# CHARACTERISTICS OF PERIODS WITH HIGH FLOW ON THE RIVERS FROM CĂLIMAN MOUNTAINS.

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**Abstract. Characteristics of periods with high flow on the rivers from Căliman Mountains.** The Căliman Mountains in the central part of the Eastern Carpathians represent the highest volcanic massif in Romania. The river network is organized on three hydrographic basins (Someş to the west, Mureş to the south and Siret to the east). The work was developed following the processing and interpretation of data from 14 hydrometric stations. The calculation period was 1981-2010. In the characterization of the periods with high flow, the high waters and the floods were analyzed as important phases in the daily regime of the water flow of the rivers. -spatial of some temporal, quantitative and form parameters.

**Keywords:** high flow periods, high water, floods, temporal, quantitative and form parameters, Căliman Mountains.

## 1. INTRODUCTION.

The Căliman Mountains occupy the northwestern part of the central group of the Eastern Carpathians, representing the largest and highest volcanic massif in Romania (2100 m in Pietrosul Călimanilor Peak).

The Căliman Mountains are bordered in the north by obvious depression areas (Colibița and Dornelor), and in the east the limit to the Bistrița Mountains can be traced on the alignment of smaller depressions (Păltiniş, Drăgoiasa, Glodu, Bilbor, Secu). In the south, the limit to the Gurghiu Mountains is clear, being given by the Mureş gorge between Toplița and Deda. In west, the transition to the Transylvanian Depression is sharp and is made through a wide Piedmont step.

In the daytime flow regime, high flow periods can be distinguished, which are maintained for a longer period (high water) or occur in a short period of time and with a high intensity (floods) during the year.

Between these periods, periods with small waters are recorded for fairly long intervals, when the flow rates are kept below the annual average value.

## 2. USED METHODS AND DATA

To identify and characterize the periods of high flow, 14 hydrometric stations were selected from the Căliman Mountains and the bordering region, which were selected four representative stations (Bitricioara, Miţa, Haita and Bistra), as well as the data provided from four meteoological stations and eight rainfall stations. (Fig. 1)

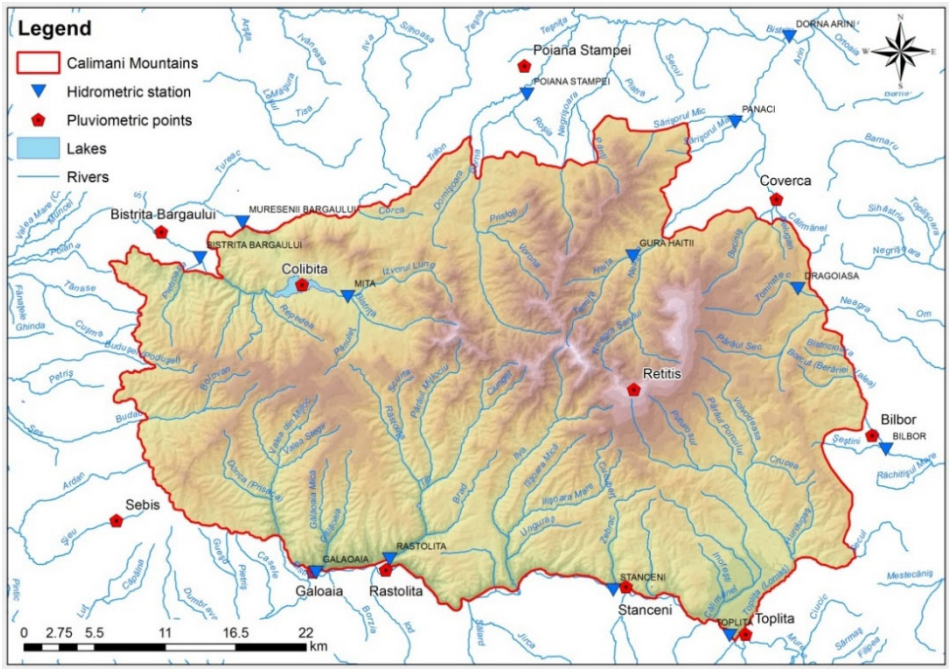


**Fig. 1**. Căliman Mountains hydrometric and pluviometric points

In the analysis, processing and interpretation of the data base and the elaboration of the paper, several methods were used, from case studies, specific to geography (observation, comparison, synthesis, etc.) to modern ones (statistics, mapping and geospatial analysis, etc.), as well as different working techniques based on various programs (Microsoft Excel 2013, CAVIS, HydroOffie, TLM extension).

## 3. RESULTS AND DISCUTIONS

High flow periods are an important phase in the flow regime of rivers, both by their extreme character and by the effects they can have on the components of the environment. The phenomena from the periods of high flow usually occur in the form of impulses with varying intensities, dimensions and durations, which in the water regime of the rivers are manifested in the form of large waters and streams. Knowing the genesis and mechanisms of production of these phenomena offers the possibility of preventing and combating the economic, social and ecological effects it can cause.

Large waters and floods, as component phases of high runoff periods, are generated by rainfall between May - November, snow melt in the cold season or the overlap of the two processes in winter - spring. High flow periods can be characterized by the help of some parameters: temporal (frequency, duration,

manifestation period, probability of exceedance), quantitative (flow rate, volume of drained water) and shape.

### 3.1. High waters.

Large waters represent those phases in which the daily, decadal and even monthly flows are at high values, exceeding the value of the average annual flow. They are characterized by slow increases and decreases in river level and flow. Often, large waters are accompanied by floods, which makes it very difficult to distinguish between periods only with large waters and those only with floods. Large waters are the least commonly encountered in the high mountain sector, where these phenomena rarely occur. The number of cases is increasing in the lower sector from the periphery of the Căliman Mountains.

The periods with high water have a high frequency in spring and summer when the climatic conditions of their formation are most favorable, printing a regularity in their occurrence. They represent the faithful mirror of the process of despair, which usually begins in the second decade of April in the western and southern parts of the Căliman Mountains. In the higher part of the north and east, the process of forming large spring waters is delayed, on average, from the third decade of April to the first decade of May. On the rivers from the Vetica and Szdică rivers, large waters appear more frequently in spring, and those in the north and east appear frequently in summer.

Under special climatic conditions (long frontal rainfall, the period of high water from the western rivers of the Călimanse Mountains extends until the second decade of May. The large spring waters occur more frequently with two waves, less with one. The first increase is more reduced and generated, usually, by the melting of the snow, and the second, higher, has nivopluvial genesis.

The great waters from the beginning of summer are generated by the frontal rains. In the autumn, the big waters appear very rarely, being generated by the frontal precipitations of October - November

In winter, the great waters are completely absent, being indicated only by some rivers from the bleak side of the Căliman Mountains.

### 3.2. Floods

Regarding the genesis of the floods, on most rivers the maximum frequency belongs to those of mixed and pluvial origin

Floods have a number of characteristics, from which a part is measured (maximum or peak flow) or calculated (frequency, duration, shape). The characteristics of the floods can be analyzed with the help of temporal, quantitative, and shape parameters.

Temporal parameters of the most commonly used floods are frequency (monthly and seasonal) and total duration (increasing and decreasing)

Frequency of the production of floods. On the rivers in the west and south of the Căliman Mountains the monthly frequency of the production of vitrines presents a maximum in April (between 20 and 29% of the total number of selected floods (Fig. 1). On the Topliţ River, the frequency of April presents percentage values identical to those of June (Fig. 2)

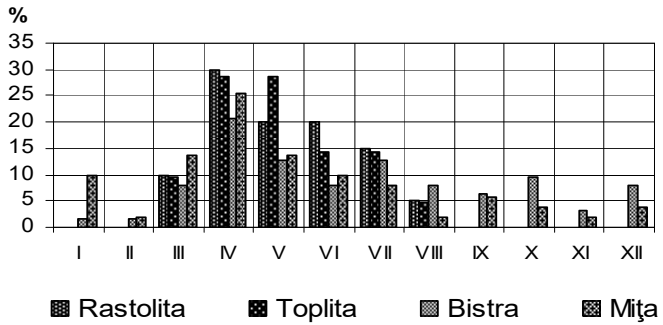


**Fig.2.** Monthly frequency of floods appearance on the rivers from the west and south of Căliman Mountains

On the rivers in the north of the Căliman Mountains, the monthly frequency of production of floods presents a maximum in June (between 20 and 27% of the total number of selected floods) (Fig. 3), and on the eastern ones the maximum frequency occurs in July. (Fig. 4).

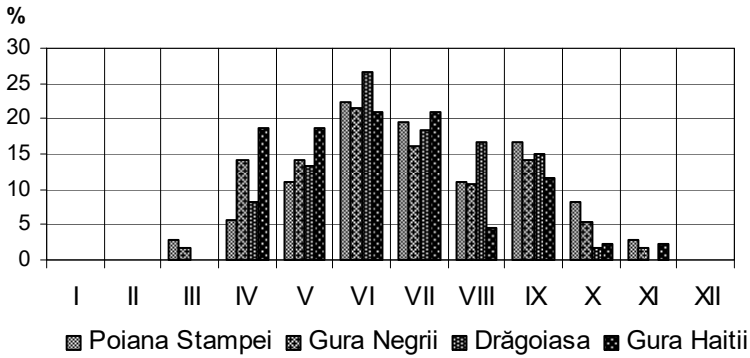


**Fig.3**. Monthly frequency of floods appearance on the rivers from the north of Căliman Mountains

At the Gura Haitii hydrometric station, the frequency in June presents the same percentage values as in July (Fig. 3)

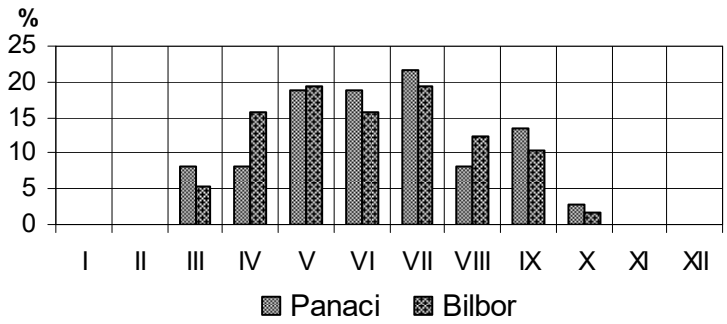


**Fig.4**. Monthly frequency of river floods from the east of the Căliman Mountains

Regarding the frequency of floods during seasons, we notice significant territorial differences. Thus, on the northern and eastern rivers of the Căliman Mountains the maximum frequency of the floods is reported in the summer, representing between 47% and 56% of the total selected floods (Fig. 5).

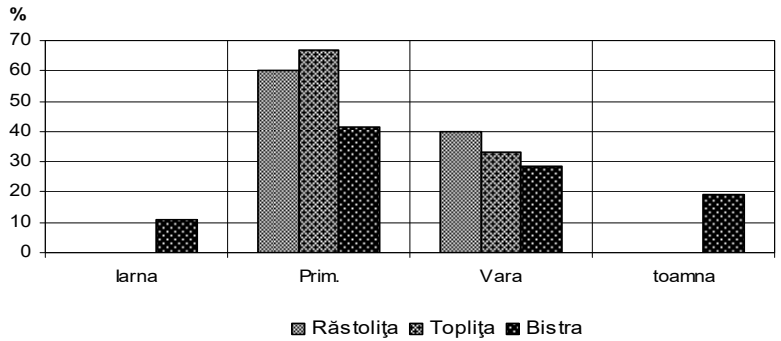


**Fig.5**. The seasonal frequency for the production of the floods on the rivers from west and south of the Căliman Mountains

On the rivers in the west and south of the Căliman Mountains, the maximum seasonal frequency is the summer, representing 40% and 67% of the total selected floods (Fig. 6). However, in the north and east of the Căliman Mountains the maximum frequency is the summer season. Higher percentage values hold the rivers in the eastern region (Fig. 6).

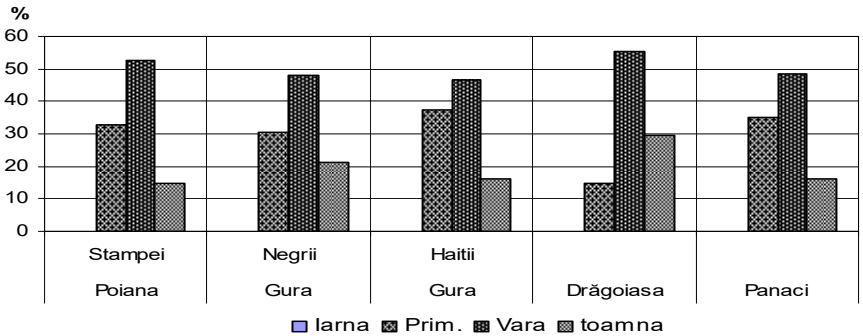


**Fig. 6**. The seasonal frequency for the production of the floods on the rivers from north and east of the Căliman Mountains

**The duration** of the flood is an important element depending on the magnitude of the effects that they can generate. The total duration (Tt) or total time consists of the increase time (Tcr>) and the decrease time (Tsc). The duration of the floods is different, depending on the character of the precipitation and the degree of melting of the snow

On most rivers, the highest frequency is for floods whose total duration exceeds 96 hours. Higher percentage values are the rivers of the west and south of the Căliman Mountains (70-90% of the total number of cases) (Table 1).

**Table 1.** Total flood time

| River | Hydro. Station | 0-24 hs. | | 25-48 hs. | | 49-72 hs. | | 73-96 hs. | | >96 hs. | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. case | % | No. case | % | No. case | % | No. case | % | No. case | % | No. case | % |
| Dorna | Poiana Stampei | 2 | 3,3 | 8 | 13,1 | 14 | 22,9 | 6 | 9,8 | 31 | 50,8 | 61 | 100 |
| Dornisoara | Poiana Stampei | 2 | 5,4 | 5 | 13,5 | 3 | 8,1 | 11 | 29,7 | 16 | 43,2 | 37 | 100 |
| Neagra | Gura Negrii | 1 | 2,1 | 5 | 10,6 | 13 | 27,6 | 9 | 19,1 | 19 | 40,4 | 47 | 100 |
| Haita | Gura Haitii | 0 | 0 | 0 | 0 | 3 | 10,7 | 0 | 0 | 25 | 89,3 | 28 | 100 |
| Neagra | Drăgoiasa | 1 | 3,7 | 6 | 22,2 | 8 | 29,6 | 3 | 11,1 | 9 | 33,3 | 27 | 100 |
| Sărisor | Panaci | 4 | 10,3 | 4 | 10,3 | 8 | 20,5 | 11 | 28,2 | 12 | 30,8 | 39 | 100 |
| Topliţa | Topliţa | 1 | 4,5 | 0 | 0,0 | 3 | 13,6 | 2 | 9,1 | 16 | 72,7 | 22 | 100 |
| Drăgoiasa | Tomnatec | 10 | 16,1 | 12 | 19,3 | 8 | 12,9 | 5 | 8,1 | 27 | 43,5 | 62 | 100 |
| Răstoliţa | Răstoliţa | 0 | 0 | 0 | 0 | 1 | 5,0 | 0 | 0 | 19 | 95,0 | 20 | 100 |
| Bistra | Bistra | 0 | 0 | 1 | 10,0 | 1 | 10,0 | 1 | 10,0 | 7 | 70,0 | 10 | 100 |

The total time of the floods is higher on the river courses on the southern branch of the Căliman Mountains (Table 1). Thus, on these rivers the long duration (over 96 hours) represents between 70 and 96% of the total selected floods (Table 1). The smaller the surface area of the receiving basins, the shorter the total time. Thus, most flashfloods have been recorded in the basins of the rivers Drăgoiasa and Sărișor. The territorial differences imposed by the character of precipitations (duration, intensity) are observed and when analyzing the duration of the growth of the floods, another important element on which their mode of manifestation depends. (Table 2)

**Table 2.** Total increasing flood time

| Hydro. station | 0-6hs. | | 7-12 hs. | | 13-24 hs. | | 25-48 hs. | | >48 hs. | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. case | % | No. case | % | No. case | % | No. case | % | No. case | % | No. case | % |
| Poiana Stampei | 1 | 1,6 | 9 | 14,7 | 27 | 44,3 | 17 | 27,9 | 7 | 11,5 | 61 | 100 |
| Poiana Stampei | 1 | 2,7 | 11 | 29,7 | 14 | 37,8 | 9 | 24,3 | 2 | 5,4 | 37 | 100 |
| Gura Negrii | 2 | 3,2 | 10 | 15,9 | 30 | 47,6 | 13 | 20,6 | 8 | 12,7 | 63 | 100 |
| Gura Haitii | 0 | 0 | 0 | 0,00 | 5 | 17,9 | 8 | 28,6 | 15 | 53,6 | 28 | 100 |
| Drăgoiasa | 0 | 0 | 3 | 11,1 | 12 | 44,4 | 9 | 33,3 | 3 | 11,1 | 27 | 100 |
| Panaci | 3 | 7,7 | 10 | 25,6 | 9 | 23,1 | 12 | 30,8 | 5 | 12,8 | 39 | 100 |
| Topliţa | 4 | 18,2 | 2 | 9,1 | 6 | 27,3 | 4 | 18,2 | 6 | 27,3 | 22 | 100 |
| Tomnatec | 4 | 6,4 | 13 | 21,0 | 22 | 35,5 | 14 | 22,6 | 9 | 14,5 | 62 | 100 |
| Răstoliţa | 0 | 0 | 1 | 5,0 | 1 | 5,0 | 7 | 35,0 | 11 | 55,0 | 20 | 100 |
| Bistra | 0 | 0 | 4 | 40,0 | 5 | 50,0 | 0 | 0 | 1 | 10,0 | 10 | 100 |

The growth time of a flood shows its extreme danger. The lower this value, the more dangerous the flood. The growth time depends on several factors: the intensity and duration of precipitation, the speed with which the snow melt occurs. To these are added the morphometric peculiarities of the receiving basin (surface, the slope, the altitude, etc.), the degree of fragmentation of the relief and the degree of vegetation cover and its type, as well as the permeability of the substrate.

The maximum flow (peak) (Qmax ($m^3/s$)) represents the parameter of maximum interest, as this represents the moment of the greatest danger of the maximum flood. The maximum flows recorded on the streams of the Căliman Mountains have varied in very wide limits, depending on the numerous factors (climatic conditions, the surface of the reception basins, etc.). Thus, the maximum flows determined for the floods produced between 1981-2010 reached values between 48.2 $m^3/s$ (on the Răstoliţa river to Răstoliţa) and 281.0 $m^3/s$ (on the Bistricioara to Bilbor) (Table 3).

**Table 3**. Maximum flow of th e floods produced on the rivers from the Căliman Mountains

| River | Hydro. Station | $Q_{max}$ med. ($m^3/s$) | $H_{max.}$ med. (cm) | $Q_{max}$ abs. ($m^3/s$) | $H_{max}$ abs. (cm) | Recording date |
|---|---|---|---|---|---|---|
| Dorna | Poiana Stampei | 71,67 | 11,67 | 81,00 | 14,80 | 09/11/2001 |
| Dornisoara | Poiana Stampei | 170,54 | 4,85 | 214,00 | 10,10 | 04/06/2000 |
| Neagra | Gura Negrii | 175,04 | 28,86 | 230,00 | 113,00 | 06/12/1974 |
| Haita | Gura Haitii | 88,00 | 4,20 | 178,00 | 9,54 | 04/13/1999 |
| Neagra | Drăgoiasa | 126,63 | 3,68 | 148,00 | 7,20 | 07/29/1991 |
| Sărisor | Panaci | 153,54 | 3,89 | 210,00 | 11,50 | 07/14/1999 |
| Topliţa | Topliţa | 18,10 | | 41,10 | | 04/11/1985 |
| Răstoliţa | Răstoliţa | 20,24 | | 48,20 | | 04/11/1985 |
| Bistricioara | Bilbor | 203,82 | 12,95 | 281,00 | 34,70 | 07/27/1981 |
| Dragoiasa | Tomnatec | 134,48 | 2,70 | 176,00 | 6,77 | 08/24/1974 |

**The shape of the flood.** The knowledge of the floods shape is important in appreciating the characteristics and effects induced by the floods. Depending on the shape of the hydrographs, the floodwaters were classified into monoundic (single) and polyundic (compound). The floods produced on the rivers of the Căliman Mountains are frequently manifested by the appearance of a single wave. The percentage values of the monoundic floods are maintained between 64% (Miţa pe Bistriţa) and 90% (Bistra pe Bistra), and of the polyundic ones between 10% and 36% (Table 4)

**Table 4**. Frequency of types of floods depending on the shape of the hydrographs.

| River | Hydro. Station | Floods | | | |
|---|---|---|---|---|---|
| | | Monowaves | | Poliwaves | |
| | | No. case | % | No. case | % |
| Dorna | Poiana Stampei | 57 | 79.17 | 15 | 20.83 |
| Dornișoara | Poiana Stampei | 35 | 77.78 | 10 | 22.22 |
| Neagra | Gura Negrii | 62 | 81.58 | 14 | 18.42 |
| Haita | Gura Haitii | 26 | 81.25 | 6 | 18.75 |
| Neagra | Drăgoiasa | 25 | 83.33 | 5 | 16.67 |
| Sărisor | Panaci | 32 | 68.09 | 15 | 31.91 |
| Toplita | Toplita | 21 | 84.00 | 4 | 16.00 |
| Răstoliţa | Răstoliţa | 15 | 75.00 | 5 | 25.00 |
| Dragoiasa | Tomnatec | 70 | 89.74 | 8 | 10.26 |
| Bistra | Bistra | 9 | 90.00 | 1 | 10.00 |
| Bistriţa | Miţa | 32 | 64.00 | 18 | 36.00 |

The floods shape is also analyzed by means of a coefficient (γ) which represents the ratio between the volume of the flood and the product between the maximum flow (Qmax and the total time (Tt.). The maximum values of the shape coefficient are directly related to the altitude of the reception basins, reaching the highest values (over 0.8) on the rivers in the high sector of the Căliman Mountains.

## 4.CONCLUSIONS

The periods with high drainage from the rivers of the Căliman Mountains are frequented by floods and rarely by large waters.

The use of the temporal parameters (monthly and anotimpual frequency, total duration and growth), quantitative (debitmaxim, volumes) and shape (monolithic and cyipundial floods, shape coefficient), allow a relevant characterization of periods with high flow.

The processing and use of data from the 4 hydrometric stations allowed the identification of the temporal-spatial characteristics of the periods with high flow.

Knowing the temporal-spatial particularities of the high leakage devices offers the possibility of applying the most appropriate measures to prevent and combat the negative effects induced by the high leakage periods.

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