DOMINANT DISCHARGE IN THE KOR RIVER, FARS PROVINCE, IRAN

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ABSTRACT

Estimation of the frequency of dominant discharge in the rivers is necessary for flood plain management. The determination of the dominant discharge is also very important for flood mitigation and estimation of flood damage. In this study the frequency of dominant discharge of the Kor River in the Fars Province is investigated and the rate of flow for dominant discharge was also determined. The flood discharge of 36 years at ChamRiz station, upstream the Doroodzan dam was collected and analyzed. The flood frequency analysis was used to find the ARI of the dominant discharge in the Kor River, upstream Doroodzan Dam. It was found that the dominant discharge in the Kor River at the above station has an ARI of 1.11 years on partial series analysis. The dominant discharge was found to be 552.75 cubic meter per second for the Kor River, upstream Doroodzan Dam.

Keywords: Dominant discharge, Kor River, Doroodzan Dam, Iran

INTRODUCTION

Determining the dominant discharge is very important for sedimentation problem in the river and it is very useful for river stabilization. The dominant discharge is a discharge which forms the river shape and morphology. It is also very important for the riverine stabilization and fish habitats. Despite the importance of the dominant discharge, it is not yet completely determined for the existing rivers. Inglis [1] defined that the dominant discharge in a natural stream is a discharge, representative of a whole range of discharges that pass through the channel and that forms the channel morphology. The dominant discharge is usually defined as; i) the most effective discharge for sediment transport. Benson and Thomas [2] defined that the dominant discharge is the discharge which transports the most sediment transport in suspended load. Pickup and Warner [3] defined the dominant discharge as the discharge that transports the sediment particles as the bed load. Andrew [4] defined the dominant discharge as the discharge which transports the most sediment particles as total load. ii) The natural bankfull discharge or the discharge in a river which just fills the main channel and not overbanking the flood plains. iii) The dominant discharge is also defined as the discharge or a flood of fixed frequency such as 1-2 years flood and iv) it is defined as the discharge which exhibits the best statistical correlation with various channel morphological characteristics.

Dominant discharge was also studied by many researchers; for example, Williams [5] found that the dominant discharge is a bankfull discharge of approximately 1.5 years. Keshavarzi and Erskine [6] and Erskine and Keshavarzy [7] investigated that the dominant discharge on South Creek in New South Wales, in Australia has an average recurrence interval (ARI) of 1.89 to 2.40 years on the partial series. Valentine and et al. [8] studied regime theory and the stability of straight channels with bankfull.

In this research paper, the frequency of dominant discharge of Kor River in the upstream part of Doroodzan Dam was determined using 36 years of recorded flood discharge. The stage discharge curve and meander wavelength method were also used to find the dominant discharge.

MATERIAL AND METHODS

Study site

The Kor River valley is one of the most important rivers in Fars with a catchments basin area of 9650 km^2 which to branch off from elevation Palangy and Baraftab mountains and it drains the Konfiroz, Ramjrd and Karbal plains and finally enters into the Bakhtegan Lake. An aerial view of the Kor River upstream Doroodzan Dam is shown in Figure 1. It is significant for urban water supply and agricultural purposes.

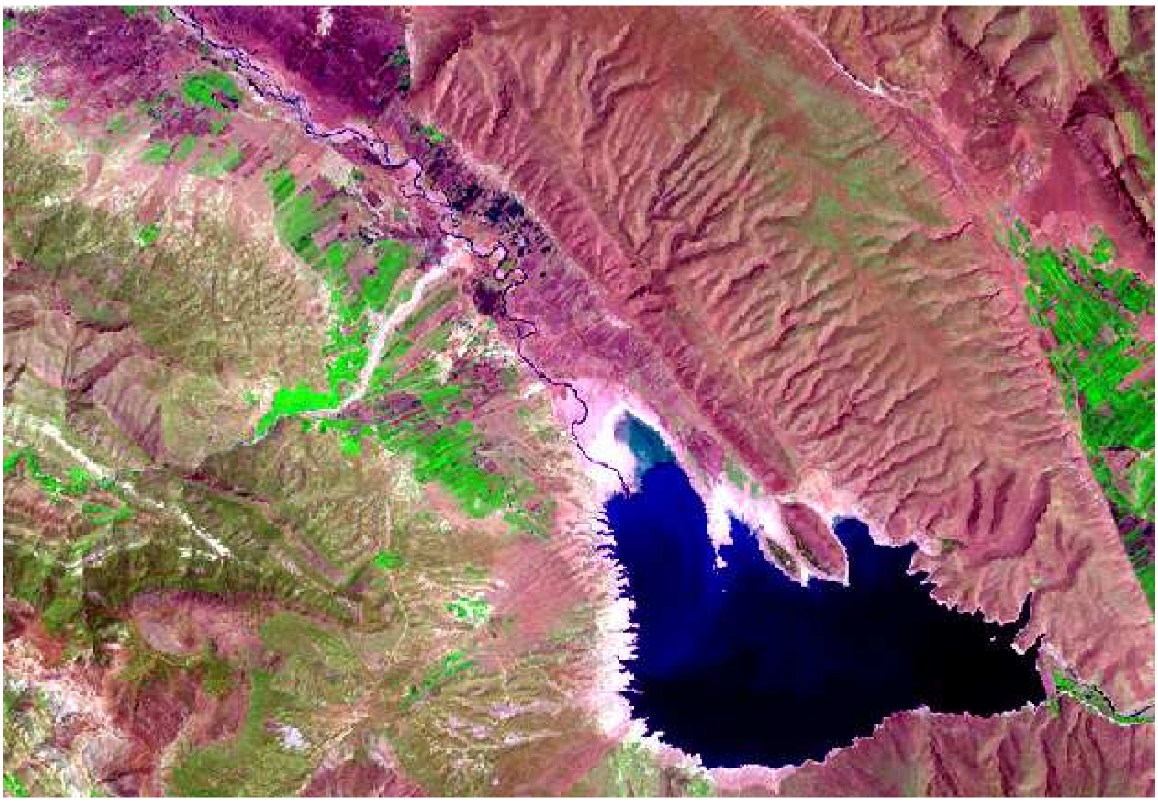

Figure 1: Aerial View of the Kor River

The flood frequency analysis was applied to the 36 flood data at ChamRiz station, upstream Doroodzan Dam. The stage discharge curve of flood discharge at the above station was also used to find the bankfull discharge. The bankfull stage is that discharge which just fills the channel without overtopping the banks and inundating the flood plain at the specified location. While a number objective definition of bankfull have been proposed (Riley [9]), they are no more reliable than subjectively determined assessments (Williams, [5]). Thus, in this study a definition of the dominant discharge is used. It is defined as the discharge at which the rating curve exhibits an abrupt flattening of slope. The Dury's method [10] for definition for the dominant discharge using meander wavelength was also used. Wavelength meanders were measured on 1:25000 topographic maps.

RESULTS AND DISCUSSION

1. Stage – discharge curve

As mentioned previously, a definition of dominant discharge was equal to the bankfull discharge and in the stage discharge curve is the point at which the rating curve exhibits an abrupt flattening in slope.

Knight and Demetriou [11] concluded that there is a linear relationship for the in-bank flow and out-bank flow. It is represented in equation (1) with a hinge point at the bank full level.

$$\log H = \gamma . \log Q + \delta \tag{1}$$

where γ and δ=constants whose values are determined by linear regression, H= depth (mm) and Q = discharge (l/s)

Sellin [12] has discussed that the presence of some interactions along the vertical interface between the shallow and deep sections which results in the transfer of linear momentum between the main channel and the flood plain. Bankfull discharge can be derived from the point of abrupt change in the rating curve. The slope of the rating curve just for channel flow is steeper than that for channel and overbank flow.

From the rating curve in logarithmic scale for Kor River at ChamRiz station, upstream Doroodzan Dam, the flow for bankfull level was found to be 552.75 m^3/s. It is shown in Figure 2.

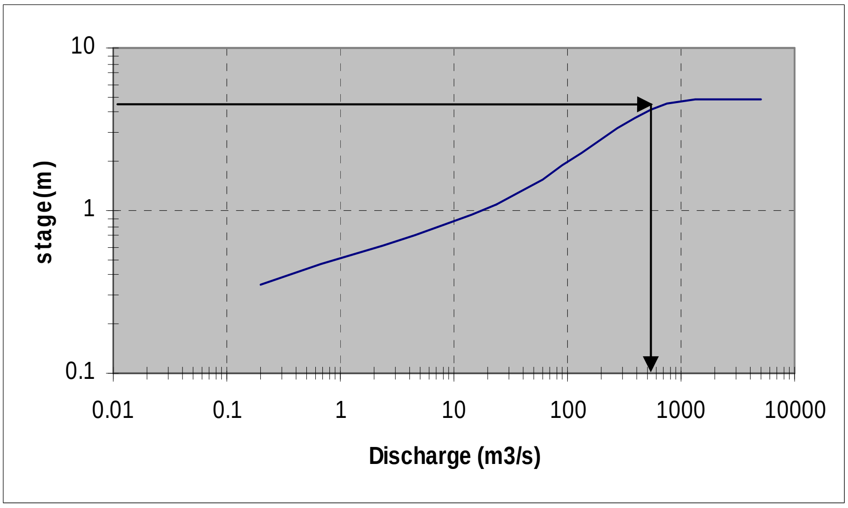

Figure 2: Rating Curve for Kor River at ChamRiz station

2. Meander wavelength

Meander wavelength varies with the square root of bankfull discharge and any empirical relationship between wavelength (L) and bankfull discharge (Q_{bf}) may be statistical rather than causal (Dury, [10]). Wolman and Leopold [13] concluded that bed width is determined directly by discharge, whereas wavelength depends directly on width and thus only indirectly on discharge. Then;

$$L = K.q^{b} \tag{2}$$

Where L= meander wavelength, q = dominant discharge, K = coefficient and b is the exponent. The above parameters are in FPS unit.

Inglis [1] found a relationship between width (W) and discharge (q):

$$L = 36q^{0.5} \tag{3}$$

Dury [10] used a very large data set and found that

$$L = 30q^{0.5} \tag{4}$$

The above relationship was applied to the meander wavelength in the Kor River. Wavelength meanders were measured on 1:25000 topographic maps.

The numbers of recognized meanders (n) were found to be 19 and the average meander wavelength (L) was 1271.053 meters (Table 1). Therefore, bankfull discharge calculated by the Dury's method (equation 3) is found to be about 547.141 m^3/s. This discharge agrees closely with the discharge which was determined from stage discharge curve.

Table 1 - Number and meander wavelength

Number	Meander(m)
1	2100
2	900
3	1350
4	2300
5	1600
6	1200
7	1550
8	800
9	900
10	1200
11	1750
12	850
13	800
14	900
15	1600
16	1200
17	900
18	1050
19	1200

3. Flood frequency analysis

Wolman and Leopold [13] recommended that bankfull discharge has an Average Recurrence Interval (ARI) of 1-2 years ($Q_{bf} = Q_{1\text{-}2years}$) on the annual series. Dury [10] suggested that bankfull discharge is a discharge with ARI of 1.58 years or $Q_{bf} = 0.97Q_{1.58}$.

If the annual maximum flood series confirms to the theory of extreme values, the mean annual flood has a return period of 2.33 years and the most probable annul flood has a return period of 1.58 years (Pickup and Warner [3]).

In this study, the partial series was selected for flood frequency analysis the maximum peak discharge per month was considered. The number of floods (K) normally differs from the number of years of record (N) and depends on the selected threshold flood. The variable (K) is assumed to be equal to (2N) (Pillgrim and Doran [14]) As a result, in this paper, the 38 largest floods during the 38 years were selected. Therefore the 76 largest floods were selected for the flood frequency analysis in this study.

Flood frequency analysis is a statistical method for analysis of recorded floods. It can estimate annual exceedance probability from the peak instantaneous discharge. Flood frequency analysis may be done analytically or graphically.

For the analytical method a probability distribution is fitted mathematically to the recorded data. For the graphical method the recorded data is plotted on appropriate probability paper and a frequency curve is drawn. Here the following probability distributions were used to determine of best probability frequency to the data.

1- distribution Normal
2- distribution Log normal
  2-1- distribution Log normal (2 parameter)
  2-2- distribution Log normal (3 parameter)
3- distribution Pearson Type III
4- distribution Log Pearson Type III
5- distribution Gumbel Extremal Type I

The root mean square error with equation is compute using

$$RMSE = \left[\frac{1}{n}\sum_{i=1}^{i=n}\left(M_i - S_i\right)^2\right]^{0.5} \times \frac{100}{\overline{M}} \qquad (5)$$

Where $RMSE$ is the Root Mean Square Error, M_i is the discharge measurement, S_i is the discharge of output model, $\overline{M}$ is mean discharge measurement and n is the number of years. The Root Mean Square Error for all distributions is shown in Table 2. With the comparison of the errors it was found that the best fitted frequency distribution to the data was log-Pearson. Therefore, the annual exceedance probability (AEP) of dominant discharge in Kor River was found using log-Pearson III.

Table 2 - Root Mean Square Error for all distributions

Number	Type of Distribution	RMSE
1	Normal	13.44635
2	2 parameter Log normal	7.720215
3	3 parameter Log normal	8.400560
4	Pearson Type III	6.974963
5	Log Pearson Type III	6.550569
6	Gumbel Extremal Type I	8.116070

The log-Pearson III distribution is shown in figure 3. The annual exceedance probability (AEP) is inversely related to the average recurrence interval (ARI). Table 3 shows both AEP and ARI of bankfull discharge for the 547 m^3/s.for all distributions. The AEP’s for the bankfull discharge were derived from flood frequency curves with five distributions and six methods and the results are shown in Table 3.

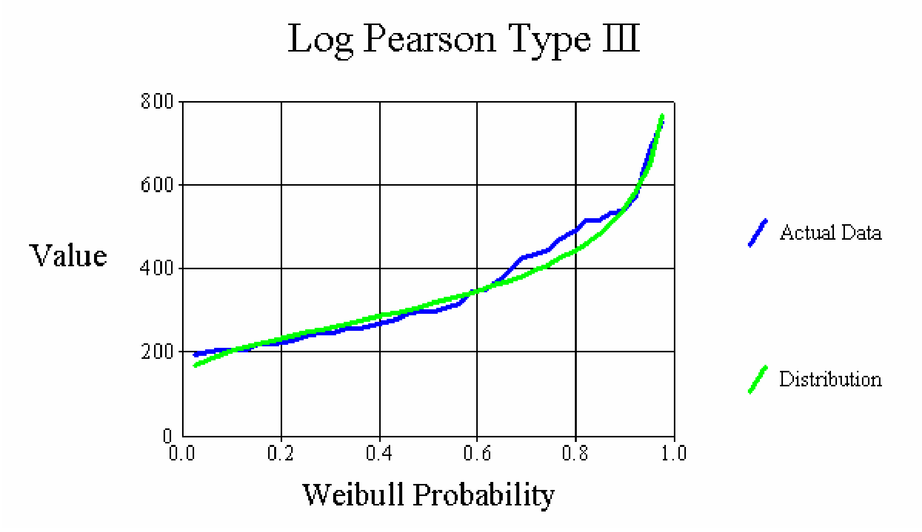

Figure 3: Flood frequency analysis

Table 3 - Results of flood frequency analysis with some distribution

Number	Type of Distribution	AEP	ARI(years)
1	Normal	0.92	1.087
2	2 parameter Log normal	0.9	1.111
3	3 parameter Log normal	0.9	1.111
4	Pearson Type III	0.93	1.075
5	Log Pearson Type III	0.88	1.136
6	Gumbel Extremal Type I	0.91	1.099

Also average recurrence interval (ARI) was computed using:

$$T = \frac{1}{P} \tag{6}$$

where T is average recurrence interval and P is annual exceedance probability.

From the rating curve the value of bankfull discharge is found to be 552.75(m^3/s). This agrees closely with the characteristic discharge which is determined from meander wavelength (547.141 m^3/s). Therefore the ARI of dominant discharge for the Kor River upstream Doroodzan Dam was found from the log-Pearson III distribution and it was 1.11 years.

CONCLUSION

In this study, the characteristic discharge and rating curve methods were used to determine bankfull and dominant discharge in the Kor River upstream Doroodzan Dam Fars Province, Iran. It was found that the dominant discharge of Kor River at Chanriz station was 547.141 m^3/s with an ARI of 1.11 year.

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