

PRECIPITATION SURPLUSES OF THE DECADES 1970-1980 AND 1981-1990 IN THE CRIȘURI HYDROGRAPHICAL BASIN. HYDROLOGICAL AND SOCIO-ECONOMIC EFFECTS

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Abstract: *Precipitation Surpluses of the Decades 1970-1980 and 1981-1990 in the Crișuri Hydrographical Basin. Hydrological and Socio-Economic Effects.* The precipitation surpluses were emphasized based on the positive deviations of the annual and monthly precipitation amounts compared to the multi-annual average, taken as "normal". In the interval 1970-1990 exceptional precipitation quantities produced and generated important flash floods on the rivers in the Crișuri hydrographical basin. Such were the ones of June 1970, June 1974, July 1980 or March 1981. Their effects consisted of broken embankments, flooded settlements and farmlands on large areas, damaged bridges, railways and roads. While the decade 1970-1980 was rainier, the decade 1981-1990 was the draughtiest of the period 1961-2000, in the Crișuri hydrographical basin.

Key words: hydrographical basin, surplus, flash flood, decade.

Introduction

By the surplus of soil humidity they generate, precipitation surpluses are considered climatic risks. In return they produce other natural risks: hydrological, pedological, ecological, economic, social (O. Bodgan, E. Niculescu, 1999). Generally, precipitation surpluses produce great material damages and that is why they need to be studied.

The Crișuri hydrographical basin is adjacent to the Someșului Basin at the North and North-East and to the Mureșului Basin at the East and South. It overlaps almost entirely the administrative territory of the County of Bihor and includes parts of the counties of Arad, Hunedoara, Cluj, Sălaj and Satu Mare. Crișul Alb, Crișul Negru, Crișul Repede, Barcău and Ier are the main rivers that form this basin.

1. Data and methods

On the territory of the Crișuri hydrographical basin precipitation surpluses have been emphasized based on the positive deviations of the annual and monthly precipitation amounts compared to the multi-annual average, taken as „normal”. Precipitation data from the National Meteorology Administration were used and the weather stations used for the analysis were a few of the ones situated on the territory mentioned above: Săcueni, Oradea, Holod, Chișineu-Criș, Ineu, Borod, Ștei, Gurahonț.

2. Results and discussions

2.1 *Precipitation surpluses of the decades 1970-1980 and 1981-1990*

The period 1961-2000 was chosen, for a better comparison of the results of precipitation surpluses analysis between the two decades. The years and months with the highest precipitation surplus of this period were emphasized.

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In the interval 1961-2000, most of the weather stations recorded a number of 8-9 years with positive deviations compared to the normal, above 100 mm at the stations located in the plain and 9-10 years for the ones in the gulf-depressions (fig.1-2). The number of years with deviations above 200 mm was higher at the North of the basin and at the stations located at higher altitudes (2-3 years). The situation is due to the oceanic climatic influences more pronounced in the north-western sector of the country, as well as to the precipitation increase once with the altitude. As a result, precipitation amounts are bigger in these sectors of the basin.

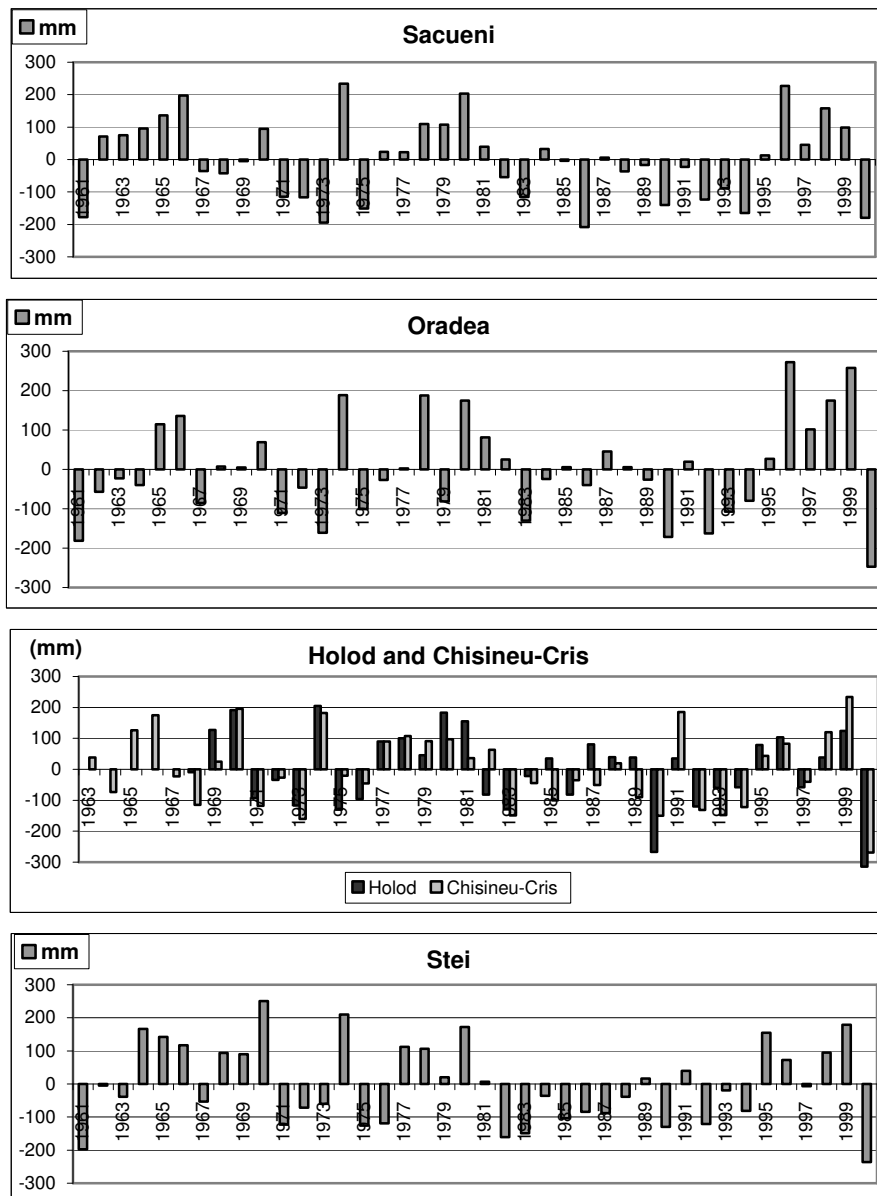


Fig.1 The deviations of annual precipitation amounts compared to the multi-annual average in the Crișuri hydrographical basin (1961-2000).

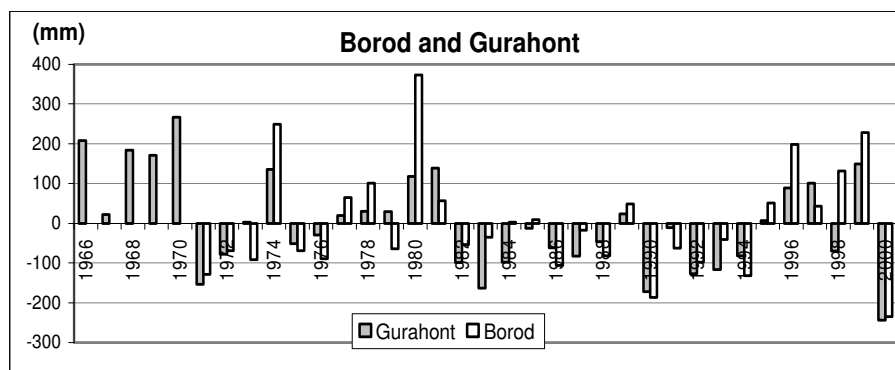


Fig.2 The deviations of annual precipitation amounts compared to the multi-annual average in the Crişuri hydrographical basin (1966-2000).

In the interval 1961-2000, the maximum annual deviation grew at the plain stations to **272.4 mm** at Oradea in 1996 and at the stations in the depressions to **373.4 mm** at Borod in 1980. During the years with maximum deviations, the annual precipitation amounts exceeded 800 mm at the stations in the plain, being almost 900 mm at some of the stations (as for instance Holod: 896.5 mm in 1974). At the stations located at higher altitudes it went over 1000 mm (1083.8 mm at Borod in 1980; 1005.0 mm at Gurahont in 1970).

The rainiest years of the two decades mentioned above were: 1970, 1974, 1978, 1980 and 1981. The rainiest years were **1974**, especially at the stations in the northern half of the basin and **1970** especially for those in the southern half. In 1974 the precipitation covered the entire analysed territory and the annual deviations grew up to 135-250 mm, higher in the northern half of the basin. Also this was the year with the richest precipitation amounts during 1961-2000 at the stations Săcueni and Holod (over 200 mm deviation).

The year 1970 measured high precipitation amounts, especially in the southern part of the territory. The deviations rose to almost 200 mm at Chişineu-Criş and Holod and 250-260 mm at Ştei and Gurahont. For the last two stations, 1970 is the year with the richest precipitation amounts during the period 1961-2000. 1980 was an exceeding year over the entire Crişurilor Basin. It recorded high precipitation amounts especially in the northern half of the territory, with maximum deviations at Borod (373.4 mm) and Săcueni (203.7 mm).

For most of the stations, the decade 1970-1980 had a greater number of years with surplus (6-7 years) than with a deficit. In return, the decade 1981-1990 had a deficit at most of the stations, with records of a great number of years with a deficit (6-8 years). The years with a deficit equals in number the years with surplus only at the stations of Oradea and Holod. However, the values of the negative deviations outnumber the positive ones. The highest deficit was recorded in the southern part of the basin, where the precipitation amounts are smaller because of the predominant Mediterranean influences of the climate.

Figure no.3 also shows that the decade 1971-1980 was less rainy than the former (1961-1970), but rainier than the next. The decade 1981-1990 showed the highest deficit at all the stations in the basin. Actually, we can observe that the precipitation amounts lessened during the first three decades and slightly increased during the last decade, for all the stations.

The graphs in figures no.1-2 show the existence of periods of consecutive years with surplus, for the interval 1970-1990. The periods of 2-3 and 5-6 consecutive years are

most frequent. The periods of 5-6 years are absent only along the Crișului Repede Valley, at Borod and Oradea.

The highest monthly positive deviations are recorded during the summer months *June-July*, months with rich rainfalls, when the dynamic and thermic convection superpose. June is the month of the pluviometric maximum. During the interval 1961-2000, the deviations grew to 100-160 mm in these months. High positive monthly precipitation deviations might also occur in autumn, in *October* or *September*. In October the maximum deviations had values of 90-130 mm. In September they reached 60-140 mm.

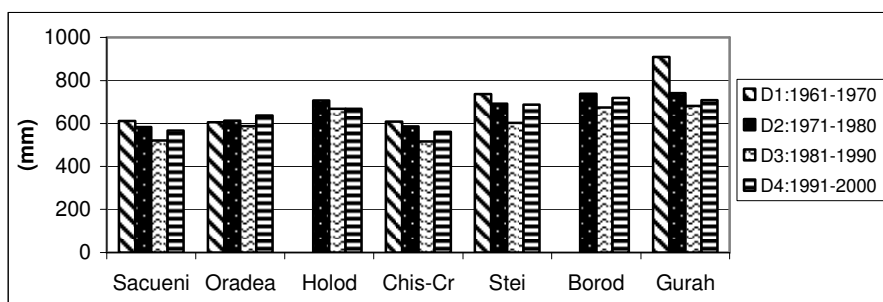


Fig. 3 The average of annual precipitation amounts per decades in the Crișuri Basin (1961-2000).

Table 1 The longest and the rainiest periods with surplus recorded in the Crișuri hydrographical basin (1970-1990).

Station	Period	Number months	Total surplus (mm)	Maximum deviation (mm)/month
Săcueni	March-July 1980	5	177,7	73,1/July 1980
	Nov.1969-March 1970	5	111,2	42,4/Jan.1970
	May-August 1974	4	236,8	119,7/June 1974
	June-August 1979	3	154,3	95,2/Aug.1979
Oradea	Nov.1969-June 1970	8	170,6	43,1/June 1970
	Febr.-July 1978	6	214,6	101,2/July 1978
	May-August 1974	4	178,8	120,1/June 1974
Holod	Nov.1969-June 1970	8	261,8	67,3/June 1970
	Oct.1987-March 1988	6	147,3	102,2/March 1988
	March-July 1980	5	188,1	123,3/July 1980
	May-August 1974	4	190,9	119,0/June 1974
Borod	Nov.1985-April 1986	6	100,2	40,7/Nov.1985
	March-July 1980	5	361,7	158,7/July 1980
	May-August 1974	4	265,8	113,0/June 1974
Chișineu-Criș	Febr.-Sept.1978	8	135,2	32,3/Sept.1978
	May-July 1974	3	180,1	136,0/June 1974
Ștei	Nov.1969-July 1970	9	346,7	98,2/June 1970
	Jan.-April 1977	4	113,3	47,2/Febr.1977
	May-July 1974	3	227,4	143,4/June 1974
Gurahonț	Nov.1969-July 1970	9	371,1	90,6/Febr.1970
	April-August 1975	5	151,9	76,8/Aug.1975
	Febr.-May 1978	4	127,5	66,5/Febr.1978
	May-July 1974	3	150,0	98,2/June 1974

High precipitation surpluses can also occur in spring, in March (maximum deviations of 50-125 mm) or May or in summer, in August, because of the pronounced thermic convection. These surpluses are especially characteristic to the north-western part of the basin (Săcueni station) or to the stations at the limit of the Crișurilor Plain with the Western Hills (Oradea, Holod). So, at Holod and Săcueni, the monthly maximum deviations measured about 100-125 mm. The highest deviation values were recorded at the

northern station Borod (100-160 mm), where the rainfalls are richer due to higher altitude of the station (333 m).

At the stations in the Crişuri hydrographical basin, periods with consecutive months with surplus were pointed out (table 1). In the interval 1961-2000, most periods were recorded at the stations in the north-western sector of the basin, due to the oceanic influences of the climate and at those situated at higher altitudes in the depressions sector. In the interval 1970-1990, the maximum length of these periods raised to 9 consecutive months at the stations Ştei and Gurahonţ, 8 months at Oradea, Holod and Chişineu-Criş, 6 months at Borod and 5 at Săcueni.

The longest period with surplus was recorded in the rainy year 1970 – *November 1969- July 1970* – and lasted 9 months at Ştei and Gurahonţ, and more reduced at the other stations (8 months at Oradea and Holod, 5 at Săcueni). We can also point out the interval *February-September 1978* at Chişineu-Criş, 8 months long, shorter at Oradea (6 months) or Gurahonţ (4 months). We can add the short periods with surplus but very intense from the pluviometric point of view. Such was the interval *May-August 1974* (150-265 mm deviation), more intense to the North and North-West of the basin. Within 4 months, the station of Borod recorded a precipitation surplus of 265.8 mm, Săcueni 236.8 mm and Ştei 227.4 mm in 3 months. The month with the richest precipitation amount was June (deviations of 100-140 mm).

2.2 Hydrological and socio-economic effects

During the mentioned decades, many flash floods with serious social and economical effects produced in the Crişuri hydrographical basin. The most important ones, as recorded values and generated effects, are presented below.

In summer time the flash floods occurred as a result of frontal nature rainfalls with great length and intensity. Such were the ones in June 1970, June 1974 and July 1980, in the Crişul Negru hydrographical basin. Flash floods of mixed origin, as a result of both rich precipitation amounts and the water coming from the sudden snow melting in the intervals with fast air temperature raise, were recorded in March 1981 on the Crişul Negru and Crişul Repede rivers (according to the Direction for Water Management “Crişuri” of Oradea).

The floods of 1970 affected the entire territory of the country, especially Transylvania (they were more intense in the basins of the rivers Mureş and Someş). In the Crişurilor basin, at the stations Ştei and Gurahonţ, the period with surplus lasted 9 months (November 1969-July 1970) and 8 months at Oradea and Holod, as it was mentioned before. In this interval, the precipitation surplus totaled up an amount of 350-370 mm at Ştei and Gurahonţ and 170-260 mm at Oradea and Holod (table 1). The maximum precipitation deviations were recorded in June and February 1970 and were bigger in the southern part of the basin. In June 1970 they had values of 80-120 mm at the stations in the southern half of the basin and 20-65 mm at the ones in the northern half (table 2). At Chişineu-Criş the precipitation were 2.5 times bigger than the average of June. In February 1970 the highest deviations were recorded at the stations in the depression areas Ştei and Gurahonţ (about 90 mm). The precipitation fallen here, about 130 mm, were 3.5 times bigger than the average of February.

According to the analyses performed by N. Topor (1970), in 1970 there were rich rainfalls all over the country, especially in May, June and August. It generated high water flows that produced catastrophic floods especially in the hydrographical basins of the rivers of Transylvania. The cause of these great surpluses was the persistence of a polar front particularly active all over Europe, generated at the contact between two air masses with great thermo-baric differences. Those differences came out of an extremely cold winter in

northern Europe and Scandinavian Peninsula and an extremely warm winter in northern Africa (N. Topor, 1970).

The rainy spells during the greatest flash floods of the decades 1970-1980 and 1981-1990, produced in the Crișuri hydrographical basin

Table 2

Station	Period	Total prec. amount (mm)	Maximum diurnal amount	Monthly prec. amount(mm)	Monthly deviation (mm)
Săcueni	10-12.06.1970	67,0	34,4/10.06.1970	96,9	+17,5
	10-15.06.1974	69,2	20,1/14.06.1974	199,1	+119,7
	21-31.07.1980	114,2	34,8/23.07.1980	135,0	+73,1
	10-12.03.1981	12,5	9,2/11.03.1981	60,5	+28,2
Oradea	10-12.06.1970	81,8	34,3/10.06.1970	129,5	+43,1
	10-14.06.1974	74,2	19,9/13.06.1974	206,5	+120,1
	21-31.07.1980	198,5	48,7/23.07.1980	204,3	+131,1
	10-13.03.1981	18,3	11,7/11.03.1981	75,2	+41,8
Holod	10-12.06.1970	105,5	42,0/12.06.1970	165,7	+67,3
	10-14.06.1974	79,0	20,3/11.06.1974	217,4	+119,0
	21.07-1.08.1980	188,6	43,5/31.07.1980	197,8	+123,3
	10-14.03.1981	42,5	26,8/11.03.1981	76,9	+39,8
Borod	10-15.06.1974	84,7	26,4/12.06.1974	219,7	+113,0
	21.07-1.08.1980	234,8	75,3/23.07.1980	250,9	+158,7
	10-12.03.1981	51,5	32,6/11.03.1981	75,0	+41,3
Chișineu-Criș	10-12.06.1970	95,4	67,6/11.06.1970	203,3	+122,2
	10-14.06.1974	51,9	18,1/11.06.1974	217,1	+136,0
	21.07-1.08.1980	101,0	40,2/23.07.1980	104,3	+43,0
	10-12.03.1981	11,0	7,6/11.03.1981	51,8	+21,9
Ștei	10-12.06.1970	79,6	35,0/12.06.1970	196,8	+98,2
	10-15.06.1974	81,8	34,3/12.06.1974	242,0	+143,4
	21.07-1.08.1980	169,2	64,3/23.07.1980	196,0	+120,4
	10-12.03.1981	39,5	20,3/11.03.1981	83,7	+47,8
Ineu	21.07-1.08.1980	137,2	50,8/23.07.1980	145,5	+81,9
	10-12.03.1981	17,0	9,8/11.03.1981	71,7	+35,9
Gurahonț	10-13.06.1970	46,9	21,3/11.06.1970	188,8	+81,7
	10-15.06.1974	98,5	40,6/14.06.1974	205,3	+98,2
	21.07-1.08.1980	167,2	42,5/23.07.1980	197,5	+113,7
	10-14.03.1981	62,8	29,2/11.03.1981	111,8	+70,3

In the west of the country, *the flash flood of June 1970* affected especially the lower basin of the rivers Crișul Negru and Crișul Alb. On the Crișul Negru River, in the interval 10-13 June 1970, two successive flash flood produced, so, at the Beiuș hydrometric station, in the night of 10th/11th of June, the flood quota was reached and exceeded (flood quota "Ci"³=250 cm) and the maximum level was 313 cm. On the 11th of June the water levels started to drop, but as the rain was falling continuously and intensely, a second flash flood occurred in the afternoon of June the 12th, bigger than the first. Its maximum level reached 364 cm. Subsequently the waters became lower, so that on the 13th of June the flood quota was reached again.

At the hydrometric station Tinca were also recorded two flash floods. The first in the afternoon of the 11th of June, with a recorded maximum level of 536 cm (Ci=300 cm) and a maximum discharge of 626 m³/s, and the second one, in the morning of the 13th of June, when it reached a maximum level of 530 cm. At the hydrometric post Talpoș, the first flash flood measured 842 cm and at the post of Zerind 822 cm, produced in the morning of June the 12th. The second flash flood reached 866 cm at Talpoș and a maximum discharge of 820 m³/s and 994 cm at Zerind (Ci = 950 cm) and 517 m³/s in the afternoon of June the 13th (according to D.W.M. "Crișuri").

The effects felt on this river after the flash floods consisted in infiltrations or cracks in the embankment. On June the 13th, along the settlement of Boiu it broke 150-200 m long, because of the great discharge and wrong positioning of the embankment. As a result, about 8,000 hectares of land were flooded (according to D.W.M. "Crişuri").

On the Crişul Alb River also produced two flash floods: the first one, weaker, in the interval 7th-9th of June, and the second one in 12th-14th of June, superposed over the first, therefore with a greater impact, affecting the entire river flow. Thus, the maximum recorded levels were 378 cm at Gurahonţ in the morning of June 13th, 660 cm at Ineu, 924 cm at Chişineu-Criş and 750 cm at Vârşand on June 14th. The effects consisted of infiltrations, overflows and upstream of Chişineu-Criş, it produced a 130 m long break in the embankment. Consequently, about 12,000 hectares of land were flooded by nearly 100 millions cubic metres of water. It also destroyed the Arad-Oradea railway on a length of about 300 m (according to D.W.M. "Crişuri").

Table 2 shows that in 3 days time (June 10th-12th, 1970), about 80-100 mm precipitation fell at the weather stations in the Crişurilor Basin. At almost all the stations the amount was near or even exceeded the average of June (Holod, Chişineu-Criş). High diurnal precipitation amounts were recorded within the entire interval. So, 67.6 mm were recorded at Chişineu-Criş in 24 hours, on June 11th. All these were superposed a long period with surplus. As a result, the floods and the great damages were inevitable.

Roughly, **the flash flood of June 1974** affected the same areas in the Crişul Negru Basin. On June 15th, the maximum level reached 503 cm at the hydrometric station Tinca and 994 cm at the station Zerind. The maximum recorded discharge was 594 m³/s at Tinca and 511 m³/s at Zerind. This great amount of water produced a break in the embankment by the settlement of Misca and consequently, large farmland areas were flooded (according to D.W.M. "Crişuri").

In the interval 10th-15th of June 1974, precipitation amounts of about 70-100 mm were recorded at all the stations in the basin (table 2). The rain fallen in that 5-6 days time approached the average of June. The diurnal amounts rose at values of 20-40 mm. The interval is part of a longer, particularly excessive period – May-August 1974 – when the total surplus exceeded in some places, 200 mm precipitation, as specified above.

The flash flood of July 22nd-August 4th 1980 occurred as a result of torrential rains that generated great amounts of water, reported in two distinct pluvial episodes: 22nd-23rd of July and early August. The two pluvial events gave birth to long lasting floods that affected the entire Crişurilor Basin. So, along the Crişul Repede River, at the hydrometric station Oradea the maximum level reached was 392 cm on July 23rd (Ci=320 cm). On the Crişul Negru River, a maximum level of 543 cm was recorded at the station Tinca and 1049 cm at Zerind, in the interval 24th-25th of July. The discharge grew up to 914 m³/s at Tinca and 685 m³/s at Zerind. At the station Sălard on the river of Barcău, a maximum of 690 cm (Ci=700 cm) and 230 m³/s were recorded on July 26th.

As a result of the flash flood, the embankments gave way (the backwater embankment on the river of Teuz broke) and some settlements and over 15,000 ha of farmland, especially the ones at the junction area of the rivers Crişul Negru and Teuz, were flooded and so was the country road between Tinca and Belfir (according to D.W.M. "Crişuri").

In the interval July 21st-August 1st 1980, during the 12 days period, all the analysed stations located in the basin recorded precipitation amounts much higher than the average of July. At most of the stations they were 2-2.7 times higher than the average, the highest value being recorded at Oradea. The richest rainfalls were recorded for the North of the territory (table 2). So, at Oradea and Holod, were measured almost 200 mm of precipitation and at Borod 235 mm. All the other stations had extremely rich rainfalls (100-

170 mm). Exceptional diurnal precipitation amounts, of 40-75 mm (75.3 mm at Borod on July 23rd), were recorded. The interval is part of the longer period with surplus March-July 1980 (table 1), with the maximum surplus in July. Therefore, the huge amounts of water fallen within this interval, gave birth to the flash floods and their disastrous effects, as described above.

The flash flood of March 1981, as it was mentioned before, occurred as a result of lasting torrential rains, in great quantities and in addition the water coming from the melting of the snow, which had a thickness of over 1 m in the mountain areas. The situation was the result of the sudden warming of the weather, with high temperatures both during the day (20°C) and the night (10°C).

On the Crișul Repede River, at the hydrometric station Oradea, the maximum water level reached 386 cm on March 12th and the discharge rose to 689 m³/s. On the Crișul Negru River, in the interval 12th-13th of March, the maximum water levels were 370 cm at station Beiuș, 532 cm at Tinca and 1057 cm at Zerind. The maximum discharge values were 712 m³/s at Beiuș, 920 m³/s at Tinca and 696 m³/s at Zerind. On the Crișul Alb River, during the same interval the maximum levels were 346 cm at Gurahonț, 648 cm at Bocsig and 854 cm at Chișineu-Criș, while the discharges grew to 323 m³/s at Gurahonț, 655 m³/s at Bocsig and 659 m³/s at Chișineu-Criș (according to D.W.M. "Crișuri").

The flash flood on the Crișul Repede River damaged the Decebal Bridge in Oradea city and a bridge in Ghirișu de Criș village. Over 30,000 hectares of land and about 1,300 houses were flooded in the Crișul Negru Basin. The backflow embankments on the Teuz River were broken. In the Crișul Alb Basin the damages were also important, over 800 houses and about 15,000 hectares of land were flooded (according to D.W.M. "Crișuri").

In the interval 10th-12th March 1981 (or 10th-14th March, at some stations) rich precipitation amounts were recorded especially at the stations in the gulf-depressions (Borod, Ștei, Gurahonț) and at the station Holod, where, in 3-5 days time the average of March was surpassed up to 1.5 times. At the stations in the plain the rainfalls were weaker and toted 10-18 mm in 3 days. The maximum diurnal precipitation amounts grew up to 20-30 mm at the stations in the depressions (table 2). Therefore, the floods in this interval were due to snow melting in the mountain areas rather than to rainfalls.

Conclusions

In the interval 1970-1990 exceptional amounts of precipitation occurred, which generated important flash floods on the rivers in the Crișuri hydrographical basin. Such were the ones of June 1970, June 1974 and July 1980, as a result of frontal rainfalls long lasting and of great intensity, or the ones of March 1981, of mixed origin, due to rich rainfalls as well as to the water coming from the sudden snow melting. The effects of the flash floods consisted of broken embankments, flooded settlements and farmlands on large areas, damaged bridges, railways and roads.

While the decade 1970-1980 was rainier, the decade 1981-1990 was the driest of the period 1961-2000, in the Crișuri hydrographical basin.

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