THE FLOOD WAVES ANALYSIS AT PĂŞUNEA MARE GAUGING STATION ON TALNA RIVER (TUR BASIN)

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ABSTRACT. The flood waves analysis at Păşunea Mare hydrometric station on Talna River (Tur Basin). The analysis of the flood waves has been done using the data recorded for a period of 25 years, between 1979 and 2004. Thus, in each year, two of the largest floods have been evaluated, in order to obtain several characteristics such as the maximum discharge values, the increasing and decreasing time and also the frequency of occurrence during different seasons. A particular analysis has been made in respect with the defence levels at the hydrometric station and the maximum discharge values. The study also analyses the volumes of water translated through the river bed during those major flooding events.

Keywords: floods, frequency, increasing and decreasing time, threshold levels.

1. INTRODUCTION

Floods are the most significant threats that can appear into a catchment area. Due to their unpredictable appearance, with a great time distribution, floods can effect on a large scale communication networks, habitats, buildings, croplands. Talna River is a tributary of Tur River, which is also a tributary of Tisa River (Fig. 1).

Talna River springs from Oaş Mountains from an altitude of 200 m, having a length of 11 km and a catchment area of 92 km². The main tributary is Tarna Mare (51 km² area, length 17 km) which springs from Oaş Mountains - Geamăna Mare sector) draining the lowland portion of the north-west *"Ţara Oaşului"* - Oaş Country (Pop, 2010).

Talna crosses the southwestern region of the Oaş Depression, on a parallel course with Tur River, its collector. After, it picks a number of tributaries from the left, drained of the southern branch of the depression; Talna River is actually a collector with a transverse watercourse to the initial deployment of Talna Piedmont.

The flood occurrence is related with the altitude of the catchment area, its shape, the amount and the intensity of the rainfalls, the thickness of snow cover at the beginning of Spring, human-made elements and their distribution near the waterways.

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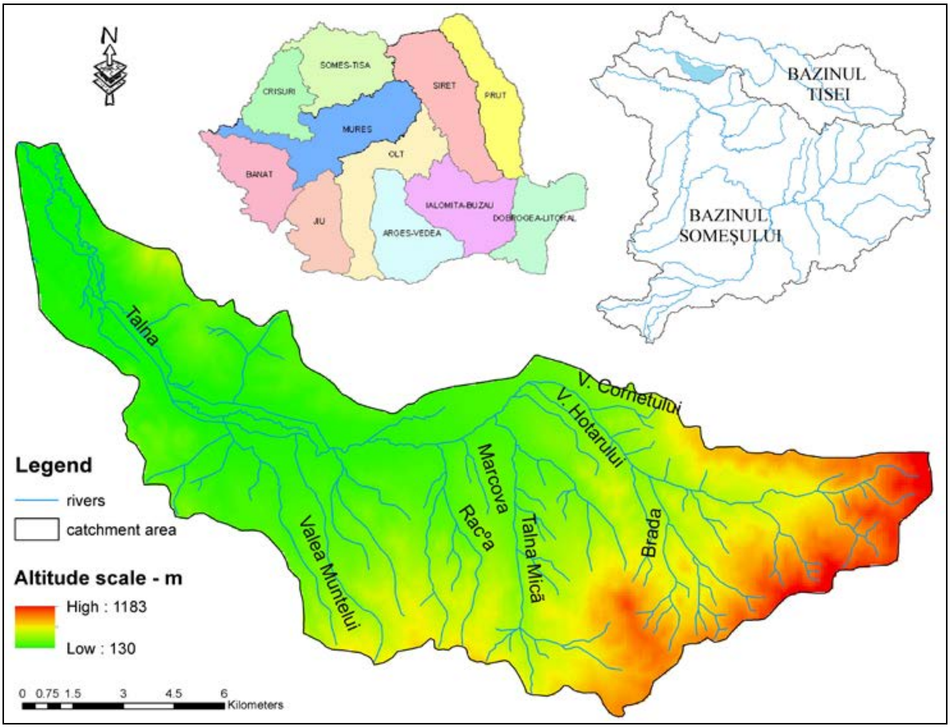

Fig. 1. Talna River catchment position in Romania

2. TEMPORAL ANALYSIS

In order to obtain expected results we have made an analysis for a 26 years period since 1979 to 2004. For each year has been taken into account the first two largest floods events that have occurred. Thus, we have considered 52 flood events, for which we have made a temporal and a data analysis.

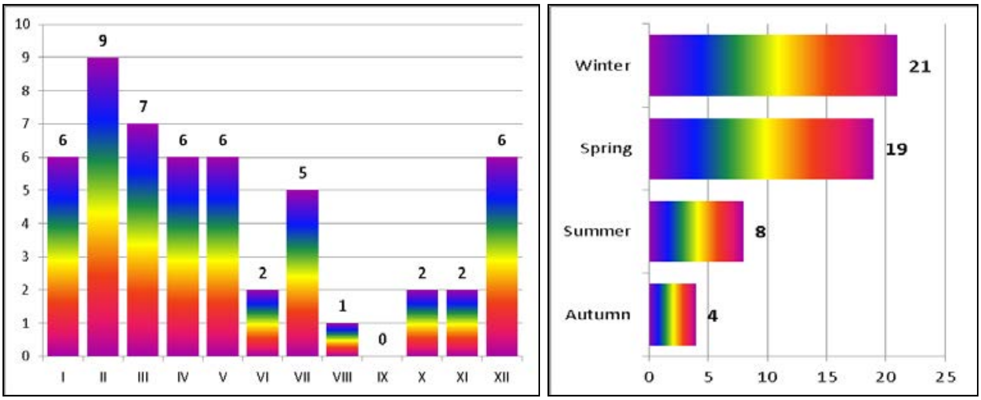

Fig. 2. Seasonal and monthly time distribution of floods at Păşunea Mare gauging station on Talna River

The seasonal time distribution of floods has revealed that the most frequent events occur in winter and spring (combining over 77 % of the total events considered). This is the result of a usually warm period that occurs at the beginning of the year, associated also with some rainy episodes (Fig. 2). Autumn is the season with very few flood events (8 % from total number).

The monthly distribution shows very high frequency of floods in the first five months of the year (six or more events), accumulating a total of 34 events (65 % of total number). Also a high number is recorded in July and December, while the lowest values are associated with October, November and August (Fig. 2). In the month of September during the 25 years of monitoring, it hasn’t been noticed a flood event.

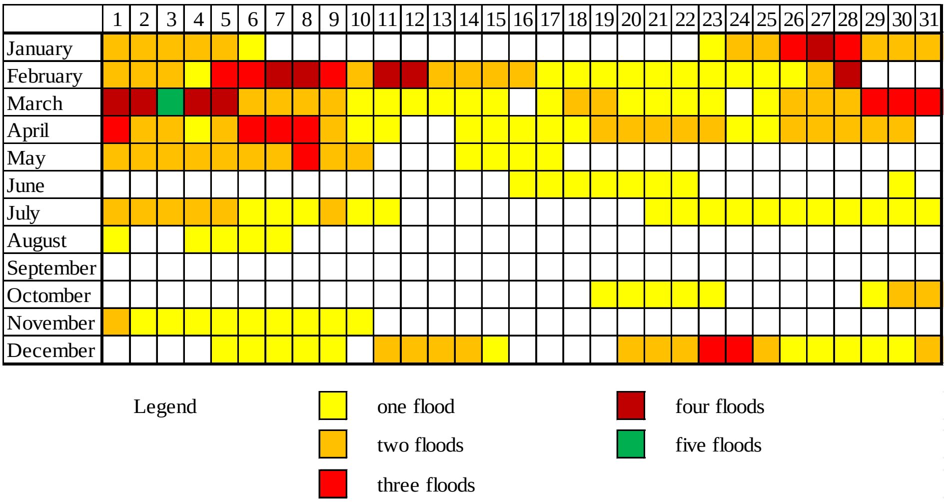

Fig. 3. The flood events occurrence at Păşunea Mare gauging station (1979-2004)

The most sensitive time of year is associated with the beginning of March, when during the interval between 1 to 5 March were recorded at least four floods that occurred during the same period (Fig. 3). Intervals with high vulnerability were also reported in February (on days 7-8, 11-12 and 28). Critical periods with three determined events were recorded for the periods March 29 to April 1, April 6 to 8, respectively 23 to 24 December. The least affected is the period from August to September, and even October, with a few exceptions of some isolated cases.

3. DATA ANALYSIS

The characteristic features that describe a flood event are numerously, but the most common are: the maximum discharge value, the highest reached level, the total volume, the volume form during increasing time and the volume form during decreasing phase, the runoff layer, the total duration, increase time phase and decrease time phase.

In order to obtain these values we have integrated the observed raw data into specific software, called *Cavis*, developed by Ciprian Corbuş, from INHGA Bucarest. This program can offer wide models for obtaining the specific parameters that can describe a flood event The synthetic statistic data that we have obtained by computing each flood in the mentioned software are available in table 1.

Table 1 Synthetic statistic data of flood characteristics at Păşunea Mare (1979-2004)

	Qmax m^3	**Wc** mil. m^3	**Wd** mil. m^3	**Wt** mil. m^3	**Hs** mm	**Tc** hours	**Td** hours	**Tt** hours
Max. val.	100	15.002	15.126	20.463	120.373	266	342	397
Min. val.	10.7	0.357	0.683	1.053	6.199	3	29	38
Avg. val.	49.6	2.687	4.890	7.579	44.585	41.62	83.12	124.7

- Maxim discharge - Qmax has oscillated in the analyzed period of 25 years between 10,7 m^3/s (1990) and 100 m^3/s (1996), with an average value of 49,6 m^3/s.
- The increase volume – Wc had values betweeen 0,357 mil. m^3 (1984) and 15,002 mil. m^3 (2000), with an average value of about 2,687 mil. m^3.
- The decrease volume – Wd has values that oscillated between 0,683 mil. m^3 (1990) and 15,126 mil. m^3 (1980), with an average value of 4,89 mil. m^3.
- Total volume – Wt has values between 1,053 mil. m^3 (1990) and 20,463 mil. m^3 (2000), with an average value of 7,579 mil. m^3.
- Runoff layer – Hs had values between 6 mm (1990) and 120 mm (2000), with an average value of 44,5 mm.
- Time increase period had values between 3 hours (1997) and 266 hours (2000), with an average value of 41 hours.
- Time decrease period had values between 29 hours (1999) and 342 hours (1993), with an average value of 83 hours.
- Total time duration has oscillated between the minimum value of 38 hours (1999) and a maximum one of about 397 hours (1993), with an average value for the whole period of about 124 hours.

A detailed perspective of the flood characteristic's values recorded during each of the 52 analysed events can be observed in table 2. Besides the mentioned above parameters, the table contains data regarding the beginning and ending time of each event (Qbi and Qbf) and also the values of *Gamma* – which defines the flood shape coefficient. This item is obtained by the ratio between the total volume and the circumscribed rectangle defined by the product Q * T (1).

$$Gamma = Wt / (Qmax \cdot Tt) \qquad (1)$$

Table 2. Statistical data of flood events occurred between 1979-2004

Yr-nr	Qmax	Wc	Wd	Wt	Hs	Gamma	Tc	Td	Tt	Qbi	Qbf
1979-1	48.1	1.506	12.723	14.23	83.707	0.384	34	180	214	1/24/79 7:00	2/2/79 5:00
1979-2	55.8	1.784	3.791	5.575	32.796	0.402	17	52	69	12/11/79 12:00	12/14/79 9:00
1980-1	80.1	1.438	15.126	16.565	97.441	0.218	9	254	263	7/21/80 18:00	8/1/80 17:00
1980-2	48.6	5.15	4.202	9.353	55.021	0.453	66	52	118	11/5/80 9:00	11/10/80 7:00
1981-1	41.6	3.336	5.592	8.959	52.704	0.418	61	82	143	3/9/81 18:00	3/15/81 17:00
1981-2	73.4	2.751	4.377	7.129	41.94	0.325	32	51	83	12/11/81 19:00	12/15/81 6:00
1982-1	36.5	1.987	3.021	5.009	29.465	0.346	54	56	110	12/31/81 17:00	1/5/82 7:00
1982-2	63.9	0.459	4.142	4.602	27.071	0.344	5	53	58	6/30/82 20:00	7/3/82 6:00
1983-1	40.2	3.683	4.096	7.78	45.766	0.314	91	80	171	1/27/83 20:00	2/3/83 23:00
1983-2	42.1	2.507	5.69	8.197	48.22	0.365	31	117	148	5/2/83 9:00	5/8/83 13:00
1984-1	31.1	0.357	2.052	2.409	14.175	0.391	8	47	55	5/14/84 20:00	5/17/84 3:00
1984-2	62.8	0.94	7.006	7.947	46.751	0.338	18	86	104	7/4/84 22:00	7/9/84 6:00
1985-1	44	1.884	5.057	6.942	40.839	0.515	26	59	85	5/2/85 7:00	5/5/85 20:00
1985-2	42.2	1.698	3.136	4.834	28.44	0.395	22	58	80	7/1/85 20:00	7/5/85 4:00
1986-1	46.6	2.797	4.232	7.03	41.353	0.436	37	59	96	1/23/86 20:00	1/27/86 20:00
1986-2	43.2	1.997	4.332	6.33	37.236	0.37	28	82	110	4/19/86 0:00	4/23/86 22:00
1987-1	24.7	2.156	2.794	4.95	29.119	0.562	45	54	99	3/29/87 22:00	4/3/87 1:00
1987-2	28.1	1.542	2.224	3.766	22.158	0.404	30	62	92	4/5/87 13:00	4/9/87 9:00
1988-1	33	0.499	2.746	3.246	19.098	0.514	6	47	53	3/17/88 8:00	3/19/88 13:00
1988-2	32.6	0.957	2.105	3.063	18.021	0.243	18	89	107	12/5/88 9:00	12/9/88 20:00
1989-1	25.9	4.453	3.811	8.265	48.617	0.275	162	160	322	2/20/89 10:00	3/5/89 20:00
1989-2	74.5	2.042	3.689	5.731	33.715	0.232	27	65	92	5/6/89 23:00	5/10/89 19:00
1990-1	30.7	0.702	1.494	2.196	12.921	0.432	10	36	46	1/26/90 19:00	1/28/90 17:00
1990-2	10.7	0.37	0.683	1.053	6.199	0.592	17	29	46	5/8/90 19:00	5/10/90 17:00
1991-1	56.4	4.057	6.713	10.77	63.353	0.411	37	92	129	5/18/91 9:00	5/23/91 18:00
1991-2	37.3	1.397	1.82	3.217	18.926	0.323	30	44	74	8/4/91 6:00	8/7/91 8:00
1992-1	23.2	5.321	1.569	6.89	40.533	0.416	140	58	198	2/11/92 11:00	2/19/92 17:00
1992-2	36.8	1.235	3.085	4.321	25.42	0.326	22	78	100	10/30/92 21:00	11/4/92 1:00
1993-1	25.6	1.57	5.816	7.386	43.451	0.201	55	342	397	4/14/93 11:00	5/1/93 0:00
1993-2	55.2	3.021	5.889	8.91	52.417	0.38	25	93	118	12/20/93 9:00	12/25/93 7:00
1994-1	32.7	1.931	3.819	5.751	33.83	0.341	21	122	143	2/3/94 10:00	2/9/94 9:00
1994-2	45.9	0.761	4.531	5.292	31.135	0.305	14	91	105	4/6/94 20:00	4/11/94 5:00
1995-1	71.1	3.575	6.399	9.975	58.677	0.344	42	71	113	4/26/94 7:00	5/1/94 0:00
1995-2	66	8.866	4.081	12.947	76.164	0.435	91	34	125	12/23/95 10:00	12/28/95 15:00
1996-1	100	2.431	10.845	13.276	78.098	0.347	11	95	106	10/19/96 7:00	10/23/96 17:00
1996-2	57.6	3.136	5.1	8.236	48.451	0.381	26	78	104	12/20/96 9:00	12/24/96 17:00
1997-1	47	0.434	2.983	3.418	20.106	0.381	8	45	53	6/16/97 9:00	6/17/97 14:00
1997-2	91.5	0.7	6.736	7.437	43.748	0.418	3	51	54	7/9/97 8:00	7/11/97 14:00
1998-1	96.4	3.75	7.996	11.746	69.096	0.376	31	59	90	6/18/98 14:00	6/22/98 8:00
1998-2	95.5	4.552	6.643	11.196	65.863	0.428	22	54	76	10/29/98 19:00	11/1/98 14:00
1999-1	49.8	0.961	2.307	3.269	19.233	0.479	9	29	38	2/11/99 8:00	2/12/99 22:00
1999-2	69.7	4.746	14.135	18.881	111.068	0.358	61	149	210	2/28/99 23:00	3/9/99 17:00
2000-1	69.5	15.002	5.461	20.463	120.373	0.258	266	50	316	3/26/00 14:00	4/8/00 18:00
2000-2	72.4	3.047	5.533	8.58	50.476	0.253	58	72	130	2/7/00 7:00	2/12/00 17:00
2001-1	51.5	1.326	4.319	5.645	33.208	0.323	13	81	94	2/5/01 19:00	2/9/01 17:00
2001-2	74.5	7.582	6.617	14.2	83.528	0.476	46	65	111	3/3/01 19:00	3/8/01 10:00
2002-1	39.7	3.29	3.123	6.414	37.732	0.356	75	51	126	2/28/02 11:00	3/5/02 17:00
2002-2	23.2	3.055	2.75	5.806	34.156	0.46	79	72	151	2/10/02 10:00	2/16/02 17:00
2003-1	28.7	1.65	5.851	7.502	44.132	0.37	42	154	196	12/29/02 19:00	1/6/03 23:00
2003-2	30	1.552	1.788	3.341	19.654	0.423	21	52	73	2/5/03 10:00	2/8/03 11:00
2004-1	31.8	3.088	2.574	5.662	33.308	0.389	52	75	127	2/27/04 10:00	3/3/04 17:00
2004-2	42.3	0.714	7.703	8.418	49.519	0.335	10	155	165	3/25/04 3:00	4/1/04 0:00

4. THRESHOLD DEFENSE LEVEL ANALYSIS

For a better and efficient way of monitoring the water level oscillation during floods, according to the effects that can be produced to habitats, croplands and communication networks, it has been established for each gauging station three threshold defence level: *attention level* – first level (the lowest one), *flooding level* – second level and *the danger level* – the third one (the most highest). During flood events the overpass of these thresholds defence level, would determine certain measure, which can led even to the population evacuation from the affected territory. At Păşunea Mare gauging station, the analysis of threshold level overpasses has been observed, with frequent values over the first and second defence level (Fig. 4). During the 25 years period none of the occurred floods has overpassed the third defence level associated with the so-called „danger level" (Table 3).

Thus, form the total number of 52 events, the *attention level - AL (270 cm)* has been reached or overpassed in 51 cases. The average time duration of these situations was of about 53 hours, with a maximum value of 168 hours (first flood of 1979) and a minimum value of 4 hours (second flood from 1992). The *flood level - FL (360 cm)* was overpassed in 27 cases, with an average value for time duration of about 13 hours, a maximum of 46 hours (second flood from 2001) and a minimum value of 2 hours (second flood from 1989). The *danger level - DL (450 cm)* has not been reached in none of the analysed events. A complete statistical data is shown on table 4.

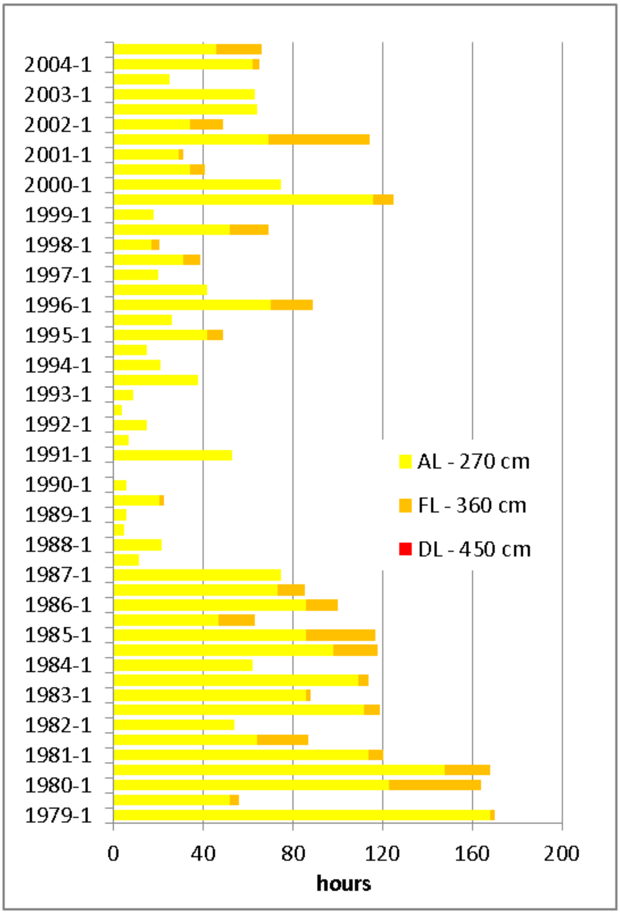

Fig. 4. The duration time of the threshold defense levels overpasses at Păşunea Mare

Table 4. Beginning and ending time moments of flood events against the threshold defence levels at Păşunea Mare gauging station (1979 - 2004)

	AL - 270 cm			FL - 360 cm			DL - 450 cm		
Yr-nr	Qbi	Qbf	Hr.	Qbi	Qbf	Hr.	Qbi	Qbf	Hr.
1979-1	1/25/1979 7:00	2/1/1979 7:00	168	1/25/1979 17:00	1/25/1979 19:00	2			0
1979-2	12/11/1979 13:00	12/13/1979 17:00	52	12/12/1979 5:00	12/12/1979 9:00	4			0
1980-1	7/21/1980 21:00	7/27/1980 0:00	123	7/22/1980 0:00	7/23/1980 17:00	41			0
1980-2	11/5/1980 13:00	11/11/1980 17:00	148	11/7/1980 17:00	11/8/1980 13:00	20			0
1981-1	3/10/1981 13:00	3/15/1981 7:00	114	3/12/1981 7:00	3/12/1981 13:15	6			0
1981-2	12/12/1981 5:00	12/14/1981 21:00	64	12/13/1981 1:00	12/13/1981 23:50	23			0
1982-1	1/2/1982 11:00	1/4/1982 17:00	54						0
1982-2	6/28/1982 1:00	7/2/1982 17:00	112	7/1/1982 0:00	7/1/1982 7:00	7			0
1983-1	1/29/1983 17:00	2/2/1983 7:00	86	1/31/1983 15:00	1/31/1983 17:00	2			0
1983-2	5/2/1983 13:00	5/7/1983 2:00	109	5/3/1983 16:00	5/3/1983 21:00	5			0
1984-1	5/13/1984 22:00	5/16/1984 12:00	62						0
1984-2	7/5/1984 4:00	7/9/1984 6:00	98	7/5/1984 14:00	7/6/1984 10:00	20			0
1985-1	5/2/1985 6:00	5/5/1985 20:00	86	5/3/1985 6:00	5/4/1985 13:00	31			0
1985-2	7/2/1985 7:00	7/4/1985 6:00	47	7/2/1985 13:00	7/3/1985 5:00	16			0
1986-1	1/24/1986 2:00	1/27/1986 16:00	86	1/25/1986 4:00	1/25/1986 18:00	14			0
1986-2	4/19/1986 13:00	4/22/1986 14:30	74	4/20/1986 6:00	4/20/1986 18:00	12			0
1987-1	3/30/1987 15:00	4/2/1987 18:00	75						0
1987-2	4/6/1987 13:20	4/7/1987 1:00	12						0
1988-1	3/17/1988 10:00	3/18/1988 7:50	22						0
1988-2	12/5/1988 22:00	12/6/1988 3:00	5						0
1989-1	2/27/1989 1:00	2/27/1989 7:00	6						0
1989-2	5/7/1989 18:00	5/8/1989 14:30	21	5/8/1989 1:00	5/8/1989 3:00	2			0
1990-1	1/27/1990 3:00	1/27/1990 9:00	6						0
1990-2									0
1991-1	5/18/1991 18:00	5/20/1991 23:00	53						0
1991-2	8/5/1991 9:00	8/5/1991 16:00	7						0
1992-1	2/16/1992 17:00	2/17/1992 8:00	15						0
1992-2	10/26/1992 21:00	10/27/1992 1:00	4						0
1993-1	4/16/1993 18:00	4/17/1993 3:00	9						0
1993-2	12/20/1993 17:00	12/22/1993 7:00	38						0
1994-1	2/3/1994 17:00	2/4/1994 14:00	21						0
1994-2	4/7/1994 6:00	4/7/1994 21:00	15						0
1995-1	4/27/1994 14:00	4/29/1994 8:00	42	4/28/1994 0:00	4/28/1994 7:00	7			0
1995-2	12/23/1995 17:00	12/24/1995 19:00	26						0
1996-1	10/19/1996 10:00	10/22/1996 8:00	70	10/19/1996 13:00	10/20/1996 8:00	19			0
1996-2	12/20/1996 17:00	12/22/1996 11:00	42						0
1997-1	6/15/1997 13:00	6/16/1997 9:00	20						0
1997-2	7/9/1997 7:00	7/10/1997 14:00	31	7/9/1997 10:00	7/9/1997 18:00	8			0
1998-1	6/15/1998 9:00	6/16/1998 2:00	17	6/15/1998 13:00	6/15/1998 16:45	4			0
1998-2	10/29/1998 13:00	10/31/1998 17:00	52	10/30/1998 2:00	10/30/1998 19:00	17			0
1999-1	2/11/1999 13:00	2/12/1999 7:00	18						0
1999-2	3/2/1999 11:00	3/7/1999 7:00	116	3/3/1999 12:00	3/3/1999 21:00	9			0
2000-1	3/28/2000 6:00	3/31/2000 9:00	75						0
2000-2	2/9/2000 7:00	2/10/2000 17:00	34	2/9/2000 16:00	2/9/2000 23:00	7			0
2001-1	2/6/2001 2:00	2/7/2001 7:00	29	2/6/2001 7:00	2/6/2001 9:00	2			0
2001-2	3/4/2001 1:00	3/6/2001 22:00	69	3/4/2001 9:30	3/6/2001 7:00	46			0
2002-1	3/3/2002 7:00	3/4/2002 17:00	34	3/3/2002 16:00	3/4/2002 7:00	15			0
2002-2	2/11/2002 11:00	2/14/2002 3:00	64						0
2003-1	12/30/2002 15:00	1/2/2003 6:00	63						0
2003-2	2/5/2003 14:00	2/6/2003 15:00	25						0
2004-1	2/27/2004 17:00	3/1/2004 7:00	62	2/29/2004 14:00	2/29/2004 17:00	3			0
2004-2	3/25/2004 9:00	3/27/2004 7:00	46	3/25/2004 11:00	3/26/2004 7:00	20			0

The longest periods in which has been noticed the overpass of threshold defence levels were recorded during floods from 1979 and 1980 (over 165 hours), respectively from 1981 and 1999 (with durations for at least 120 hours). The analysis duration, shows a certain stagnant water phase, between attention and the flood levels for a long time, in most cases, exceeding the value of 40 hours.

5. CONCLUSIONS

Floods are one of the most frequent natural hazards that occur in Romania, and probably one that creates the largest damages, after earthquakes. The western part of the country, especially the lowland area associated with the Someş, Tur and Crişuri rivers is frequently affected by this type of hazards. Unfortunately, these hydrological phenomena's have gained a certain pattern expressed by a temporal cycle, with a low value of occurrence. The impact of these hazards has been considerably lowered due to the large embankment works that have been achieved in the catchment area of Tur River, after the flooding events from 1970s.

However, the peak discharges reached during these events, overpass the threshold safety levels, which can led to a certain risk, for the population and properties situated on the river banks.

One thing to note is the fact that almost all flood events exceeded the attention level in 51 cases (98%) out of 52 analysed, indicating the destructive character of these phenomena.

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