THE FLOOD WAVES ANALYSIS AT TURULUNG GAUGING STATION ON TUR RIVER

R. BĂTINAŞ,[1] V. SOROCOVSCHI,[2] D. SANISLAI [3]

ABSTRACT. – The flood waves analysis at Turulung hydrometric station on Tur River. The analysis of the flood waves has been done using the data recorded for a period of 18 years, between 1979 and 1996. 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.

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.

Tur River is a left tributary of upper Tisa River. The catchment area is covering a surface of about 1164 km^2 and can be divided into three large sub-units defined as follows: one unit in the eastern part, associated with the mountain area, one in the middle covering the Oaşului Depression area and a third unit to the west the lowest part, occupying the northern area of Western Plain (Fig. 1).

The river source is located at an altitude of 950 m, in the Igniş Mountains, with slope degrees that are decreasing from 20 m/km in the upper mountain area up to 2-8 m/km in the middle part and under 1 m/km in the plain area.

The most important tributaries of Tur River are: Lechincioara (S=286 km^2; L=29 km.) with its own tributaries Valea Rea (S=132 km^2; L=26 km) and Valea Albă (S=64 km^2; L=19 km) and from the left Slatina (S=35 km^2; L=8 km). In the lowlands the river is meeting other two tributaries: Turțul (S=36,6 km^2; L=22 km), and Racta (S=181 km^2; L=37 km) with Egher River (S=85 km^2; L=22 km).

[1] "Babeş-Bolyai" University, Faculty of Geography, Cluj-Napoca, e-mail: rbatinas@geografie.ubbcluj.ro
[2] "Babeş-Bolyai" University, Faculty of Geography, Cluj-Napoca, e-mail: sorocovschi@yahoo.com
[3] "Vasile Goldi□" University, Baia Mare, and "Babeş-Bolyai" University, Faculty of Geography, Cluj-Napoca e-mail: sanislaidaniel@yahoo.com

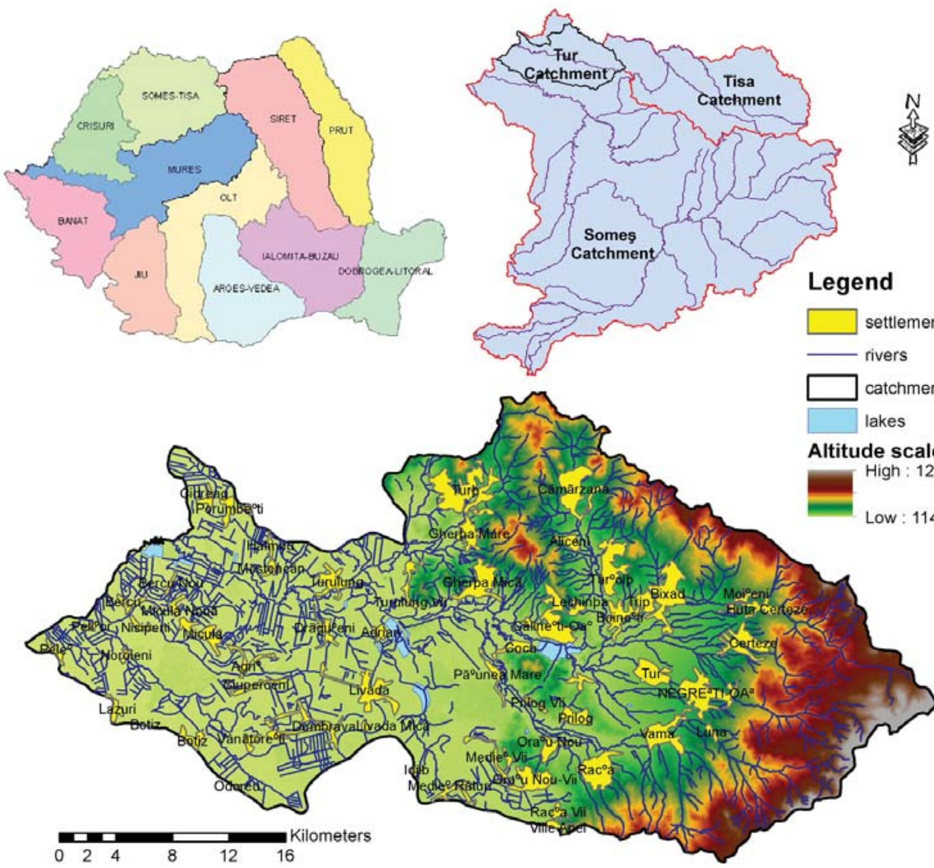

Fig. 1. Tur River catchment position in Romania

The hydrometric activity is monitored through a network of eight gauging stations, as described in table below (Table 1).

Table 1. Data regarding the hydrometric network of Tur catchment area and liquid flow (1979-2007) - (Pop, Oana, 2010)

Crt. No.	Stream	Gauging station	Hm (m)	F (km^2)	Q (m^3/s)	q ($l/s*km^2$)
1	Tur	Negreşti Oaş	716	38	0,891	23,44
2	Tur	Turulung	366	733	10,855	14,8
3	Talna	Păşunea Mare	402	170	2,311	13,59
4	Turț	Gherța Mare	315	36,6	0,523	14,28
5	Valea Rea	Huta Certeze	726	61	1,782	29,21
6	Talna	Vama	604	51	1,212	23,76
7	Lechincioara	Boineşti	318	84,6	1,009	11,9
8	Tarna	Tarna Mare	394	26,8	0,337	12,6

2. Temporal analysis of flood events

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.

In order to obtain expected results we have made an analysis for a 18 years period since 1979 to 1996. For each year has been taken into account the first two largest floods events that have occurred. Thus, we have considered 36 flood events, for which we have made a temporal and a data analysis. The seasonal time distribution of floods has revealed that the most frequent events occur in winter and spring (combining 81 % of the total events considered). This is the result of a usually warm period that occurs at the beginning and ending of the year, associated also with some rainy episodes (Fig. 2). Summer is the season with very few flood events (8 % from total number).

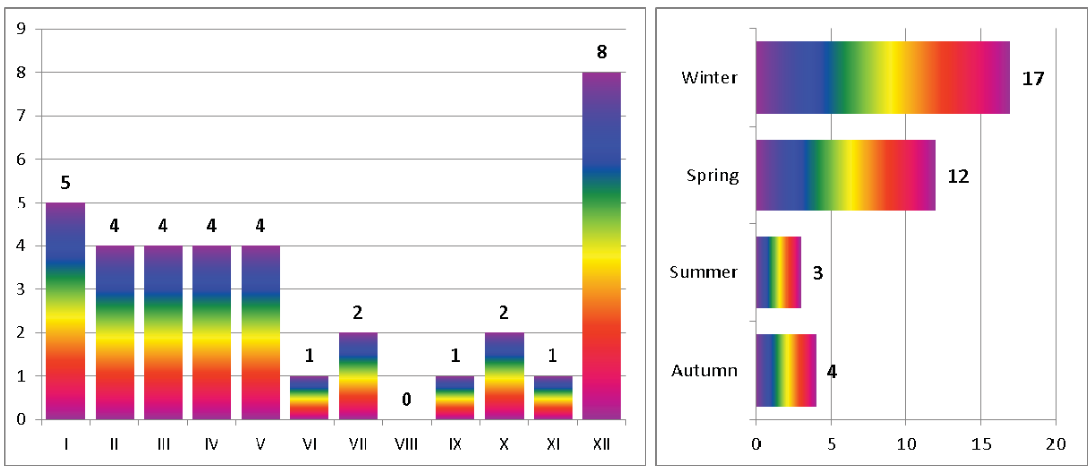

Fig. 2. Seasonal and monthly time distribution of floods at Turulung gauging station on Tur River (1979 - 1996)

The monthly distribution shows very high frequency of floods in the first five months of the year (four or more events), accumulating a total of 21events (58 % of total number). The highest number is recorded in December (8 events), while in August, has never been recorded a single event (Fig. 2).

A special analysis has been focused on the temporal moments of starting and ending for each flood event. The most sensitive time of year is associated with the ending of January, when during the interval between January 27 to 31, 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 1-5, 20-22) and December (on days 12-16. 23-26). Critical periods with three determined events were recorded also in May between the days 2 – 6. The least affected is the period from August to September, and even October, with a few exceptions of some isolated cases.

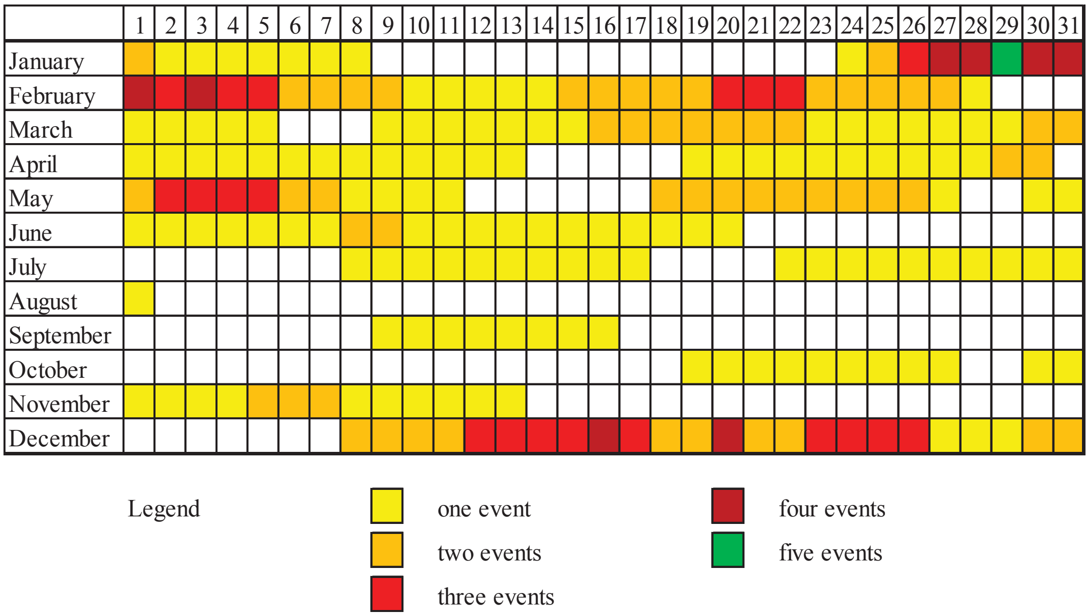

Fig. 3. The flood events occurrence at Turulung gauging station (1979-1996)

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.

Table 2. Synthetic statistic data of flood characteristics at Turulung gauging station

	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.	220	37.488	52.204	88.651	120.943	153	243	369
Min. val.	34.6	2.113	11.798	19.285	26.31	15	65	95
Avg. val.	108.49	11.514	28.645	40.159	54.717	59.64	145.7	205.3

In order to obtain these values we have integrated the observed raw data into specific software, called *Cavis*, developed by Ciprian Corbuş, from INHGA

Bucharest. 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 have leaded us to the following results:

- Maximum discharge - Qmax has oscillated in the analysed period of 18 years between 34,6 m^3/s (1990) and 220 m^3/s (1980), with an average value of 108 m^3/s.
- The increase volume – Wc had values between 2,113 mil. m^3 (1990) and 37,488 mil. m^3 (1979), with an average value of about 11,514 mil. m^3.
- The decrease volume – Wd has values that oscillated between 11,798 mil. m^3 (1991) and 52,204 mil. m^3 (1980), with an average value of 28,645 mil. m^3.
- Total volume – Wt has values between 19,285 mil. m^3 (1991) and 88,651 mil. m^3 (1979), with an average value of 40,159 mil. m^3.
- Runoff layer – Hs had values between 26 mm (1991) and 120 mm (1979), with an average value of 54 mm.
- Time increase period had values between 15 hours (19957) and 153 hours (1989), with an average value of 59 hours.
- Time decrease period had values between 65 hours (1993) and 243 hours (1979), with an average value of 145 hours.
- Total time duration has oscillated between the minimum value of 95 hours (1988) and a maximum one of about 369 hours (1979), with an average value for the whole period of about 205 hours.

4. Threshold defence 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 Turulung gauging station, the analysis of threshold level overpasses has revealed that for all 36 flood events analysed it has been overpassed the first defence level *(AL = 360 cm)* and for 35 flood events the second defence level *(FL = 420 cm)*. Regarding the danger defence level *(DL = 540 cm),* the monitored flood events have overpassed the third threshold level for 14 times (39 % of total events) (Table 3).

Table 3. Beginning and ending time moments of flood events against the threshold defence levels at Turulung gauging station (1979-1996)

	AL -360 cm			CI - 420 cm			DL - 540 cm		
Yr-nr	Qbi	Qbf	Hours	Qbi	Qbf	Hours	Qbi	Qbf	Hours
1979-1	1/25/1979 9:00	2/9/1979 7:00	358	1/25/1979 14:00	2/8/1979 5:00	327	1/25/1979 21:00	1/31/1979 21:00	144
1979-2	12/11/1979 20:30	12/15/1979 17:00	93	12/12/1979 2:45	12/14/1979 17:00	62	12/12/1979 13:00	12/13/1979 7:00	18
1980-1	7/22/1980 10:00	7/31/1980 17:00	223	7/22/1980 15:00	7/30/1980 19:00	196	7/22/1980 23:00	7/26/1980 17:00	90
1980-2	11/6/1980 7:00	11/15/1980 17:00	226	11/7/1980 7:00	11/13/1980 7:00	144	11/8/1980 1:00	11/9/1980 15:00	38
1981-1	3/10/1981 17:00	3/21/1981 17:00	264	3/11/1981 7:00	3/18/1981 7:00	168	3/12/1981 2:00	3/14/1981 9:00	55
1981-2	12/9/1981 7:00	12/18/1981 4:00	213	12/9/1981 12:00	12/15/1981 17:00	149	12/13/1981 5:00	12/14/1981 5:00	24
1982-1	1/1/1982 17:00	1/7/1982 17:00	144	1/3/1982 3:00	1/5/1982 7:00	52			
1982-2	4/28/1982 7:00	5/2/1982 17:00	106	4/28/1982 17:00	5/1/1982 15:00	70			
1983-1	1/30/1983 7:00	2/4/1983 17:00	130	1/30/1983 16:00	2/3/1983 7:00	87	1/31/1983 18:00	2/1/1983 10:00	16
1983-2	5/3/1983 3:00	5/6/1983 17:00	86	5/3/1983 12:00	5/5/1983 17:00	53			
1984-1	6/1/1984 6:00	6/7/1984 18:00	156	6/1/1984 18:00	6/2/1984 7:00	13			
1984-2	7/5/1984 18:00	7/10/1984 18:00	120	7/6/1984 4:00	7/9/1984 13:00	81			
1985-1	4/30/1985 6:00	5/9/1985 6:00	216	5/2/1985 22:00	5/7/1985 23:00	121	5/3/1985 14:00	5/5/1985 1:00	35
1985-2	5/19/1985 18:00	5/25/1985 06:00	132	5/20/1985 18:00	5/24/1985 06:00	84	5/21/1985 00:00	5/21/1985 03:00	3
1986-1	1/23/1986 17:00	1/30/1986 17:00	168	1/24/1986 15:00	1/29/1986 07:00	112	1/25/86 3:00	1/26/1986 22:00	43
1986-2	4/20/1986 06:00	4/24/1986 14:00	104	4/20/1986 10:00	4/23/1986 18:00	80	4/20/1986 20:00	4/21/1986 10:00	14
1987-1	2/15/1987 14:00	2/26/1987 07:00	257	2/16/87 5:00	2/25/1987 07:00	218			
1987-2	3/30/1987 17:00	4/5/1987 6:00	133	3/31/1987 07:00	4/3/87 9:00	74			
1988-1	3/17/1988 7:00	3/21/1988 07:00	96	3/17/88 11:00	3/20/88 5:00	66			
1988-2	3/21/1988 17:00	3/31/1988 06:00	229	3/22/1988 5:00	3/28/1988 18:00	157			
1989-1	2/21/1989 00:00	3/3/1989 17:00	257	2/25/1989 07:00	3/2/89 17:00	130			
1989-2	4/7/1989 22:00	4/11/1989 19:00	93	4/8/1989 3:00	4/10/1989 18:00	63			
1990-1	1/27/1990 07:00	1/29/1990 14:00	55	1/27/90 14:00	1/28/1990 07:00	17			
1990-2	6/10/90 6:00	6/11/90 18:00	36						
1991-1	5/19/1991 06:00	5/25/1991 18:00	156	5/19/1991 15:00	5/24/1991 20:00	125	5/20/1991 01:00	5/22/1991 01:00	48
1991-2	9/10/1991 12:00	9/15/1991 06:00	114	9/12/1991 18:00	9/13/1991 12:00	18			
1992-1	2/14/1992 17:00	2/20/1992 07:00	134	2/16/1992 07:00	2/19/1992 17:00	82			
1992-2	10/24/1992 17:00	11/7/1992 17:00	336	10/27/1992 17:00	11/6/92 17:00	240	11/1/92 3:00	11/2/92 3:00	24
1993-1	12/12/1993 7:00	12/21/1993 14:00	223	12/15/1993 17:00	12/20/1993 11:00	114	12/17/1993 10:00	12/18/1993 09:00	23
1993-2	12/19/1993 10:00	12/27/1993 17:00	199	12/20/1993 13:00	12/27/1993 07:00	162	12/20/1993 22:00	12/24/1993 11:00	85
1994-1	2/3/1994 2:00	2/13/1994 17:00	255	2/3/94 9:00	2/9/94 17:00	152	2/4/94 6:00	2/5/94 7:00	25
1994-2	12/12/94 21:00	12/18/94 18:00	141	12/13/94 19:00	12/18/1994 07:00	108	12/15/1994 03:00	12/15/1994 17:00	14
1995-1	1/24/1995 9:00	2/5/1995 2:00	281	1/24/1995 12:30	2/3/1995 7:00	235	1/26/1995 13:00	1/30/1995 07:00	90
1995-2	12/23/1995 21:00	1/2/1996 21:00	240	12/23/1995 23:30	1/1/1996 17:00	210	12/24/1995 07:00	12/29/1995 07:00	120
1996-1	10/19/1996 10:00	10/27/1996 11:00	193	10/19/1996 17:00	10/26/1996 07:00	158	10/19/1996 23:00	10/22/1996 17:00	66
1996-2	12/15/1996 4:00	12/27/1996 07:00	291	12/21/96 1:30	12/26/1996 07:00	126	12/21/1996 10:00	12/23/1996 07:00	45

The average time duration for overpassing the alert level was about 179 hours, with a maximum value of 358 hours (first flood of 1979), respectively a minimum value of 36 hours (the second flood event from 1990) (Fig. 4). The flooding alert level has an average time duration of 122 hours, with a maximum value of 327 hours (first flood of 1979), and a minimum value of 13 hours (first flood of 1984).

The danger threshold level was frequently overpassed, the average time duration associated with these occurrences was 49 hours, with a maximum value of 144 hours (first flood of 1979) and a minimum value of 3 hours (second flood of 1985).

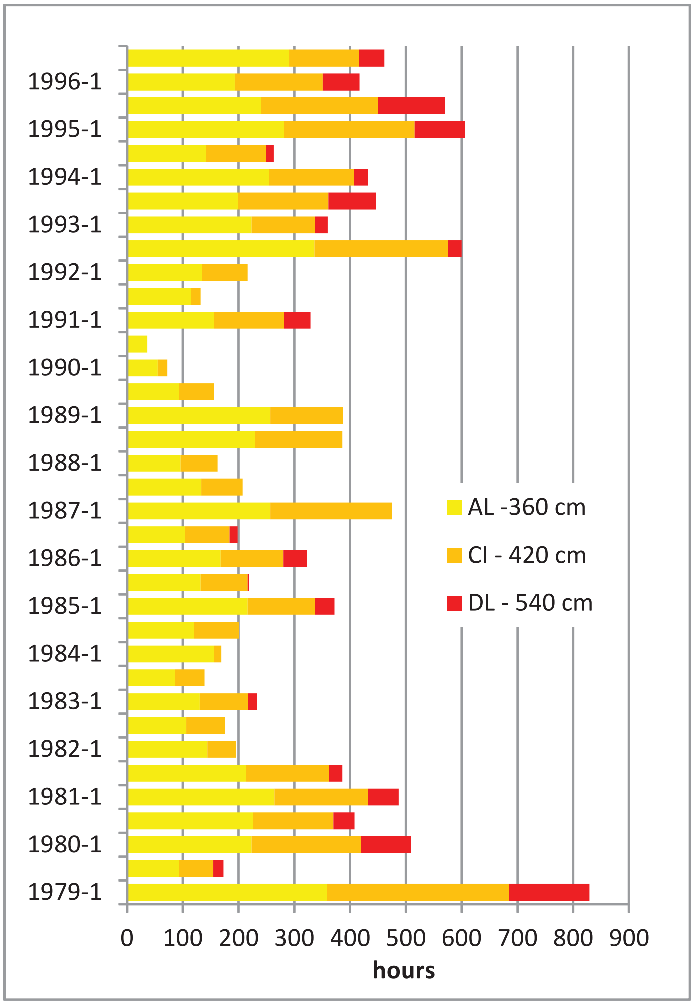

Fig.4. The duration time of the threshold defense levels overpasses at Turulung

The longest time duration period with excedeence of threshold defence levels are associated with the floods from 1979 (over 800 hours), floods from 1992 and 1995 (over 600 hours), floods from 1980, 1981 and 1987 (over 400 hours). We can noticed also that the last years from the analysed period were characterised by a high probability that the occurring flood events to overpass the threshold defence levels, including the highest one – the danger level.

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 and flood level in 35 cases (97 %) out of 36 analysed, indicating the destructive character of these phenomena.

REFERENCES

1. Arghiuş V. I., (2008), *Studiul viiturilor de pe cursurile de apă din estul Munților Apuseni şi riscurile asociate,* Editura Casa Cărții de Ştiință, Cluj Napoca.
2. Bătinaş, R., Sorocovschi, V., Şerban, Gh., (2002), *Fenomene hidrologice de risc induse de viituri în bazinul inferior al Arieşului¸* Seminarul Geografic Dimitrie Cantemir, Iaşi.
3. Bătinaş, R., Sanislai, D., (2012), *Some Aspects Regarding the Flood Waves Analysis at Satu Mare Hydrometric Station on the Someş River*, vol. Aerul şi Apa, componente ale Mediului, pag. 127 – 132, Cluj-Napoca
4. Bătinaş, R., sorocovschi, V., Sanislai, D., (2014), *The flood waves analysis at Păşunea Mare gauging station on Talna River (Tur Basin),* vol. Aerul şi Apa – componente ale mediului, Editura Casa Cărții de Ştiință, Cluj-Napoca.
5. Pop, Oana, (2010), *Studiul scurgerii lichide din bazinului hidrografic Tur*, Teza de doctorat, Facultatea de Geografie, Cluj-Napoca.
6. Toma Florentina-Mariana, Barbu, I., (2011), *Issues concerning occurrence of floods on the Vedea River*, vol. Aerul şi Apa, componente ale Mediului, Cluj-Napoca.
7. *** *Cavis software* – developed by Ciprian Corbuş, INHGA, Bucureşti.
8. *** (2012), TICAD - Tisa Catchment Area Development, *Development Strategy of the Someş Catchment Area*, Coordinators: P. Cocean, Annamaria Goncz ISBN 978-973-53-0736-3, Editura Risoprint, Cluj-Napoca.
9. *** *Hydrological data recorded at Păşunea Mare hydrometric station*, ABA Someş-Tisa, 1974 – 2004.