Scientific Papers. Series A. Agronomy, Vol. LVI, 2013
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

STUDY ON THE HIDROCLIMATIC PARAMETERS IN THE UPPERBASIN OF THE TÂRGULUI RIVER AND THEIR ENVIRONMENTAL IMPACT

Cristina-Mihaela CHICHIREZ, Sorin Mihai CÎMPEANU, Doru Ioan MARIN

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blvd., District 1, 011464, Bucharest, Romania

Corresponding author email: chichirez.cristina@gmail.com

Abstract

The evaluation of the hydrological parameters allows the elaboration of the hydrological forecasts and the identification of the risks arising from flash flood, construction size and improvement of the hydrotechnical buildings. In the upper basin of the Târgului River, annual precipitation ranges from 429.6 mm to 1209.3 mm, the lowest amounts being recorded in February (36.9 mm) and highest in June (115.8 mm). The mean annual runoff was recorded at the Voina hydrometric station, i.e. 2.05 m^3/s, and the highest reached was 75. 0 m^3/s. Between 1970 and 2009, 181 flash floods occurred, of which 7 were major (4%), with flow rates above 38 m^3/s, exceeding the attention share. Probabilistic calculations show that every 100 years the maximum flow rate can reach 99.10 m^3/s, and every 50 years it can exceed 76.84 m^3/s. The hydrotechnical objectives built on the Târgului River in the 1980s changed the natural flow of water, affecting the morphology of the area and its ecological balance.

Key words: *accumulation, attention share, runoffs, precipitations, flash floods.*

INTRODUCTION

Knowledge of the characteristics and particularities of a hydrographical basin presents a special importance for the sustainable and efficient management of water resources, in accordance with the current legislation. 'The defense and improvement of the environment is an issue of major importance which affects the well-being of populations and economic development throughout the world. It corresponds to the desire of the peoples of the world and is a duty for all governments" (Stockholm Declaration, June 1972).

Water resources present a sharp sensitivity to climate change. Relatively small variations in climate can cause large problems for water resources. Besides the climatic factors, the anthropic factor has an important role owing to the changes in the water flow regime and the morphology of the area (Musy and Laglaine, 1992).

The Hydrographical Basin of the Târgului River is the most important water system of the Upper Argeş, with an area of 1096 km^2, a length of about 70 km and a mean width of about 25 km. Springing from the Iezer Mountains, the Târgului River drains via the tributaries Bătrâna and Râuşor, ice beneath of the peak of the Iezer Mountains. After crossing the Câmpulung Depression, in the Piedmont Hills area, it receives two main tributaries, Bratia and Bughea on the right, and the Argeşel River on the left.

There is a series of hydrotechnical objectives built on the Târgului River in different stages, which have an interconditioned operation, in order of upstream-downstream: accumulation of the Râuşor, CHE Lereşti, Lereşti polder, CHE Voineşti , Voineşti polder, Schitu Goleşti and Voineşti accumulation and Schitu Goleşti CHEMP. These arrangements have increased its economic importance but have also changed its ecological balance.

MATERIALS AND METHODS

For this study we used the data from the Câmpulung weather station (A.N.M.) and for the assessment of water resources we used the data from the Câmpulung hydrological station (ANAR-DAAV) for the period 1970-2009. The following were calculated and interpreted:

- monthly and annual precipitation;

- the mean, minimum and maximum monthly and annual flow;
- extreme phenomena – flood production.

RESULTS AND DISCUSSIONS

The orographic configuration of the Târgului River basin, with the altitudinal layout of the main forms of relief, and a general orientation to the South and the mountains in the North, have marked the distribution of air masses and the weather course directly, causing a local climate characteristic of the Carpathian Depressions.

In the Câmpulung Muscel Depression, precipitations amount varies greatly from one year to another due to the continuous fluctuations of the general circulation of the atmosphere, as determined by the frequency and duration of displacement and the development of the atmospheric systems, baric fronts, and air mass nature. Pluviometric fluctuations result from the years with significant cyclonic activity, alternating with years of blockage and persistent anticyclonic circulation.

At Câmpulung, the mean multiannual of the annual precipitations amount was 798.5 mm. Equation of the regression line recorded a negative coefficient (-0.8823), which showed a slight declining trend in the annual precipitations, caused by the increasing anticyclonic activity (Figure 1).

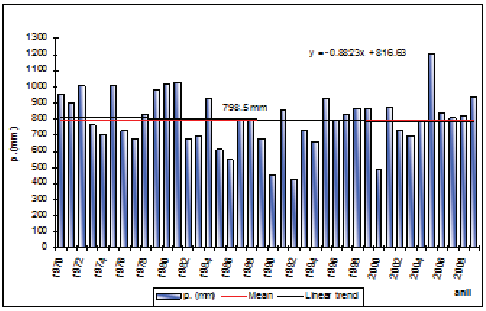

Figure 1. Annual variation of precipitations (mm) at Câmpulung (1971-2009)

Between 1970 and 2009, the lowest precipitations were: 1992 (429.6 mm), 1990 (452.9 mm), 2000 (485.8 mm), 1986 (546.3 mm) and 1985 (610.4 mm). The highest precipitations were recorded in 2005 (1209.3 mm), 1981 (1026.7 mm), 1980 (1016.7 mm), 1975 (1012.2 mm), 1972 (1006.2 mm) and 1979 (975.3 mm).

Annual precipitations differ from one month to another, due to the influence of the front type acting in the area, resulting in the interference of the tropical air masses with the polar ones. The lowest precipitations occurred between January and March, as a result of the predominant anticyclonic regime which prevented the development of the thermal convection.

The driest month was February, in the period 1970-2009, when the mean precipitations amount was 36.9 mm. Since March, precipitations increased progressively until June, when they recorded the maximum (115.8 mm), after which they started to decline towards the end of the year, the multiannual mean of December being 46.6 mm. The monthly extreme precipitations amounts varied between very broad limits of 0.1 mm (December 1972) to 147.4 mm (December 1981). In the warm season, they varied between 21. 2 mm in June 2003 and 277.2 mm in June 1974 (Figure 2).

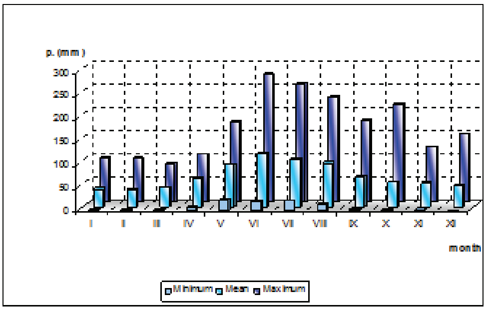

Figure 2. Monthly variations of mean, minimum and maximum precipitations at Câmpulung meteorological station (1971-2009)

The analysis of the precipitations fallen within 24, 48 and 72 hours was also important. Large precipitations in a short span of time were favoured by certain synoptic situations, and less local physical and geographical conditions.

In the Câmpulung Muscel Depression between 1971 and 2010, the highest precipitation amount fallen in 24 hours was 104.4 mm (June 1975). The highest amounts fallen in 48 and 72 hours were 133.7 mm and 138.2 mm (July 1981 and 1975, respectively) (Figure 3).

Precipitations with a rate of over 100 mm in 3 days were recorded in June 1975, 1979 and 1984, July, 1975 and 1981, August 1997 and 2005, September 2005 and October 1972.

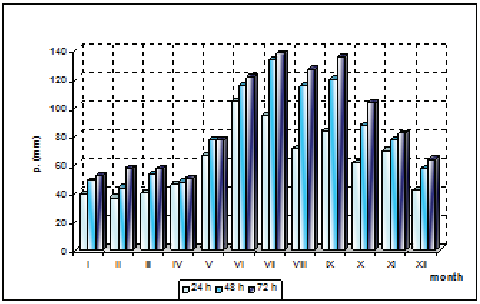

Figure 3. Maximum precipitations fallen at Câmpulung in 24, 48 and 72 hours (1971-2010)

The probabilistic calculation, after the Gamma double exponential distribution method, highlighted that every 100 years the maximum precipitations fallen in 72 hours might reach 152.8 mm, every 50 years could surpass 141.1 mm, and every 20 years could exceed 124.5 mm. For the highest precipitations recorded, the amount was 2.44% (138.2 mm), 4.88% (135.7 mm), 7.32% (133.7 mm) and 9.76% (126.9 mm) (Figure 4).

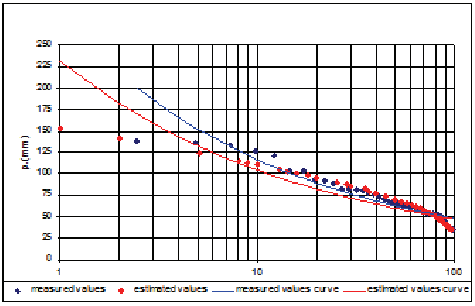

Figure 4. Highest precipitations measured and estimated in Câmpulung Muscel Depression in 72 hours (1971-2010)

The monthly and annual fluctuations of precipitations in turn generate large variations of the riverflows. In this context, the annual mean of the runoff recorded on the Târgului River at the Voina hydrometric station ranged between 1.09 m^3/s, in 1990 and 3.20 m^3/s in 2005; the multiannual flow mean was 2.05 m^3/s (Figure 5).

The flow rates under the multiannual mean were concentrated in the period 1982-2003, which represented 55%, except for 1991 and 1998, when the flow exceeded the multiannual mean. The lowest mean annual flows were recorded in the years: 1986 (1.39m^3/s), 1990 (1.09m^3/s), 1992 (1.11m^3/s), 1993 (1.37 m^3/s) and 2000 (1.32 m^3/s). The flow rates over multiannual mean were present in 45% of the cases, being concentrated in the range 1970-1981. The highest mean annual flows were recorded in the years: 1970 (3.05 m^3/s), 1972 (2.86 m^3/s), 1975 (2.84 m^3/s), 1991 (2.73 m^3/s) and 2005 (3.20 m^3/s). Throughout the analyzed period, the multiannual mean flow rates recorded an increasing trend, the regression line equation having a negative coefficient.

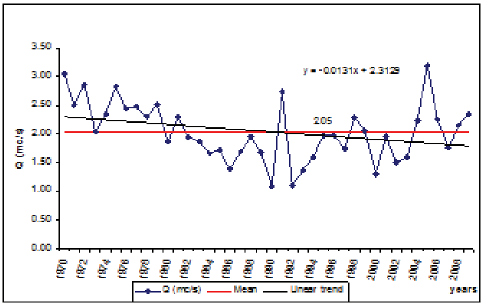

Figure 5. Annual mean flows, recorded on the Târgului River, at the Voina hydrometric station (1970-2009)

Studying the seasonal repartition of the mean flow at the Voina hydrometric station during 1970-2009, we found that the lowest amount of drained off water was recorded in winter (13.5%), and highest in summer (33.8%) (Figure 6).

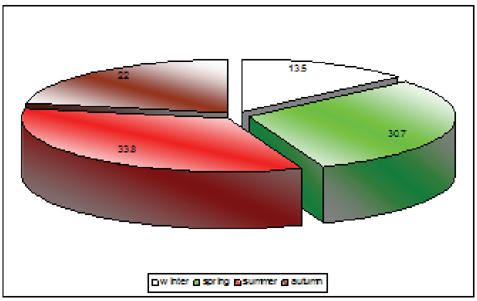

Figure 6. Seasonal repartition of the mean runoff on the Târgului River, at Voina (1970-2009)

The monthly mean of the flow highlighted a large variability of the flows during the year. The lowest values of the flows were recorded in January, February, March and December, i.e. between 0.94 and 1.33 m^3/s, and the highest in May and June, i.e. 4.16 m^3/s and 3.51 m^3/s, respectively. The minimum flow rates were between 0.34 m^3/s in February 1984 and December 1976, and 0.95 m^3/s, in June 1992 (Figure 7).

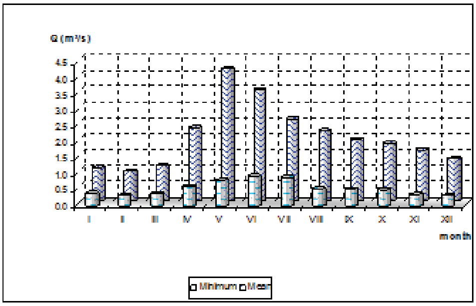

Figure 7. Monthly minimum and mean flows recorded on the Târgului River, at Voina (1970-2009)

The maximum runoff values ranged between 5.74 m^3/s in March 1976 and 75.00 m^3/s in August 1999 (Figure 8).

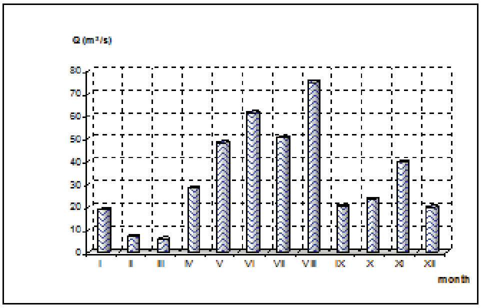

Figure 8. Monthly maximum flows recorded on the Târgului River, at the Voina (1970-2009)

The minimum and maximum flow are important characteristics of the hydrological regime, with major practical implications that need to be taken into account in the design, implementation and operation of hydroconstructions, the judicious management of the water, the pooled flood vulnerability and defense (Pişotă et al., 2005).

The maximum flow is the most important phase, being generated by torrential rains, sudden snow melt or superimposition of the two events. At the Voina hydrometric station, at a rate of 38 m^3/s, water level reaches a warning shade of 120 cm, which means share danger of major floods in the riverbed (Drobot et Şerban, 1999).

At the Voina hydrometric station between 1970 and 2009, the share of attention was superseded in 7 years, representing 17.5 % of the situations. The years when the shade of attention was superseded were: 1973 (48.5 m^3/s), 1975 (50.5 m^3/s), 1983 (50.7 m^3/s), 1998 (61.7 m^3/s), 1999 (75.00 m^3/s) 2004 (39.61 m^3/s) and 2005 (38.5 m^3/s), maximum flow rates due to an uptrend (Figure 9).

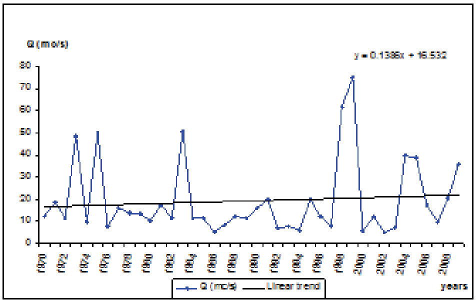

Figure 9. Annual maximum flows recorded on the Târgului River, at the Voina (1970-2009)

The Pareto curve highlighted the possible registration of the maximum flow rates higher than the measured ones (Helsel et Hirsch, 1992). Probabilistic calculations showed that every 100 years (0.01 %) the maximum flow rate could reach 99.10 m^3/s, every 50 years (0.02) they might exceed 76.84 m^3/s, and every 20 years (0.05 %) they could exceed 52.98 m^3/s (Figure 10).

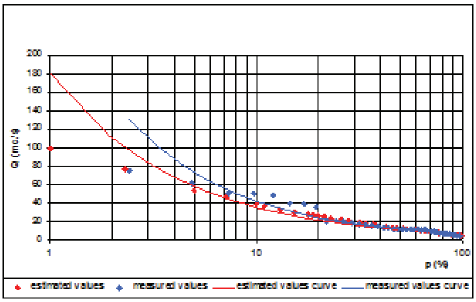

Figure 10. Assurance of maximum flows measured and estimated at the Voina hydrometric station (1970-2009)

The highest flow recorded had an assurance of 2.44 % (75.00 m^3/s), 4.88 % (61.70 m^3/s), 7.32 % (50.70 m^3/s) and 9.76 % (50.50 m^3/s).

On the Târgului River, at the Voina hydrometric station, between 1970 and 2009, there were 181 flash floods, with flow rates ranging between 5.00 and 75.00 m^3/s, of which 91% were minor flash floods, with flow rates of 5 m^3/s to 15 m^3/s, 5% of mean flood with flow rates between 15-38 m^3/s, and 4% major flash floods with flow rates above 38 m^3/s (Figure 11).

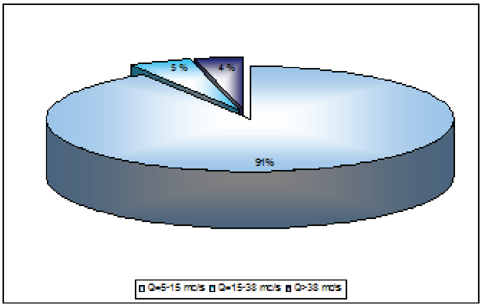

Figure 11. Classification of flash floods from flow on the Târgului River, at Voina (1970-2009)

Most flash floods were recorded on August 13, 1999, as a result of abundant rainfall, which totalled 170 l/m^2 in the range August 11-13.

The maximum flow rate reached 75 m^3/s, considered a historic flow, the highest recorded on the Târgului River, at Voina (Figure 12).

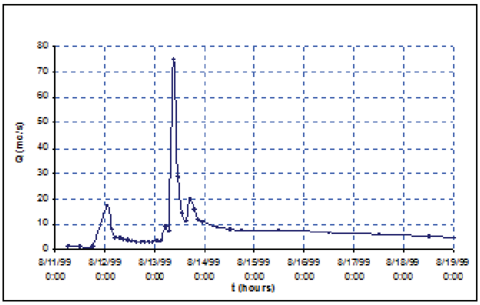

Figure 12. Flood hydrograph recorded on the Târgului River, at Voina (August 11-19, 1999)

Several objectives were built on the Târgului River in the 1980s, which altered the water regime of the natural water flow, affecting the morphology of the area and its ecological balance. The most important goal is the Râuşor accumulation, with an area of 160 hectares and a volume of 52.80 mil. m^3. In addition to the constructive functions of the Râuşor dam electricity production, the supply of drinking water and industrial area of Câmpulung, and mitigation of flood waves recorded an available volume of 15.6 million m^3 (Figure 13).

Figure 13. The Râuşor dam and accumulation (original photo)

By creating the lake, the flow of ground water was altered, with a considerable influence on slope stability. Large and rapid fluctuations of the water levels in the lake rose due to inertia and large-scale gradients, which enabled an underground leak, causing a series of landslides in 1988 and 1991 (Figure 14).

Figure 14. Slipping on the left slope (original photo)

The stability of the slope reserve was low, under conditions in which the water level in the lake was close to the normal retention (906.50 mdM); the reserve was lower and the water level was higher. For this reason, recommendations included limiting the lowering speed of the water level in the lake at the maximum value of 0.1 m/day, when the water level in the lake exceeded 890 mdM.

Stopping or reducing the important solid material transport into the lake led to the downstream flow defluation of relatively clean water, with increased erosion, which was no longer in balance with the existing riverbed upstream (Figure 15).

Figure 15. Riverbed of the Târgului River, upstream of the dam (original photo)

Thus, the riverbed downstream from the lake would be gradually eroded until it restored the balance between the riverbed slope and the new transport. The riverbed downstream was subject to erosion due the pulsatory flow for producing electricity from the top (Figure 16).

Figure 16. Riverbed of the Târgului River downstream of the dam (original photo)

Flora had a special role in maintaining ecological balance, through air and water oxygenation, providing shelter and living conditions for animals, birds and fish and, last but not least, by the beauty of the landscape. By creating the lake, water conditions changed radically, the poor flora was replaced with lush vegetation on the banks, owing to the highly humid local micro climate (Gâştescu et al., 2003). At the same time, the hydrotechnical facilities on the Târgului River were a landmark, the beauty of the new views created by the dam, which can attracts tourists interested in a grand sight or water sports, swimming or fishing in the waters of the lake.

CONCLUSIONS

In the upper basin of the Târgului River, annual precipitations range between 429.6 mm and 1209.3 mm, with a multiannual mean of 798.5 mm. The lowest precipitations were recorded in 1985, 1986, 1990, 1992 and 2000, while the highest 1972, 1975, 1980, 1981 and 2005.

The annual precipitation values differed from one month to another, the lowest precipitations being recorded in January-March (36.9-40.7 mm) and the maximum in June (115.8 mm).

The annual mean runoff, recorded on the Târgului River at the Voina hydrometric stations, ranged between 1.09 m^3/s, in 1990 and 3.20 m^3/s, in 2005, the multiannual mean flow of 2.05 m^3/s, the lowest water volume being drained in winter (13.5%), and highest in summer (33.8%).

At the Voina hydrometric station, at a rate of 38 m^3/s, the water level reached the share of attention of 120 cm, which means danger of flooding in the riverbed. The share of attention was superseded in 1973 (48.5 m^3/s), 1975 (50.5 m^3/s), 1983 (50.7 m^3/s), 1998 (61.7 m^3/s), 1999 (75,0 m^3/s), 2004 (39.61 m^3/s) and 2005 (38.5 m^3/s).

The hidrotechnical objectives, built in the 1980s on the Târgului River, altered the natural flow of water, which may have a morphological impact and affect the ecological balance of the area.

REFERENCES

Drobot R., Şerban P., 1999. Aplicaţii de hidrologie şi gospodărirea apelor, Ed. H.G.A., Bucureşti.

Gâştescu P., Driga B., Sandu Maria, 2003. Lacurile de baraj antropic - între necesitate şi modificări ale mediului, Editura Casa Cărţii de Ştiinţă, Cluj - Napoca.

Helsel D.R., Hirsch R.H., 1992. Statistical methods in water ressources, Elsevier, Amsterdam.

Musy A., Laglaine V., 1992. Hidrologie générale, IATE-EPF, Lausanne.

***Arhiva de date climatologice a Administraţiei Naţionale de Meteorologie, Bucureşti.

***Arhiva de date hidrologice ANAR-DAAV.

***Declaraţia de la Stockholm, iunie 1972.