	9.89	24.52	32.37	45.06	56.87	56.87	116.05	225.54
14	9.45	13.54	24.85	61.61	81.33	113.21	142.88	142.88	291.59	566.69
15	1.93	2.76	5.07	12.56	16.58	23.08	29.13	29.13	59.47	115.55
16	36.84	52.79	96.92	240.25	117.15	441.44	557.14	557.14	1137.03	2209.72
17	18.87	27.03	49.63	123.03	162.41	226.06	285.31	285.31	582.26	1131.58
18	15.64	22.42	41.15	102.02	134.67	187.45	236.59	236.59	482.83	938.33
19	34.15	48.94	89.85	222.74	294.03	409.26	516.53	516.53	1054.14	2048.63
20	5.65	8.1	14.86	36.85	48.64	67.7	85.45	85.45	174.38	338.9
21	56.13	80.43	147.66	366.05	483.22	672.59	848.88	848.88	1732.41	3366.8
22	4.07	5.83	10.71	26.54	35.04	48.77	61.56	61.56	125.62	244.14
23	78.92	113.09	207.62	514.67	679.4	945.66	1193.52	1193.52	2435.76	4733.69
24	0.4	0.57	1.05	2.61	3.44	4.79	6.05	6.05	12.35	24
25	0.16	0.22	0.41	1.02	1.35	1.87	2.36	2.36	4.83	9.38
26	0.2	0.29	0.54	1.34	1.76	2.46	3.1	3.1	6.32	12.29
27	1.1	1.57	2.89	7.16	9.45	13.15	16.6	16.6	33.88	56.84
Area	0.29	0.42	0.77	1.91	2.52	3.5	4.42	4.42	9.03	13.54



Graph1. *Ratio of moment Line for Multi Distribution Statistical Common*

Table4. *Choose the Most Appropriate Distribution for the Stations*

Distribution of	Station
Generalized Pareto	Beheshtabad, Chelgerd, Kata, Barez, Hana, Tang, Zardaloo, Pol Zamankhan
Generalized Logistic	Eskandari, Sad Golpayegan
Normal log three parameters	Gabrabad, Armand, Ghamsar, Pol Hanjen
Generalized extreme values	Zarkesh, Ghale Shahrokh, Morghak, Godar Kabk, Soolegan
Pearson type three	Tang Panj, Lordegan, Marbaran, Sarab Hende, Savaran, Vaneshan
Wakeby	Tang Asfarjan, Mandarjan
Exponential	Hastijan
Uniform	Beheshtabad
Gumbel, Extreme values type one	Tang Panj, Lordegan, Marbaran

Test Goodness of Fit in Order to Determine the Most Appropriate Distribution Function Area

After ensure the homogeneous of the area, choose the most appropriate distribution function to zone done. Method used in the most appropriate distribution is stat-based Z, which by Husking and Wallis defined and previously was described.

The results of the test goodness of fit in table 6 is shown. Equal to the table, respectively distribution logistics generalized, limit values generalized, Pearson type III and generalized Pareto, the most appropriate distribution in the area to estimate the flood known. It should be noted that distributions marked with star sign selected as the appropriate distribution.

Table5. *Test Non-Uniform Stations Case Study*

Station number	Station	Lev	L skew	L kurt	D_i
1	Godar Kabk	16.28	0.367	0.13	0.49
2	Tang Soolegan	175.969	0.598	0.47	1.43
3	Tang Zardaloo	50.013	0.363	0.12	1
4	Barez	386.78	0.135	0.04	3.84
5	Marbaran	1.69	0.191	0.14	0.49
6	Morghak	179.657	0.305	0.22	0.5
7	Armand	233.89	0.438	0.28	1.27
8	Lordegan	10.032	0.379	0.26	0.1
9	Kata	72.361	0.082	0.01	0.63
10	Tang Panj	272.71	0.133	0.12	1.73
11	Hana	2.887	0.253	0.12	0.43
12	Tang Asfarjan	4.349	0.462	0.21	0.83
13	Savaran	7.199	0.537	0.32	0.38
14	Eskandari	13.268	0.477	0.39	0.5
15	Mandarjan	4.953	0.593	0.28	1.42
16	Pol Zamankhan	40.945	0.394	0.21	0.19
17	Sarab Hende	34.234	0.467	0.25	0.37
18	Sad Golpayegan	17.804	0.230	0.29	1.82
19	Tang Darkesh	28.821	0.058	0.12	1.41
20	Vaneshan	16.259	0.608	0.36	0.61
21	Beheshtabad	55.643	-0.011	0.00	1.1
22	Chelgerd	4.039	0.064	0.03	0.95
23	Ghale Shahrokh	82.34	0.280	0.21	0.1
24	Gabrabad	1.093	0.857	0.723	3.09
25	Ghamsar	0.337	0.644	0.457	0.62
26	Pol Hanjen	0.613	0.702	0.534	1.06
27	Hastijan	2.111	0.334	0.142	0.64
Weighted average		87.948	0.359	0.237	-

Table6. *Tests Homogeneity and Goodness of Fit the Stations*

Test Homogeneity
NUMBER OF SIMULATION=500 OBSERVED S.D. OF GROUP L-CV=111.4848 SIM. MEAN OF S.D OF GROUP L-CV=59.2535 SIM. S.D. OF AVE. L-CV/L-SKKEW DISTANCE=95.3109 STAND ARDIZED TEST VALUE, H 1=0.25 OBSERVED AVE. OF L-CV/L-SKEW DISTANCE=90.7641 SIM. MEAN OF AVE. L-CV/L-SKKEW DISTANCE=27.5529 STANDARDAZED TEST VALU H2= 0.66 OBSERVED AVE. OF L-CV/L-SKEW DISTANCE=0.1941 SIM. MEAN OF AVE. L-CV/L-SKKEW DISTANCE=0.1668 SIM. S.D. OF AVE. L-SKEW/L-KURT DISTANCE=0.240 STAND ARDIZED TEST VALUE, H 3= 1.14
Test Fitness
GEN.LOGISTIC L-KURTOSIS= 0.274 Z VALUE= 0.44 GEN. EXTREME VALUE L-KURTOSIS= 0.253 GEN NORMAL L-KURTOSIS= 0.225 PEARSON TYPE III L-KURTOSIS=0.176 GEN. PARETO L-KURTOSIS=0.188

Estimated Water Flow Rates of the Region Based on Selected Distributions

The last step in the regional flood analysis is to estimate the water flow rates with different alternatives in the area under study. Table 7 for generalized logistic distributions shows generalized limit values, generalized normal values, and shows the estimated values of discharge in different return periods. Also, the regional parameters of selected distributions are determined by linear moment method (Table 8).

Suggestions

As stated above, the linear moment ratios of the sample, that is, the coefficient of variation, skewness, and elongation of the distribution, are obtained by using the proposed Husking and Wallis method. The average skewness and linear elongation coefficients of the region are 0.389 and 0.237, respectively.

Given that these coefficients are not large; it can be concluded that the distribution of the region's alternate does not necessarily have much toughness. Also, the problem of data fluctuations in the current statistical period is very difficult. In the proposed Husking and Wallis method, factor D_i is used. This factor is based on sample linear moment ratios (Lev, L skew, L kurt). According to the definition, if operating D_i in a station is more than 3, that station is inconsistent with other stations.

Thus, there are stations Barez and Gabrabad, three stations Hanjen, Hastijan and Ghamsar with climate and ecological similar. So, this is expected that all four station should have similar situations in terms of hydrologic, while the test heterogeneity results contrary to the show. Thus, appears that the proposed operating D_i to study dissonance study area is not effective. The one hand, for table 4, the most appropriate distribution probabilistic station Hastijan is exponential distribution. While at stations Ghamsar, Hanjen and Gabrabad, the most suitable distribution is the normal three-parameter logarithm. As a result, it's a verdict that the four stations are homogeneous and are eligible for regional flood analysis is difficult, especially since these four stations are in the dry climate zone, and alongside the boiler stations located in the semi-arid to semi-humid climate zone, they are used in the regional flood analysis.

The degree of homogeneity within a group of stations by the H homogeneity criterion, proposed by Husking and Wallis, is achieved.

Basically criteria heterogeneity changes between the station in the moment linear sample reviews, what an area homogeneous expected, compare does. Changes between the station expected of simulation Monte Carlo on the distribution of the four-parametric Kappa obtained.

Table7. *Distribution of selected and estimated parameters water flow for courses different return*

Return period	2	10	20	100	1000
GL	47.75	187.89	320.81	777.73	2.99.61
GEV	50.19	199.31	334.36	759.531	1801.77
WAK	55.95	226.6	356.52	678.73	1194.3

Table8. *The selected distributions estimated regional parameters*

Distribution	**Parameter**				
GL	-47.751	70.438	-0.359	-	-
GEV	-85.453	91.428	-0.275	-	-
WAK	-169.8	0	0	161.134	0.057

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