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EVOLUTION OF WATER RESOURCES IN FLOODPLAINS OF EMBANKED RIVERS

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Abstract

The paper analyzes the evolution of water resources in the floodplain of the Prut river, corresponding to the Trifesti Sculeni sector: the hydrological network, under natural flow regime and under anthropic modified regime, the hydraulic arrangements realized (embankments, drainage, draining, irrigation, etc.) and their impact on the hydrological and hydric regime of the studied area are inventoried. The impact of damming on the river flow regime during floods is exemplified using data recorded at hydrological gauging stations in the natural flow and in the dammed regime: comparative graphs of floods were prepared for the Prut and Jijia Rivers.

Introduction

In Romania, for flood protection, many rivers have been dammed using the Saligny solution (non-submersible embankments).This principle was also applied along the rivers of the Prut basin (Fig 1). In this paper, the hydrological network, under natural flow regime and anthropic modified regime, the hydraulic arrangements realized (embankments, drainage, draining, irrigation, etc) and their impact on the hydrological regime of the study area are inventoried. The purposes of these arrangements were flood protection and the increase of agricultural areas.

1. Methodology / Study area

The Sculeni Trifesti dammed enclosure (Fig. 2) is part of the hydraulic works series carried out in the Prut basin for flood protection [1]. It is located in Iasi County, bordered on the north by the Trifesti locality, at east by the defense embankment built along the Prut River, at south by the defense embankment built along the Jijia River and at west by the defense embankment against high waters

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from the river valleys Frasin and Optoceni.

Prut River is the last first-order tributary of the Danube and it confluences with it at 150 km upstream of the Black Sea. Jijia River is the most important tributary on the right side of the Prut River.

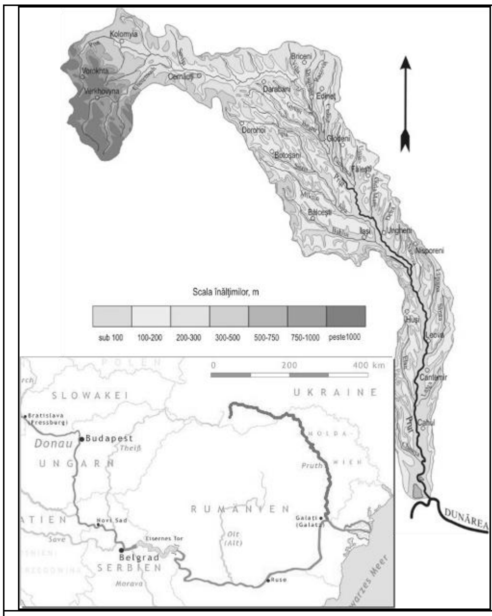


Fig. 1 – Prut basin

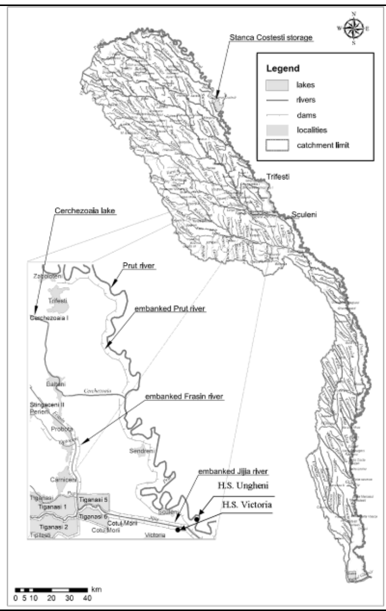


Fig.2 – Prut River Basin; Location of the Trifesti Sculeni dammed enclosure; Dammed works; Hydrometric station placement.

2. Results

Prut and Jijia floodplain area, in natural flow regime, was a regulator of the hydrological regime of the rivers as a "valve" during great floods, but also as a "tank" that provided complete flow in periods when the rivers had low flows.

Looking at maps since 1965, before the building of flood protection embankments, the initial courses of Cerchezoia, Pruteţ, Frasin Rivers, abandoned meanders, dead arms of these rivers as well as of rivers Prut and Jijia were identified. The meadow was characterized by the existence of many oxbows, backwaters, permanent ponds, swamps, river meanders and abandoned river arms.

The diversified relief resulted on one hand due to the sudden enlargement of the floodplain downstream Zaboleteni, on the other hand due to Jijia River action, whose backwater wave at high waters prolonged the longer stagnation of flood water.

The pre-terrace area, which generally lacked the natural drainage that sometimes overlaps with the central area, especially near ponds and oxbows portions under the terrace, was fed by water from springs and from the Cerchezoaia, Frasin and Optoceni Valleys, and in time of floods by the Prut River and by Jijia River action. All these maintained a regularly water excess area, feeding low micro relief forms. [1].

The floodplain water surfaces have been anthropogenically altered by the hydraulic works of defense (Fig. 2): longitudinal dams on the Prut, Jijia, Frasin Rivers, by building the Stanca-Costesti storage on the Prut River and an accumulation on Cerchezoaia River. The hydrologic regime from enclosure was modified and it was dependent then, by hydroameliorative arrangement applied in order to increase the agricultural area: drainage, draining, irrigation, regulation of runoff form slopes, etc.

3. Discussion

3.1. Researches on changes in the hydrological regime of the Prut River

Protection against flooding on Prut River basin was designed by building the Stanca-Costesti storage and by carrying out embankments as the enclosures: Trifesti-Sculeni, Prisecani-Gorban, Drânceni, Albita-Fălciu, Upper Brates and Lower Brates.

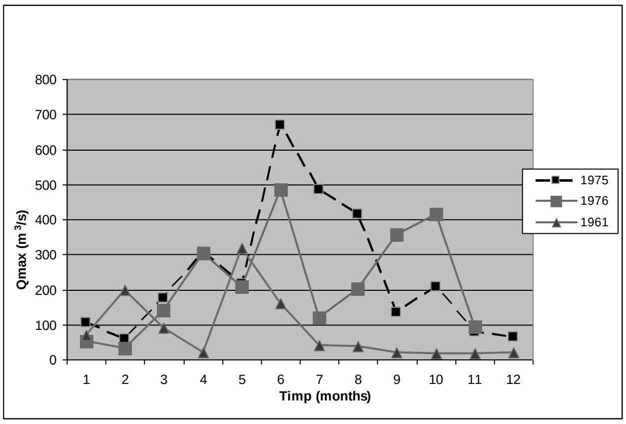


Fig.3 – Monthly flow hydrograph at the H. S. Ungheni on natural regime and dammed regime

Stanca-Costesti accumulation was put in operation in 1978 [3] and the Trifesti Sculeni enclosure was embanked during 1972-1974. The defense embankment has a length of 30 km, average top width of 4 m, average height of 3 m, embankment slopes interior / exterior 1:2 / 1:3 and it protects against floods an area of 8982 ha. For examples of hydrological changes in the Prut River, we used the hydrological data recorded at the Ungheni hydrometric station (Fig. 2) since 1961, in the natural flow regime of the river and since 1975, 1976 (Fig. 3) in the case of the embankment and data since 1961 and 1991, 2008, 2010 (Fig. 4) in the case of the embankment and controlled regime by operation of Stanca Costesti storage. By constructing the Stanca-Costesti Hydrotechnical Junction both the flow and the extreme levels were changed, resulting in changes of the hydrograph shape in required limitations.

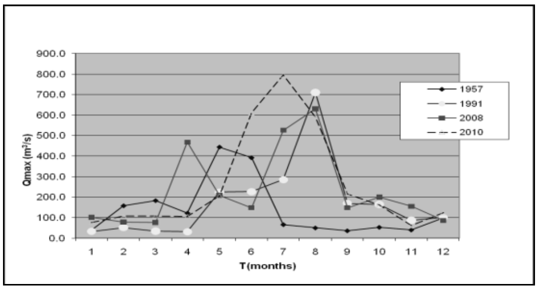


Fig.4 – Monthly flow hydrograph at the H. S. Ungheni on natural regime and dammed and controlled regime

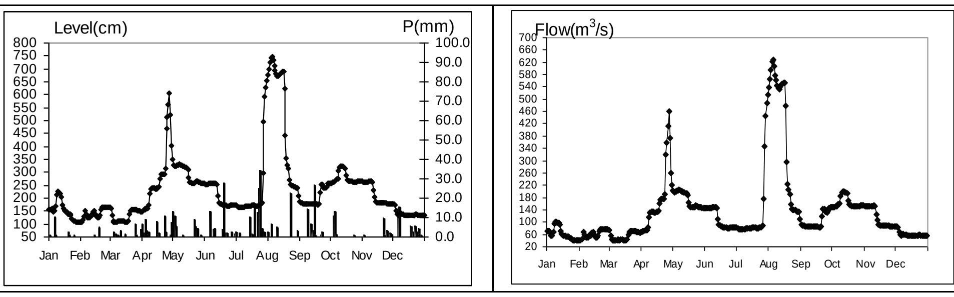


Fig.5 – Annual hydrograph of the Prut River levels / Precipitation at Ungheni H.S.-2008 (left); Annual hydrograph of the Prut River flows (right)

An increase of peak flows due to embankments can be observed, although the Stanca Costesti accumulation reduces the flood flow.

Spring flood hydrograph shape is asymmetric: rapid growth and slow decline and the summer hydrographs have a bell-shape (Fig. 5).

3.1. **Researches on changes in the hydrological regime of Jijia River**

In the south of the enclosure, the damming on both sides of Jijia river were completed in 1974, on a length of approx. 6.4 km, with average top width of 4 m, average height of 3 m.

For examples of hydrological changes in the Jijia River, we used hydrological data recorded at hydrometric station Victoria (Fig. 2) since 1960 and 1964, in the natural flow regime of the river and since 1985 (Q_{max} = 130m^3/s, in 24.06.1985 date), 1988 in the case of the embankment regime (Fig. 6).

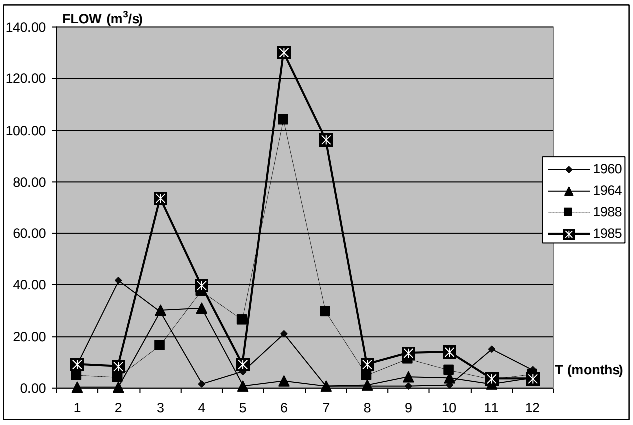
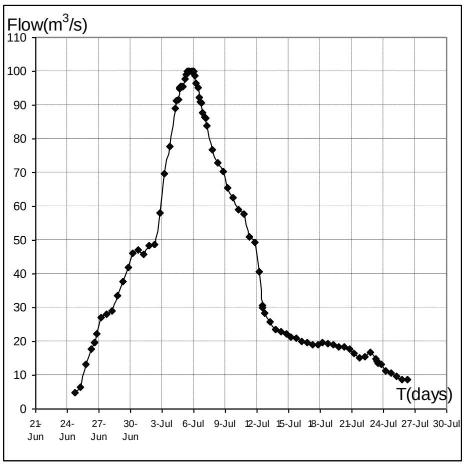


Fig.6 – Monthly flow hydrograph at H. S. Victoria on natural regime and dammed regime

Currently, the Jijia River hydrological regime during floods, on the sector of river afferent to the Trifesti-Sculeni enclosure, depends by controlled exploitation of I-VI Tiganas polders, built (upstream of the area under study) to attenuate the flow of Jijia River with a probability of 1%, from 500 m^3 / s to the value of 220 m^3/s (Fig. 2).

These six embanked (polders) enclosures can hold together a volume of 79,67 million m^3 of water. The total length of the arrangement is 11 103 km. The IV, V and VI polders were put into operation in 1996, the I Tiganasi polder in 2008 and the II Tiganasi polder in 2003.

The I, II and V Tigănasi polders are inundated in case of floods higher than 5%. The III and IV polders are flooded by floods higher than 10% and the IV polder will protect against floods higher than 1%, because in this site there are the pumping station and the transformer that serves the irrigation system Tiganasi – Perieni [3].



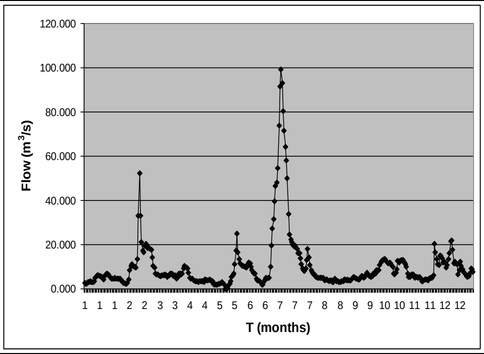


Fig.7 – Flow hydrograph at H. S. Victoria in June-July 2010 (left); Annual flow hydrograph at H.S. Victoria in 2010 (right)

For flood protection and reduction of solid leakage from the slope, the left side of the Frasin River was dammed and on Cerchezoaia Valley, south of Trifesti village, an accumulation was made (Fig. 8). The diffluent flows from the Cerchezoaia accumulation discharges in the CCS7 drainage channel, placed at the terrace base, which ensures the transit of flows to the CC NORTD Balteni channel, in order to evacuate the water excess in the Prut River by the discharge pumping station (DPP) Bălteni.

Tab.1 – Tharacteristics of Cerchezoaia accumulation [3]

NRL		ATTENUATION CAPACITY (between N.R.L and verification level) mil.m^3
Level m above Black Sea	Volumemil.m^3	
54.20	0.160	0.820

The balance of water regime was modified by drainage, draining arrangement too, for eliminating the excess water inside the embanked enclosure.

Completion of the drainage works (collection - disposal channels) and pumping plants for evacuation was achieved during 1974-1975.

The works consist in a network of open drainage channels that are designed to take surface water from precipitation that stagnates in the lowlands with no possibility of escape. They were made on an area of 8130 ha, in two functionally independent systems, NORTH Bălteni system (3 900 ha) and SOUTH Bălteni system (4 230 ha), consisting of a collecting channels network with a total length of 153.0 km. The drainage network is provided with a central collector traced across the meadow in the middle enclosure, near Bălteni, down to the Prut embankment. The collector takes the water from the north of the enclosure (the NORH Bălteni sector), collecting from the secondary collecting channels; the distance between them is 400 m. The collected waters are discharged into the Prut River by the DPP Bălteni. The excess waters in the south of the enclosure (the SOUTH Bălteni) are collected by the second collector, which is drawn parallel to the transversal embankment, taking the water from the secondary collectors, which are drawn at 400 m. Drainage of water from the enclosure over the embankment into the Jijia River is performed by the DPP Sculeni [1]. Some of the pools intercepted by collecting channels went into farming.

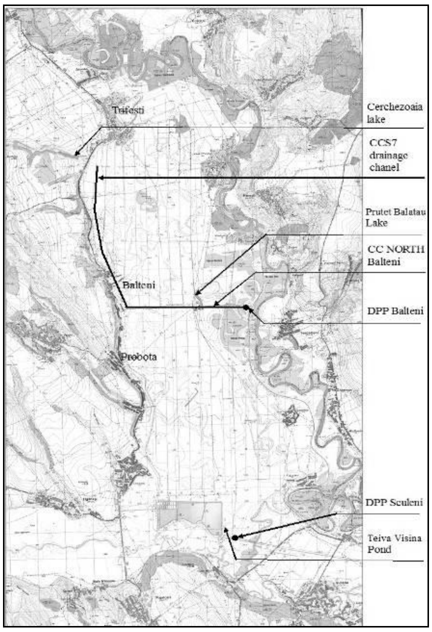


Fig. 8 – Trifeşti Sculeni embankment enclosure; draining channels; evacuation of excess of water in the Prut and Jijia Rivers

Arable land was obtained by grubbing the pastures and natural grassland, clearing forests, bushes and hybrid vineyards as well as by drainage and leveling of ponds that have small depth and are intercepted by the drainage sewers, realizing the total drainage of water from them.

The deep oxbows and the abandoned former meanders of the Prut River, e.g. Potcoava, Rediu Lakes, due to the functioning of the draining system, became terrains without water, ground water levels at 1 to 1.4 m depth and the total content of salts on the soil surface of 0.500 g/l.

It was proposed that the negative forms of micro-relief located in the shore's sand bank area, where water level and its quality are directly influenced by water changes of the Prut or Jijia Rivers be left as pools for fishing. It is the case of the Pruteţ Balatău and Teiva Vişina ponds, which are declared water reserves at the national level [4].

Pruteţ Bălătău Lake is characterized by special conditions for the reproduction of sheatfish (Silurus glanis), bream (Abramis brama brama), carp (Cyprinus carpio carpio), gold fish (Carassius auratus gibelio), pike (Esox lucius) and gudgeon (obtusirostris gobio) [4].

Teiva – Vişina Pool: the characteristic of this biotope is the presence of tench (Tinca tinca), carp (Cyprinus carpio carpio), gold fish (Carassius auratus gibelio), perch (Perca fluviatilis) and pike (Esox lucius).

After 1990, the use of irrigation was drastically reduced, favoring the salt soils appearance.

The inventory of hydraulic works and water network, of the Trifesti Sculeni sector of the Prut River major meadow, under natural and man-modified system, is needed to research the evolution of water resources and quantify the anthropogenic changes impact over the hydrologic regime of the study area.

By removing the effect of flooding from the major river bed, thus reducing the territories covered by water, the land use and the biotope specific to flood fluctuations were changed; the land of the protected soil is used in positive ways, of agricultural productivity growth.

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