sciendo Ovidius University Annals Series: Civil Engineering, Year 20, 2018
DOI: 10.2478/ouacsce-2018-0005

Analysis on Variability of Buzau River Monthly Discharges

Cristina Amalia Mocanu -Vargancsik, Alina Barbulescu

***Abstract* – The purpose of this article is analysing the variability of Buzau river monthly mean discharges, maximum and minimum over time and the impact of Siriu Dam on these discharges. Keeping a stable, moderate variability on the water flow has a significant importance, as this assures normality of life and functionality of the dams. On another hand, the dams are in-built with a range of parameters, decided according to this variability of the discharges. The used data has been collected from Nehoiu and Basca Roziliei hydrometric stations and spans on 55 years, from 1st January 1955 to 31st December 2010. Mid-period, on 30th September 1984, Siriu Dam started operating and the results reveal that its impact on the variability has been moderate on a large time scale. Important changes appear on smaller time scale, as months. The results are supported by graphs drawn in Excel and methods embedded by software.**

Keywords – Buzau River, monthly maxim, monthly minim, monthly mean discharges, standard deviation, Siriu Dam

1. INTRODUCTION

The changes of a river flow can be seen only doing an analysis over a long period of time. In this way, can be noticed the impact of the climate changes, hydrological constructions, the human activities, and the appropriate use of the river resources. All lead towards a conclusion affecting the environment and help to take necessary steps for protection, preservation, and good exploitation. The main purpose of the dam construction is the reduction of flow therefore of stream power in order to control flood, to generate power, irrigation, sediment control, industrial and domestic supply. Usually, peaks are reduced. (Higgs and Petts, 1988, apud [1]).

The topic for the monthly mean discharges of Buzau River has been treated in some other papers Chendes (2011), Minea (2011), Minea and Barbulescu, (2014), Barbulescu (2017). In the last two mentioned papers, the same period of time has been divided in before and after the construction of Siriu Dam. To these existing studies, this article adds the variability of monthly extreme values, before and after Siriu Dam construction. Because its late inauguration in 1984 (30th September), the data has been divided in 1955-1984 and 1985-2010.

In Romania, high water levels are characteristic to spring due snow-melting and rains and in autumn due frontal rains. Although may occur any time, floods are most likely in spring and summer, when up to 40%-50% of overall annual floods occur in Romania (***,

ISSN 2392-6139 / ISSN-L 1584-5990

1971). They are short-lived (from few hours to few days), but have spectacular peaks. This is the good reason of seasonal observations of water peaks.

2. EXPERIMENT DESCRIPTION

Our focus is on Buzau River with the drainage area of 5264 km2, lying in a temperate-continental climate, in the Carpathians' Curvature. The study area is shown on Figure 1.

The last 50 years, the mean annual air temperature was about 6°C and the minimum one was about 1°C. In the period 1950-2010, the mean multi-annual average precipitation was between 500 mm and 1000 mm and the maximum precipitation of 130 mm [4], recorded in the period June – July. The local winds that influence the climate are Crivat – a north-easterly during the winter time – and Austru – a south-easterly with dry air during the summer time that warms the winter days [10].

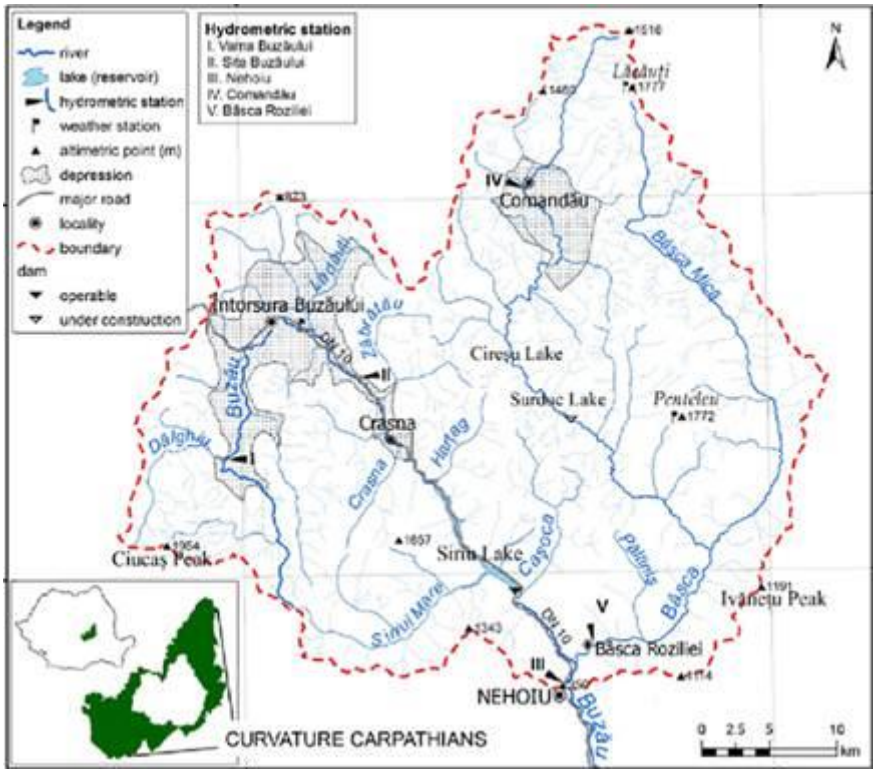

Fig. 1 The upper part of the Buzău River Catchment (Minea and Chendes, 2013)

The series were collected at Nehoiu and Basca Roziliei hydrometric stations (hs). Nehoiu is situated at the latitude of 45°25'29", the longitude of 26°18'27". This station has the following morphometric and hydrological characteristics: river length from the source of 71.5 km, the average slope of the river from the source of 0.73°, the areal area of 1567 km2, the average elevation of the areal at the station of 1043 m, the multi-annual mean of the flow of 21.9 m^3/s, the specific mean of 17 $l/s.km^2$. At Nehoiu station, Buzau river drains

a surface of 1,567 km^2 [8]. Bâsca Roziliei hs is situated on Bâsca River - tributary to Buzau River. Bâsca River flows into Buzau River at a point upstream Nehoiu station, such that Nehoiu hs records the joint flows from Buzau River downstream Siriu Dam and Bâsca River (see Figure 1). Bâsca Roziliei hs is at the latitude of 45°26'32", the longitude of 26°16'38" and it has the following morphometric and hydrological characteristics: the river length from the source to the hydrometric station is 17.1 km, the average slope of the river from the source to the hydrometric station of 1.66°, the basin area associated to the hydrometric station of 107 km2, the average elevation of the basin at the hydrometric station – 1275 m, the average multi-annual fluid flow 2.3 m^3/s; the specific mean 21.5 l/s.km^2 [8].

The hydrological working data have been provided by the National Institute of Hydrology and Water Management Bucharest, Romania and consist in daily mean flow discharges during 01.01.1955 and 31.12.2010. This series has been divided in 01.01.1955-31.12.1984 and 01.01.1985-31.12.2010, corresponding to pre- and post- Siriu Dam construction. The minim of 20 year continuous data measurement is satisfied, as per methodological requirements of hydrological series.

Let us define the deviation of a data as the difference between the actual value and the mean value of the data set.

Monthly deviations of the mean, minim and maxim for Nehoiu hs have been computed. Standard deviations of monthly means, maxim and minim have also been calculated. Computations have been provided for Basca Roziliei hs only for those particular months that have "abnormal" behaviour from the general trend.

3. RESULTS AND SIGNIFICANCES

For Nehoiu hs, the output for each monthly deviations of the mean, minim and maxim have been represented on the same graphs, using different colours: blue for the mean, green for the minim and red for the maxim (Fig. 2 and Fig. 3). On each graph, the red dotted vertical line separates the time line (x-axis) in pre- and post- Siriu Dam construction.

The mean and minim show a small and moderate variability, depending on the season. With no exception and as expected, for all the months, the maxim shows the biggest variation. After 1984, all monthly parameters are diminished in value and their peaks are diminished in number and value. They vary from a month to another due of the pluvial or nival regime.

On a large scale, the influence of the Siriu Dam is obvious.

In order to support the importance of the Siriu Dam, the monthly standard deviation of the mean, minim and maxim before and after the construction of the Siriu Dam and their percentages of changes have been calculated. The results are summarized in Table 1.

To bring more significance, the decreasing percentages are green and the increasing ones are red.

The large majority of the results confirm our statement with significant numbers. March and April – months with seasonal rains – support our statement, as well October, November, December and January. The only two high percentages of increase occur for June in mean and maxim. Smaller increases are noticed in February for the mean and the minim, in May for the minim, and in August for the mean and the minim.

Fig. 2 January to June monthly deviations for mean, minim, maxim

Table 1. Monthly Standard Deviations and Percentages of Changes at Nehoiu

Month	Std. Dev. Before 1984			Std. Dev. After 1984			Percentages of Changes (%)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
January	7.62	3.19	31.41	5.82	2.09	17.76	-23.68	-34.47	-43.46
February	7.23	2.79	31.43	7.43	3.08	17.14	2.77	10.15	-45.47
March	15.48	3.90	67.40	10.77	2.94	49.71	-30.44	-24.65	-26.25
April	22.91	12.25	51.94	19.34	8.49	34.93	-15.61	-30.73	-32.75
May	21.07	6.99	138.54	18.21	7.42	50.63	-13.54	6.14	-63.45
June	12.21	4.56	72.51	19.30	3.21	140.89	58.12	-29.60	94.30
July	20.97	4.25	169.48	14.18	4.11	46.49	-32.40	-3.17	-72.57
August	11.99	3.88	70.23	12.49	4.04	37.41	4.15	4.14	-46.73
September	11.59	3.51	94.43	9.67	2.03	42.92	-16.59	-42.24	-54.55
October	14.20	5.78	57.59	7.83	2.81	26.79	-44.85	-51.37	-53.49
November	9.16	4.79	62.77	6.84	2.28	29.97	-25.38	-52.35	-52.25
December	9.15	3.88	62.35	7.74	2.33	23.77	-15.41	-39.95	-61.87

Fig. 3 July to December monthly deviations for mean, minim, maxim

For these months, the same parameters have been analysed at Basca Roziliei hs. The results are summarized in Table 2. We remark t he same type of changes (increase or decrease) for the same parameters. Moreover, the percentages of increase are much larger than those at Nehoiu hs. These confirm our theory that Siriu Dam attenuates the water flows. June still remains a problematic month. June is the main seasonal flow exhibited by most rivers is the Subcarpathian pluvial regime, in which rains fall, often accompanied by floods, generates high flows.

Table 2. Monthly Standard Deviations and Percentages of Changes at Basca Roziliei

Month	**Std. Dev. Before 1984**			**Std. Dev. After 1984**			**Percentages of Changes (%)**		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
February	2.88	0.98	15.97	3.13	1.44	9.73	8.79	46.59	-39.03
May	12.61	3.88	77.01	12.46	3.99	43.85	-1.19	2.82	-43.06
June	6.56	2.40	45.07	12.53	2.41	100.00	90.92	0.29	121.88
August	6.54	1.74	38.57	6.89	2.29	34.95	5.39	31.54	-9.37

4. CONCLUSION

The dam construction comes with a lot of benefits for flow regulation, flood prevention and area safety. After the studied period, in 2013, in July 2013, the left bank of Basca River required immediate action of soil strengthening because of landslide [9]. Usually seasonal rains cause this problem. As far as known, a small dam has been built on Basca River in order to prevent floods and landslides.

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Note:

Mocanu -Vargancsik Cristina Amalia – Doctoral School, Technical University of Civil Engineering Bucharest, Bd. Tei, 122-124, Bucharest, Romania (corresponding author to provide phone: +40-740-077375; e-mail: cristina_mocanu06@yahoo.com).
Barbulescu Alina - Doctoral School, Technical University of Civil Engineering Bucharest, Bd. Tei, 122-124, Bucharest, Romania (e-mail: alnadumitriu@yahoo.com).