

HYDROLOGICAL RISK IN DANUBE REGION IN BULGARIA

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Abstract

This paper presents the parameters of flood waves of watershed in Danube region. It contains an analysis of monthly and seasonal frequency of the flood waves, continuation, volume and shape of flood waves and also provides information about flood discharge including absolute maximum discharge of flood waves in the specific conditions of the mountains watershed.

Key words: Danube, hydrological risk, large waves, flood

Introduction

Typical elements of the river regime in the Danube region are flood waves, which are considered a hydrological risk. This paper investigates the spatial and time parameters of the flood waves in the Danube region. On the focus are represented territorial regularities, regional characteristics and local specificity of the frequency and the duration of the increases in water level.

Study area

The Danube region embraces the bigger part of Northern Bulgaria. This region is divided in the following river valleys: Ogosta river and the rivers western from Ogosta -Topolovec, Voinishka, Archar, Skomlja, Lom, Tsibritsa, and the rivers Erma and Nishava; Iskur; Vit; Osum; Jantra; Rusenski Lom and rivers in Doubrudza. Annually around $6\,017,0 \cdot 10^6 \text{ m}^3$ water resources are formed in this region, which is 31 % of the whole water resources (Hristova, 2005). Around 22 million m^3 of the waters in the region are transferred in the West Aegean basin. The regime of the rivers is Mildness-continental type (Hristova, 2003) are with spring high water, summer-autumn low water and transitional water during winter. The high water begins from February (March) till June (July). The low water is from July (August) until October. The transitional water includes the period November-December or November-February. There are two types below. The first type below is described with equal duration of the high water, the low water and the transitional water, each lasting four months. The characteristics of the second type below are high water, which last five months, short low water and transitional water from November till February.

Materials

This investigation is based on the data received from 92 hydrometeorological stations in the investigated region. The calculated period is from 1950 to 1980. The initial data for the investigation are the dates of the appearance of flood waves, volume of the flood waves and the duration of the raising and the fall of the flood waves. In this paper are presented only a part of the results, due to the large volume of the data sheets.

Methods

This investigation is based on the standard statistical and hydrological methods. The frequency of the appearance of flood waves is presented in relative units, because the number of the flood waves for the calculated period is different during the same time period. The average durability of the flood waves, as well as the duration of their raisings and fall (in hours), have been calculated with the standard statistical procedures. This investigation includes also the chronological analyse of the flood waves.

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Results

Flood waves in the river basins from the Danube region appear in all months (tabl.1). Flood waves are most frequent in the spring hydrological season (March-June). In about 2/3 of all investigated basins, flood waves have their biggest share in the months – May and June, which is the after-effect of the precipitation maximum. The biggest relative frequency in May is between 16 (Jantra – Radanovo, Jantra – Gabrovo, Kamenica, Rusenski Lom, Lefedza) and 40 % (Malyk Iskyr – Svoge, Rosica, Stakevska river). The highest stability shows distribution of flood waves in the mountain regions. In May-June is observed the increase of frequency of appearance of the flood waves with the rise of altitude.

In geographical aspect is observed one more specificity – with the highest number of flood waves in May are the river basins located in the western and central part of the investigated region. For the basins of the rivers Jantra and Rusenski Lom more typical is the occurrence of flood waves in June. With the highest frequency of flood waves within the borders of the spring hydrological season, but in the March and April are the basins of rivers Erma, Nishava, Topolovec, Wojnishka River, Lom, Cibrica and Ogosta (att. 1). The maximum frequency varies between 15 and 35 %. Flood waves in the spring hydrological season and most often are the part of high water flow. Flood waves in the spring hydrological season are most often part of the high water. Their appearance verifies the fact that high water of the flow in the Danube region is “unpredictable continuation of separate, sudden, not durable, and almost without connection between each other fluctuations of the flow.” (Panajotov, 1972).

The appearance of the flood waves in the winter and summer hydrological seasons is with their lowest frequency. The most typical is the case of appearance of one or two raisings of the flow levels. In some is noticed an equalized frequency of the high waves during the spring months. This case is typical for the rivers Stakevska reka, Martinovska reka, Lesnovska reka, Bybresh, Kamenica, Katunecka, Lefedza and others. Most often flood waves in the winter hydrological season are observed in December and February. They are representative for the basin of river Jantra and especially for her tributaries – Rosica and Lefedza. With comparatively high frequency (19,3 %) are flood waves in February in the river basin of the river Cherni Lom. The highest number of flood waves in the summer-autumn hydrological season occurs in June. They are registered mostly in the mountain basins of rivers Cherni Vit, Beli Vit, Lom, Iskyr and others. In August, September, and October the appearance of flood waves is episodic. Chronological analysis verifies annual occurrence of flood waves in the investigated river basins. Most typical are the cases with the occurrence of one or two waves. In the different years have been registered from 5-6 to 11 cases of flood waves in the rivers – Gradishte (11 flood waves in 1960), Jantra – Veliko Tyrnovo (9 cases in 1960, 7 – in 1956, 6 – in 1965 and 1966 r.), Cherni Vit (8 flood waves in 1956 and 1957), Rosica (7 flood waves in 1957 and 1965), Cherni Lom (10 cases of flood waves in 1966) and etc..

In geographical plan there can be delineated some territories with the simultaneous occurrence of flood waves. For example in the northwest parts of the Danube region fast increases of water level have been registered on the 15th -16th of December 1952., the 16th of December 1955, the 13th -15th of May 1956 , and the 28th - 29th of May 1957. On May 19th , 1970 high waves have been observed in the central part of the investigated territory. There are local cases of flood waves in the basin of river Osym – on the 7th of March 1962, in river Iskyr – on the 5th of July 1970. In the central part of the investigated region flood waves in the same dates have been observed in 1951 (the 7th and the 25th April), 1953 (the 1st of January), 1964 r. (the 24th of September), 1968 (the 21st of August), 1973 (the 11th of April) and others. Simultaneous appearances of flood waves in the eastern part of the Danube region (river Rusenski Lom) have been observed on June 14th and September 27th 1964.

The duration of the flood waves depends of their origin, condition of the transform system (stages of moisture, forestation, inclination and others) and the hydrological features of the river basins (form, symmetrics and others). Flood waves with snow origin as a rule are with higher duration, as the one with rain origin are with shorter durations. Forestation facilitates the process of snow-melting and increases the duration of high water levels and vice versa – aforested slopes accelerate surface flow and respectively decrease duration. The variety of combinations of the indicated conditions are expressed in the big differences between the durability of the flood waves during the years for each basin and in neighboring basins in the simultaneous events of snow-

melting and rain fall. The average durability of the flood waves in the Danube region fluctuates in wide ranges - from 26 hours for river Rusenski Lom – Razgrad to 179 hours (7 days) for river Iskyr-Oriahovica. The highest average duration – above 150 hours, are flood waves in the river basins in Beli Iskyr and Iskyr-Oriahovica. The average durability above 100 hours is the flood waves in the basins of the rivers Ogosta, Skyt-Mizia, Iskyr-lower parts, Lefedza. The lowest durability (from 20 to 50 hours) are the flood waves in the basins of the rivers Rusenski Lom, Nishava, Belica, Cherni Lom. The wide range on which oscillates the lowest and highest durability of the flood waves is a strong indicator of the variety of combination between climate conditions and morphological characteristics in the river basins.

The average durability of the flood waves is between 11 hours (Rusenski Lom – Razgrad) and 52 hours (Iskyr- Oriahovica). Most often is between 20 and 30 hours for most rivers. Average duration of the decrease is between 15 (Rusenski Lom) – 127 hours (river Iskyr- Oriahovica) and is typical for flood waves.

There is a big variety in the duration of flood waves for different time intervals. The frequency of flood waves with different durability varies from 24 hours (1 day) to 268 hours (13 days). The shortest are flood waves in the small river basins – Cherni Lom (100 % of the flood waves cases), Nishava (66 %), Chiprovska river (60 %), Balica (65 %), Kamenica (59 %), Katunecka river (58 %), Archar (52 %), Ostrecka river (50 %), as well as in the dobrudja rivers - Caracar (100 %), Senkovicica (87 %), Kanagiol (74 %), Sucha reka (72 %).

The highest is the number of cases of durability of flood waves from 96 hours or 3-4 days. It is typical for the basins of the rivers Dzulunica (100 % of all cases of flood waves), Jantra–Karanci (90 %), Lom – Trajkovo (79 %), Osym-Lovech (66 %), Cibrica (65 %) and others. For most rivers the flood waves with durability from 3 to 4 days are with frequency between 20 and 40 %.

Flood waves with high durability– 6-7 days, are observed in the lowest parts of the rivers Iskyr and Jantra. Their duration is a reflection of the morphological characteristics of the river basins and outlines one very well marked geographical regularity – increase of the durability of high water levels from the upper to the lower parts of the river basins and from the small to the large river basins.

The cases with the durability of the flood waves from 10-13 days refer to high mountain basins of the rivers Mursalenska Bistrica, Cherni Iskyr and Beli Iskyr and are mainly part of the high water flows, than passing and fast increases of the flow.

Conclusion

Flood waves are characteristic elements in the flow regime of the rivers in the Danube region. They are observed every year and in all months of the hydrological cycle. Flood waves are with the highest frequency in May and June, with general durability from 26 to 179 hours, asymmetrical – with short progress and prolonged fall, and with durability from 1-2 to 3-4 days. In the time parameters of flood waves can be delineated several geographical regularities: In May and June is observed an increase of the frequency of appearance of the flood waves with the rising of the latitude of the rivers basins; The highest amount of flood waves in May are the river basins in the western and central parts of the Danube region; The duration of the flood waves increase from the upper towards the lower part of the river basins and from the small to large river basins.

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Table 1: Frequency and volume of food waves

Rivers	months												Volume of flood waves (m ³)		
	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	W _{min}	W _{average}	W _{max}
Erma - Tran		11,1		16,6	27,7	5,6	5,6	11,1	11,1	5,6		5,6	591	5931,78	17298
Nisava - Boiste						13,3	33,3	33,3	13,3			6,8	64,4	288,23	813
Topolovets - Akatsievo				3,6	39,3	17,9	14,3	7,1	3,6	7,1		7,1	418	7384	11113
Voinishka - Tarnjaje		3,6	3,6	7	32,1	17,9	21,4	3,6	3,6	3,6		3,6	434	3262,75	8107
Vestitska - Vestitsa		4		8	4	16	4	40	20			4	257	1740,12	4239
Barza reka - Gorni Lom		15,6	6,4	3	9,5	9,5	25	12,5	12,5		3	3	163	1389,25	6041
Lom - Gorni Lom		16	4	4	4	16	20	16	16		4		324	4347,48	9988
Ogosta- Chiprovtsi	4	20		8		16	12	24	8		4	4	87,1	1319,76	3324
Ogosta - Mizia		4,7		7	4,7	20,9	23,2	27,9	2,3	2,3	4,7	2,3	14760	73282,4	209880
Dalgodelka Ogosta - Dalgi del		4,6		13,6	13,6	13,6	36,2	4,6	4,6		4,6	4,6	1699	4064	6266
Shirine - Barzia					6,7	13,3	33,3	26,7	13,3		6,7		23,2	647,01	5538
Berkovska-Begovitsa				7,1		14,3	35,8	21,4	21,4				1370	2864,93	4991
Botunja - Stojanovo				12,5	2,5	17,5	25	22,5	10	2,5	7,5		965	15840,33	122760
Skat - Mizia			4,6	4,6	18,1	13,6	13,6	18,1	13,6	4,6	4,6	4,6	418	7827,09	30978
Cherni Iskar - Govedartsi	4,6	4,6					50	27,1		4,6	9,1		1138	4141,59	10474
Iskar - Orjahovitsa		5	2,5	12,5	10	20	22,5	12,5	5	2,5	2,5	5	45144	238436,55	687600
Musalenska Bistritsa - Borovets						4,2	62,4	29,2	4,2				253	2130,5	7642
Beli Vit - Teteven	3,7	2,5	3,7	5	6,2	16,2	20,2	18,8	12,5	3,7	5	2,5	3441	13984,2	43387
Cherni Vit - Cherni Vit	2,9	4,4	4,4	2,9	2,9	11,8	19,2	20,6	17,6	7,3	4,4	1,6	814	6076	23240
Cherni Osam - Stoinovska	1,7	3,4	10,3	3,5	8,6	12,2	19	20,7	10,3	5,2	3,4	1,7	2340	7591,2	21931
Beli Osam - Vasilecska	3,7	2,5	7,4	4,9	4,9	13,8	19,7	22,2	12,3	3,7	3,7	1,2	895	6518	29708
Osam - Sanadinovo	5,9		5,9	5,9	11,8	5,9	17,6	23,5	17,6	5,9			6869	32898	83210
Jantra - Gabrovo	6,1	14,4	16,3	6,1	8,2	16,3	14,3	8,2	2	6,1	2		2858	9785	25135
Jantra - Cholakovtsi		7,1	7,1	10,7	8,3	13,1	19,1	15,5	8,3	3,6	3,6	3,6	2814	26763,36	123804
Lefedza - Slivovitsa	4,2	8,3	8,3	8,3	4,2	16,6	12,5	16,7		12,5	4,2	4,2	2672	20373,96	56530
Veselina - Jovkovtsi		4,8	19,1	9,5	9,5	9,5	9,5	28,5		4,8		4,8	799	7378,05	18900
Rositsa - Vodolei	2,6	2,6	2,6	10,3	2,6	10,3	15,4	33,2	5,1	5,1	5,1	5,1	554	29702,95	148680
Vididma - Sevlievo		3,2	3,2	9,5	9,5	12,7	20,6	20,6	11,1	3,2	4,8	1,6	1876	12645,21	43630
Rusenski Lom - Basarbovo	4,3	4,3	4,3	10,9	10,9	15,3	8,7	15,2	10,9	6,5	6,5	2,2	2047	8746,17	36360
Cherni Lom - Kardam	7	5,3	3,5	19,3	10,5	8,8	7	21,2	1,7	10,5	3,5	1,7	247	3527,26	19470
Cherni Lom - Shirokovo		3,2	3,2	16,3	9,7	6,4	6,4	32,3	3,2	12,9	3,2	3,2	568	6201,87	24975
Tsaratsar - Goljam Porovets				20	6,7		20	26,7	13,2	6,7	6,7		27	416,9	3600
Suha reka - Novo Botevo	3,8	3,8	15,4	15,4	26,9	7,8	3,8	11,5		3,8	7,8		47	1259,36	17712