HYDROLOGICAL RISK PHENOMENA CAUSED BY EXCESS RAINFALL ON THE PRUT RIVER

FENOMENE DE RISC HIDRIC ASOCIATE REGIMULUI PLUVIOMETRIC EXCEDENTAR PE RÂUL PRUT

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Abstract :*Prut Basin is an objective with an international importance. The river which drains this area is the eastern border of the European Union and NATO. Devices to monitor water resources are unevenly distributed within the three states : Ukraine, the Republic of Moldova and Romania. Flood risk assessment is difficult as the genesis of this phenomenon is a complex process. Climatic factors have an essential influence on floods. The heavy rainfall of the Wooded Carpathians triggered large quantities of water on Prut River in 2008 and 2010. They were significantly reduced in Romania after the construction of the dam at Stanca – Costesti. The upstream sector has been affected by floods due to a large volume of water stored behind the dam. The diminishing role was decisive for the downstream flood waves: they did not have the same impact. Unauthorized exploitation of gravel from the riverbed and deforestation increased floods damage, so the anthropogenic impact is highlighted.*
Key words : *rainfall, flood, hydrographer, management, risk*

Rezumat : *Bazinul Hidrografic Prut este un obiectiv de importanță internațională. Râul care drenează această suprafață este granița de est a Uniunii Europene și a NATO. Infrastructura de monitorizare a resurselor de apă din bazin este inegal distribuită în cele trei state pe care se întinde: Ucraina, Republica Moldova și România. Evaluarea riscului la inundații este dificilă deoarece geneza unei viituri este un process complex. Factorul climatic influențează decisiv viiturile. Ploile torențiale căzute în Carpații Păduroși au declanșat inundațiile pe râul Prut în 2008 și 2010. Ele au fost diminuate, pe teritoriul României, după construirea acumulării Stânca – Costești. Sectorul situat în amonte a fost afectat de inundații din cauza stocării unui volum însemnat de apă în spatele barajului. Rolul de atenuare a fost hotărâtor pentru viitura să nu aibă un impact la fel de puternic în aval. Exploatările neautorizate de pietriș din albia minoră și defrișările au amplificat pagubele provocate de inundații.*
Cuvinte cheie : *precipitații, viitură, hidrograf, management, risc*

INTRODUCTION

Flash floods occur in the river valleys when the water level exceeds the rate banks of the riverbed or accidentally, when defense constructions are discharged or they fail to static or dynamic action of water currents. Natural flooding happens

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regularly and the land area affected depends on the variation of the land rates, high water level, the flow and duration of the flood wave (Hâncu et al., 1971).

Floods impact has grown in the contemporary period as a result of climate change and urbanization, and there have been significant economic damages and casualties (Pandi, 2010). In the last years the main rivers in Eastern Romania recorded their historic flows: Siret (2005) – 4650 m^3/s, Suceava (2008) - 1946 m^3/s and Prut (2008) – 4240 m^3/s.

Prut Basin is an objective with an international importance. The river which drains this area is the eastern border of the European Union and NATO. Devices to monitor water resources are unevenly distributed within the three states: Ukraine, the Republic of Moldova and Romania, as well as the distribution of qualitative and quantitative water properties. The differences between the three states result from quality management policies, economic requirements, control of environmental pollution. The number of devices with the role of wastewater treatment which are located along the tributaries is also unequal.

In Europe, the Prut River Basin is located in the extreme eastern part of the Danube Basin. Prut River is a left tributary of the first order. It flows from the Wooded Carpathians and it enters Romania north of Oroftiana, after scouring 251 km in Ukraine.

MATERIAL AND METHOD

This paper aims to highlight the characteristics of fluid flow in July – August 2008 and 2010, knowing the values recorded at hydrometric stations, placed along the Prut River, upstream and downstream of the Stânca – Costești Lake : Rădăuți – Prut, Stânca – Aval. This information was supplemented with data from journeys made by authors in the field. We made average daily flow hydrographs to compare significant values with the average flow for the months under discussion. The hydrograph shape ilustrates two types of floods: simple and compound. (Minea et al, 2007)

This paper analyses the hydrological risks following two aspects: recorded values and the flood type.

RESULTS AND DISCUSSION

Flood risk assessment is difficult as the genesis of this phenomenon is a complex process. The Romanian authorities' effort to plan Prut River Basin by damming and building Stânca – Costești Lake illustrates the climatic factor, without diminishing the importance of others that cause floods (geological, morphological and morphometric) (Rusu, 2007).

The heavy rainfall in the Wooded Carpathians triggered large quantities of water on Prut River in 2008 and 2010. In 2008 the average rainfall values recorded at meteorological stations in Romania were between 150 mm and 200 mm in 40 days (At Botoșani station the average was 178 and at Cotnari the value

achieved 209,1 mm) (Romanescu et. al., 2010). Precipitation amounts have increased the flood in Rădăuți – Prut section and the same scenario was repeated in 2010, when the flood peak had a value of 2137 m^3/s.

Currently the anthropogenic intervention on the Prut basin is represented by unauthorized exploitation of gravel in the riverbed and deforestation, which have increased the damage from floods (Soroceanu et al, 1997 - 1998).

In 2008, the flood started on 24th July at Rădăuți – Prut, the initial flow value registered 217 m^3/s and on the hydrograph we observed a simple flood. In late July, the flow was 589 m^3/s, but the flood continued in the first decade of August. The final flow value was 176 m^3/s on 7th August 2008, and the base flow reached 196,5 m^3/s. The July average was 568 m^3/s obtained from flow values between 39,2 m^3/s (10th July, 2008) and 4240 m^3/s (28th July, 2008). The inhomogeneous nature of the records determined significant differences between the average flow and the values recorded during the flood event.

The average flow for 2008 was 137 m^3/s, higher than the multiannual average flow, which in the range from 1950 to 2008 was 81.2 m^3/s. In 2010, the annual average reached a higher value than in 2008, 156 m^3/s.

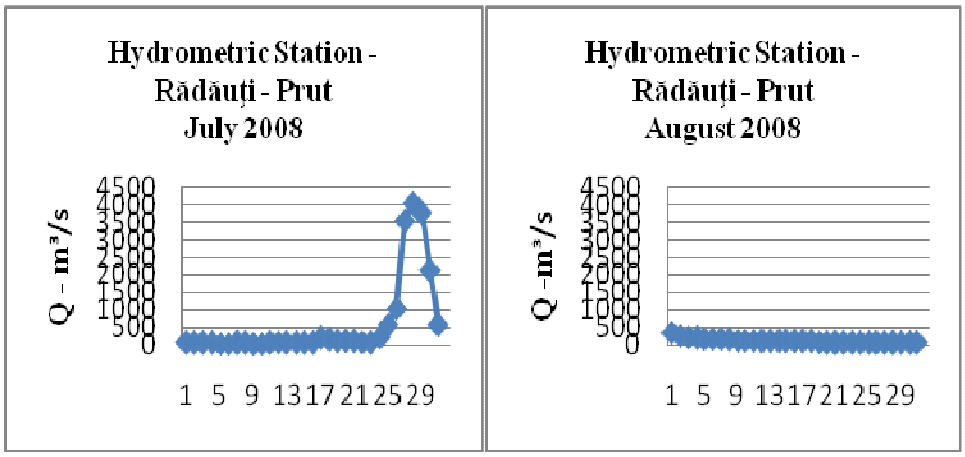

Fig. 1 - Liquid flow hydrographs - Prut River

The danger level (CP) at Rădăuți – Prut station was reached on 27th July, 2008, with a value of 1088 cm (+ 488 cm above CP) and maintained a rising trend in the next two days (1188 cm, 1134 cm respectively). To the confluence with the Danube, Prut river rates were maintained at levels between 500 and 650 cm, +10, +20 cm above the danger level.

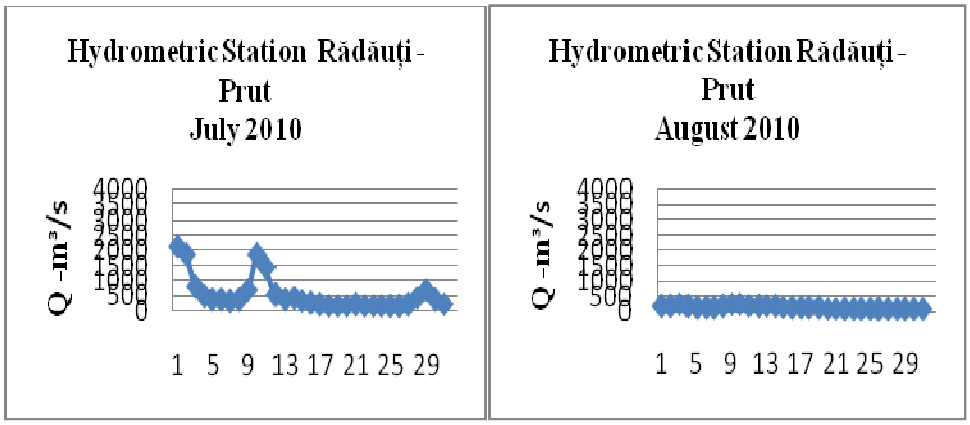

Fig. 2 - Liquid flow hydrographs – Prut River

Every two years in the same section, the flood hydrograph shows two successive peaks, but the phenomenon occurred in first half of July 2010. The first flood peak recorded a lower value than in 2008, but it is a significant one – the maximum of July in that year. The average flow registered 530 m^3/s and was obtained from values between 135 m^3/s (26th July, 2010) and 2137 m^3/s (1st July, 2010). The second peak, with a flow rate of 1878 m^3/s, recorded on 10th July 2010, is a significant value compared with the average of July in the same year.

In 2008 the impact of the flood at Radauti - Prut was due to the aggregation of contrary forces: the flood wave coming from the territory of Ukraine and the remuu wave which was originated in the lake and propagated upstream to a distance of about 70 km (Romanescu et. al. 2010).

The downstream section of the Stânca – Costeşti Lake illustrates the flood defense role. In the Romanian Register of Large Dams, Stânca – Costești ranks 49 in the order of height and 2 according to the volume of lake (1290 hm^3, after the 2100 hm^3 of Porțile de Fier I).

At normal retention (NNR - 90.80 m) the length of the reservoir is 70 km and the maximum (Nmax - 99.50 m) should not exceed 90 km. The lake surface at normal retention level is 5900 ha and 9200 ha at maximum reach. The flow calculation, providing 0.1%, is set at 1560 m^3/s and corresponds to a level of 99.50 m .

At the end of July 2008, the lake water level values were 98.21 m (30th July 2008) and 98.20 m (31st July 2008), and the maximum amount retained was 745 million m^3, a value that exceeds the gross volume of accumulating normal retention level (735 million m^3).

According to the rules of operation, flood control is achieved by the slice volume of 550 million m^3, which can be build between the normal upper retention and the high rate damper barrier, plus the slice of 115.0 million m located above

the upper edge of stem damper.The flood with a probability of 1% is attenuated from 2940 m^3/s to 700 m^3/s, which together with the existing embankments on the Prut River downstream of the reservoir, get under the effect of flood 100,000 hectares of meadow land.

At the hydrometric station Stânca – Aval, the flood of 2008 had a peak of 1050 m^3/s, while the damming of the Prut River allows a discharge flow of 756 m^3/s In 2010 values observed on the hydrographs do not exceed this flow in the range July-August 2010.

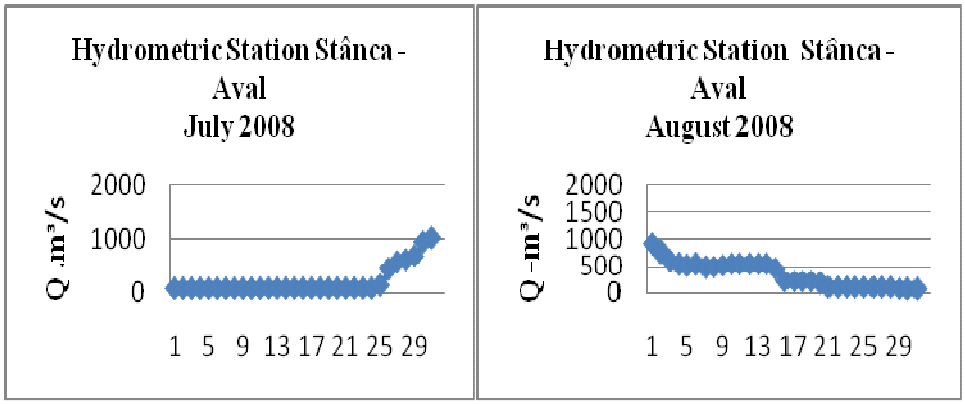

Fig. 3 - Liquid flow hydrographs - Prut River

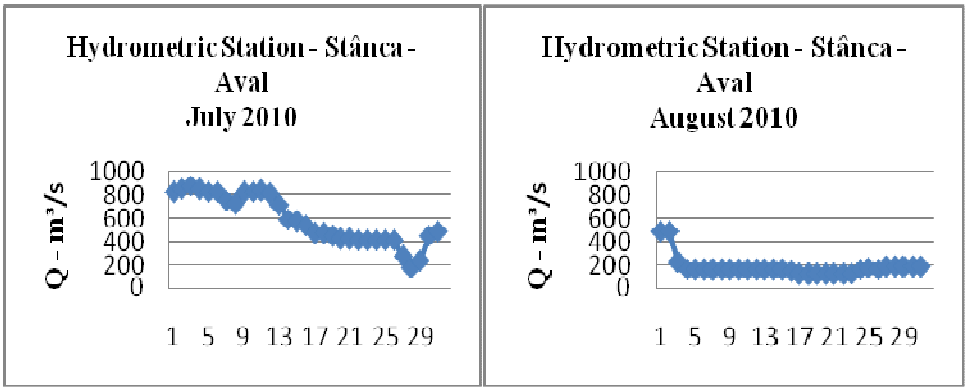

Fig. 4 - Liquid flow hydrographs - Prut River

In 2010, significant values were recorded in the first half of July: 879 m^3/s, respectively 839 m^3/s, for the average flow of 588 m^3/s. Comparing to 2008, when the average of July was 212 m^3/s and the maximum flow reached 1050 m^3/s, in 2010 the differences between the average flow and significant values are lower.

The annual average flow recorded at Stânca - Aval was 133 m^3/s, close to the maximum annual average since 1980 (139 m/s). Between 1950 – 2008, the annual average flow in this section was 83.5 m^3/s.

CONCLUSIONS

Flash floods are typical when the hydrographic network is richly supplied. Large amounts of water enter the system from the high intensity rainfall and/or sudden melting of snow, depending on the climate of the region (Pandi, 2010).

1. Prut floods were significantly reduced in Romania after the construction of Stânca – Costeşti reservoir. The impact of flooding on the upstream sector was emphasized by storing a significant amount of water behind the dam. The diminishing role was decisive for the downstream flood waves: they did not have the same impact.

2. Unauthorized exploitation of gravel in the riverbed and deforestation have increased the damage made by the floods in the Prut River. Anthropogenic intervention triggered negative reactions, and these imbalances made floods emerge stronger.

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