Flood estimation for Zhabay River Basin in Akmola region

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Flood estimation for Zhabay River Basin in Akmola region

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Abstract. The aim of the study is to carry out the flood frequency analysis of the Zhabay River Basin in the Akmola region. Powell probability distribution was employed for simulating the future flood discharge scenarios using annual peak flow data (2011–2018) from the gauging station of the Zhabay River. The predicted design floods of various return periods (T) i.e., 2, 2.33, 5, 10, 20, 50, 100, 200, 250, 500 and 1000 were obtained.

1. Introduction

Floods are natural hazards causing loss of life, damage to agricultural lands, injury and major property losses [1]. Flood frequency analysis (FFA) is the estimation of how often specified flood events will occur. Before the estimation can be done, analyzing the stream or river flow data is important in order to obtain the probability distribution of flood [2]. There are different methods for flood estimations such as Gumbel's distribution, Powell distribution, generalized Extreme Value, Log-Normal, and Log Pearson Type III distributions [3-9]. Another method for predicting and modeling of flood and inundation is to use image data and digital terrain modules and simulation based on digital terrain models [10].

The aim of this study is to analyze the flood peak for the Zhabay river basin in the Akmola region using 8 years of peak flow data by applying Powell distribution. We predict floods of various return periods (T) i.e., 2, 2.33, 5, 10, 20, 50, 100, 200, 250, 500 and 1000.

2. Study Area

Zhabay is a river in Kazakhstan, the right tributary of Ishim [11]. The length of the river is 196 km. The catchment area is 8800 km^2. The river flows through the territory of the Sandyktau and Atbasarsky districts has 14 tributaries. The height of the gauge is 266 m above sea level. Map of study area is presented in Figure 1.

3. Data collection

The data related to the study, annually peak flow data of the Zhabay river basin in Akmola region, was presented by RSE "Kazhydromet" of the Ministry of Energy of the Republic of Kazakhstan and was collected from years 2011 to 2018. The values of the flood data for 8 years are presented in Table 1.

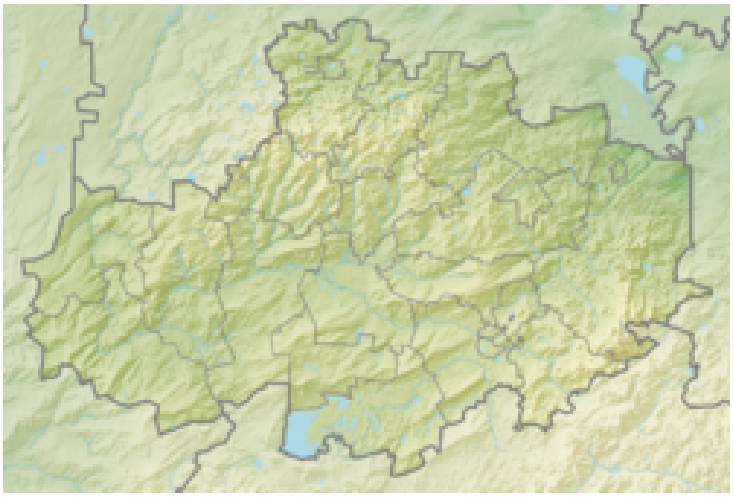

Figure 1: Study Area [11]

Table 1: Observed floods in corresponding years

Year	Peak flood in m^3/s
2011	202
2012	246
2013	194
2014	1750
2015	80,9
2016	623
2017	3290
2018	154

4. Powell Distribution

We use Powell distribution to estimate flood for the Zhabay river basin in Akmola region. As per this method, the magnitude of the flood with the return period of T and the frequency factor K is given by

$$Q_T = Q_{mean} + K\sigma, \quad (1)$$

$$K = \sqrt{6}/\pi(\lambda + \ln\ln(T/T-1)), \quad (2)$$

where T is return period, σ is standard deviation, K is frequency factor, λ is Euler's constant that is 0.57722, Q_T is magnitude of the flood with return period T, Q_{mean} is mean value.

In Powell method values of K does not depend upon the number of years of record and are given in Table 2.

5. Results

Powell distribution is applied to carry out the flood frequency analysis of the Zhabay river using 8 years annually peak flow data (2011-2018). The maximum flow of 3290 m^3/s was recorded in 2017 while the lowest flood flow of 80,9 m^3/s was recorded in 2015. The 8 years mean flood flow (Q_{mean}) is 817.4875 m^3/s, standard deviation σ is 1094. The result of calculation by Powell distribution is given below in Table 3 and Figure 2.

Table 2: Variation of K based on return period

T	K
2	-0.1642
2.33	0.0000
5	+0.7195
10	+1.3046
20	+1.8659
50	+2.5924
100	+3.1368
200	+3.6792
250	+3.8536
500	+4.3949
1000	+4.9357

Table 3: Flood estimation using Powell distribution

T (year)	Q_T from Eq.(1)
2	638
2.33	819
5	1605
10	2245
20	2860
50	3655
100	4251
200	4844
250	5035
500	5628
1000	6220

Based on the Powell method, the important parameters needed for the analysis were presented in Table 1 and Table 2 while Table 3 shows the various expected flood alongside their return periods. The results from the table shows that the expected flood discharge for return periods of 2yrs, 2.33 yrs, 5yrs, 10yrs, 20yrs, 50yrs, 100yrs, 200yrs, 250yrs, 500yrs and 1000yrs are 638 m^3/s, 819 m^3/s, 1605 m^3/s, 2245 m^3/s, 2860 m^3/s, 3655 m^3/s, 4251 m^3/s, 4844 m^3/s, 5035 m^3/s, 5628 m^3/s, and 6220 m^3/s respectively.

6. Conclusion

In this paper, we presnt a flood frequency analysis of the Zhabay river basin in Akmola region using annual peak flow in the years 2011-2018 (Table 1). Table 2 gives determined values of flood frequency factor K. Peak flood magnitudes for 2, 2.33, 5, 10, 20, 50, 100, 200, 250, 500 and 1000 years return period were estimated using Powell distribution (Table 3).

Acknowledgments

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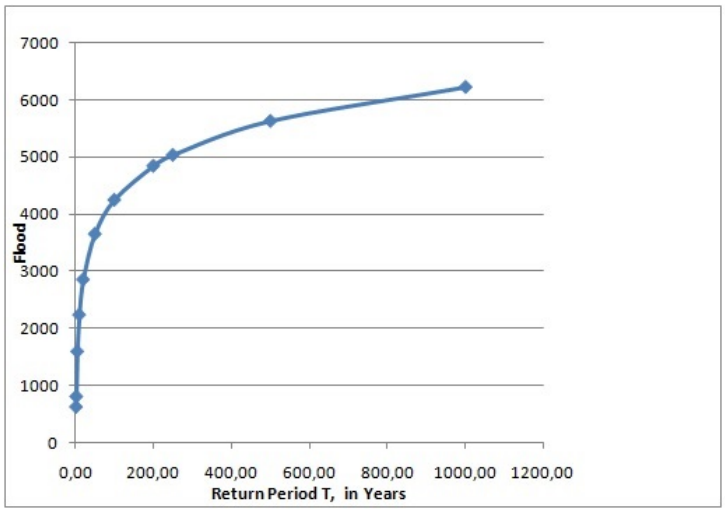

Figure 2: Plot of expected flood in the Zhabay River for different return period

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