STUDIES REGARDING THE SAFETY IN OPERATION OF VULTUREȘTI POLDER. CASE STUDY – A COMPARISON BETWEEN THE FLOODS TRANSITED ON BÂRLAD RIVER

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***Abstract**: The Vultureşti Polder, located laterally on Bârlad river, was built as a part of the investment "Hydrotechnical Works in the Barlad river catchment, for the defense against floods of Vaslui county and of agricultural lands. The Vultureşti Polder was designed and made for the purpose of attenuating the flood waves on the Bârlad river, for the defense of the municipality of Vaslui according to the second class of importance, corresponding to the probability of exceedance of 1% (in the Vaslui city section). This paper presents a brief history of the polder, focusing on aspects regarding the behavior monitoring of the polder during the years 2013-2019. It also presents a comparison between the floods transited on the Bârlad river in June 2013, June 2016 and May 2019.*

***Keywords:** polder; behavior monitoring; flood; high waters spillway; discharge limiter;*

1. Introduction

The Vultureşti polder was included in the investment "Hydrotechnical Works in the Bârlad river catchment for the defense against floods of Vaslui county and of agricultural lands". The investment was promoted as a result of the flood produced in June 1985, when significant damages occurred upstream Vaslui city, that threatened even the municipality of Vaslui. This investment includes the following objectives:

- Vultureşti storage area (polder) is to be flooded for the probabilities of exceedance smaller than 10%, on Bârlad river in Negreşti city section;
- The reprofiling of the river Bârlad and the elevation of the existing levees between the municipality of Vaslui and the city of Negreşti.

The Vultureşti Polder was designed and made for the purpose of attenuating the flood waves on the Bârlad river, for the defense of the municipality of Vaslui according to the second class of importance, and was built to achieve a 14 million cubic meters storage,

corresponding to the probability of exceedance of 1% (in the Vaslui city section), with a maximum discharge downstream of 182 m^3/s (Figure 1).

The attenuation in the polder starts from the moment of the incidence of the flood with the probability exceedance of 10% (Vaslui city section) and it is realized through of the concrete frontal dam (with the function of limiting the discharge downstream) and of the lateral access surface spillway (with the function of flooding the polder area).

The evacuation of the water from the polder is done by the lateral access spillway, the high waters spillway and the bottom outlet.

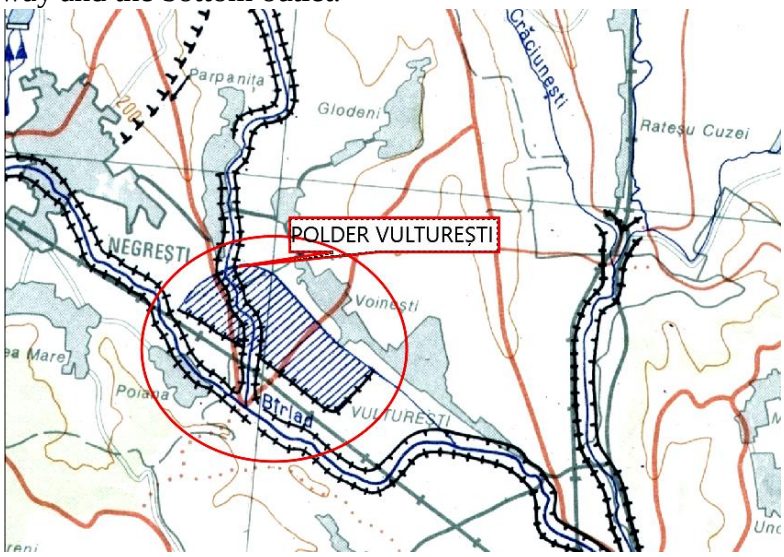

Fig. 1 – The Vultureşti polder positioning map

2. Materials and Methods

COMPONENT WORKS OF THE POLDER

a) The dam of the Vultureşti polder has a total length of about 4150 m; upstream the storage area has a closing dam about 800 m long. The height of the dam is variable (between 4 and 7 m).

b) The transverse dam is located in front of the Bârlad river and upstream of the railroad bridge is a reinforced concrete construction and has a discharge limiter consisting of three rectangular outlets and a high waters spillway (figure 2 and 3).

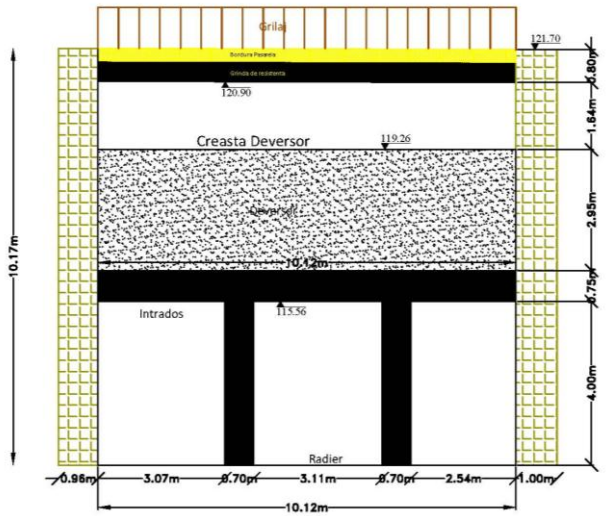

Fig. 2. Cross section of the transverse dam

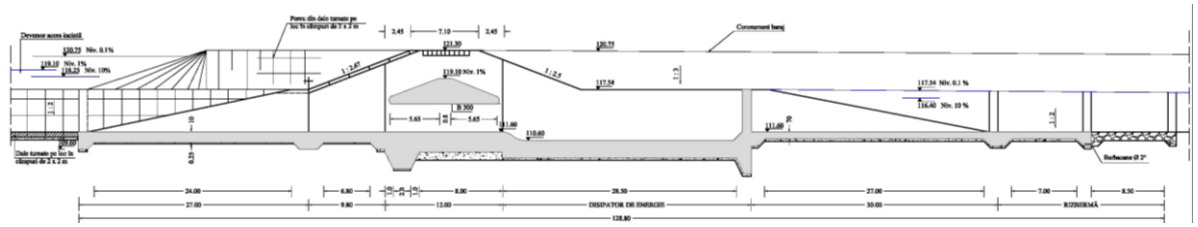

Fig. 3. Longitudinal section of the transverse dam

c) The lateral surface spillway in the polder is located upstream of the concrete dam; the length at the canopy - 180 m and the height - 1.55 m (from the ground level).

d) The bottom outlet of the polder is located on the Durduc river and it evacuates in the Bârlad river; it consists of 2 circular outlets with the diameter of 1400 mm and has a length of 40.0 m (figure 4).

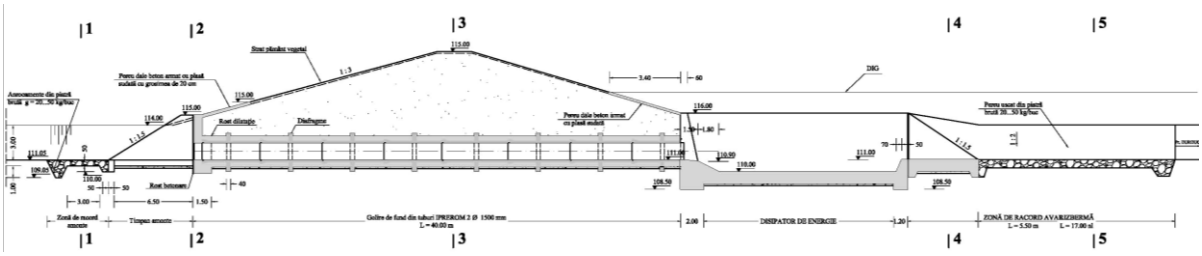

Fig. 4. Longitudinal section of the bottom outlet

e) **The downstream highwaters spillway** is located in the body of the transversal dam on the meadow of the river Bârlad and in the left embankment of the nonpermanent storage area (figure 5).

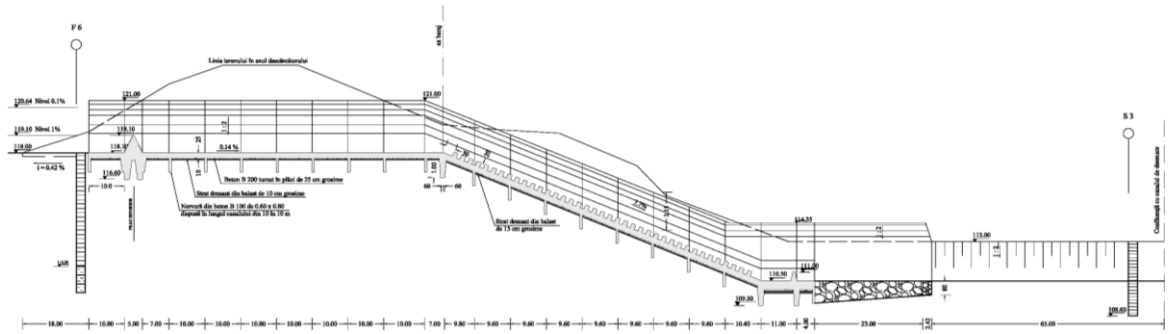

Figure 5. Cross section of the downstream highwaters spillway

The flood transit requirements through the polder are:

- The operating regime of the polder is given by the purpose for which it was built, respectively for mitigating the floods with the probability of exceedance smaller than 10%, respectively 5% and 1% corresponding to the flood defense of the city Vaslui at the second class of importance;

- It is very important for the maximum efficiency of the polder, that it is operated in relation with the Tungujei and Căzăneşti reservoirs, in regards to the downstream discharges, so the polder would be empty and able to accumulate the flood corresponding to the probability of 10%.

3. Results and discussions

The Flood of June – July 2013

a. At the Negreşti hydrometric station a maximum discharge of 177 m^3/s was registered in 1st of July at 13^{00} hour;

b. The water level recorded in the analysis section was 118.20 maSL and it was inferior with a difference of 30 cm to the canopy of the access spillway (118.50 maSL);

c. In Vaslui hydrometric station a maximum discharge of 120 m^3/s was registered at 2nd of July at the hours 13^{00} - 14^{00}, which was below the maximum flow with the probability of 10% (225 m^3/s);

d. Discharges were not evacuated from the Tungujei and Căzăneşti reservoirs, neither before, nor during the flood;

e. Although at the hydrometric station immediately upstream the polder entry (the Negreşti hydrometric station) the maximum discharge has exceeded the flow with the probability of appearance of 10%, the canopy of the lateral surface spillway was not overtopped, so the flood wasn't attenuated in the polder.

The Flood of June 2016

a. At the Negreşti hydrometric station a maximum discharge of 236 m^3/s was registered in 3rd of June at 16^{30} hour, exceeding the maximum flow with the probability of 10% (182 m^3/s);

b. The water level recorded in the analysis section was 118.85 maSL and it was superior with a difference of 35 cm to the canopy of the access spillway (118.50 maSL);

c. In the Vaslui hydrometric station a maximum discharge of 129 m^3/s was registered at 4th of June at the hours 06^{00} - 07^{00}, which was below the maximum flow with the probability of 10% (225 m^3/s);

d. Discharges were not evacuated from the Tungujei and Căzăneşti reservoirs, neither before, nor during the flood;

e. The canopy of the lateral surface spillway was overtopped for a period of time of 10 hours, so the flood was attenuated in the polder.

The Flood of May 2019

a. During the 6-7th of May 2019, important quantities of rainfall, fallen in several stages, were registered in the Bârlad river catchment.

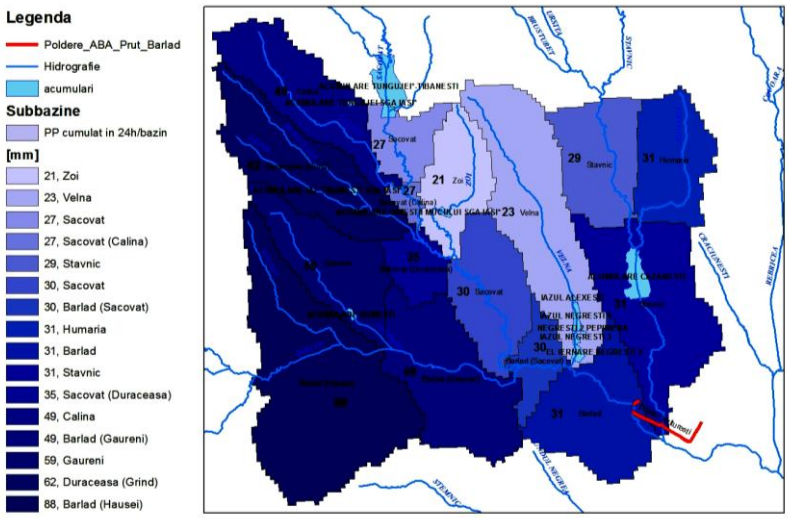

Fig. 6 - Acummulated precipitations in 24 hours in the Bârlad catchment–the 6th of May 2019

Precipitation registered in the Bârlad catchment were monitored with RADAR technology, and with ROFFG (Romanian Flash Flood Guidance) system in GIS environment the areas affected by fast floods in sub-basins were determined. With the help of the Merged Map product, the average accumulated precipitations per hour were determined, based on the spatial and temporal estimates of the precipitations, corrected and / or based on the rainfall recorded on the ground, by the automatic stations, for 06.05.2019 (figure 6).

At the Negreşti hydrometric station a maximum discharge of 237,0 m^3/s was registered in 7th of May at 10^{00} hour, exceeding the maximum flow with the probability of 10% (182 m^3/s);

b. The water level recorded in the analysis section was 118.80 maSL and it was superior with a difference of 30 cm to the canopy of the access spillway (118.50 maSL);

c. Discharges were not evacuated from the Tungujei and Căzăneşti reservoirs, neither before, nor during the flood;

g. The canopy of the lateral surface spillway was overtopped for a period of time of 3 hours, so the flood was attenuated in the polder.

Comparison between the floods

The total period of the flood wave is about 70 hours for the three flood waves and the increase time is varies between 7 hours for the flood wave registered in June – July 2013, 16 hours for the flood wave registered in May 2019 and respectively 22 hours for the flood wave registered in June 2016 (figure 8).

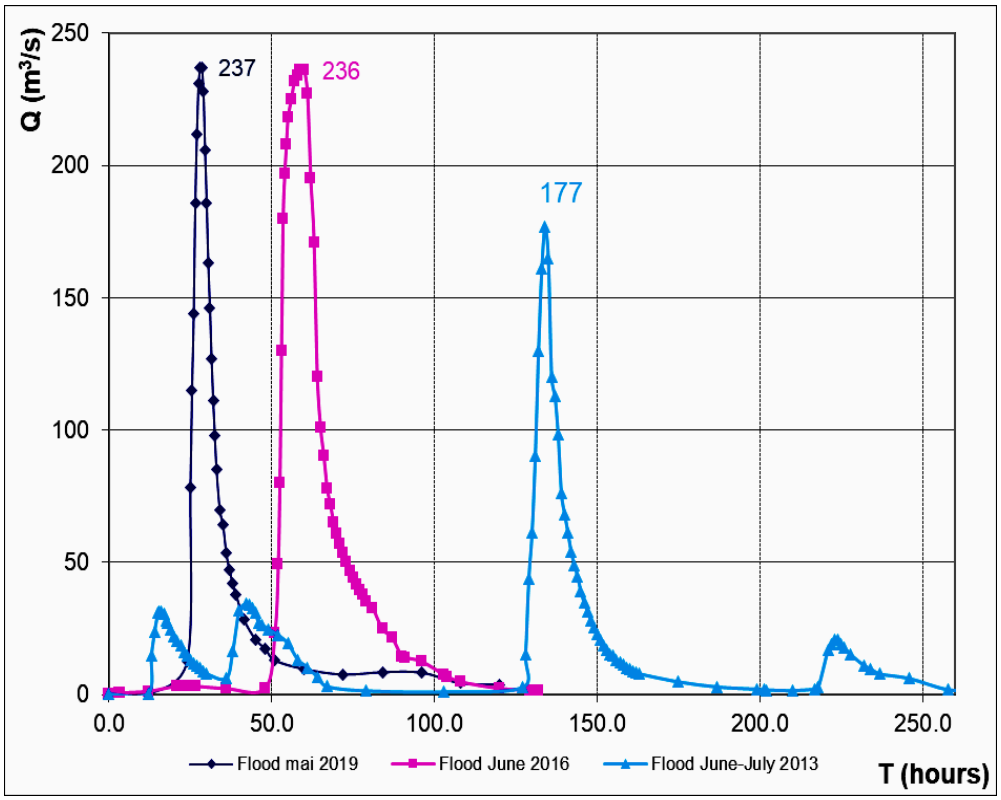

Fig. 8 – Flood waves in June-July 2013, June 2016 and May 2019

The analysis of the flood waves show that the shape coefficient is approximately 0.25 for the flood waves registered in 2013 and 2019. The flood wave that occurred in June 2016 had a greater magnitude, the shape coefficient is approximately 0.35 such that the volume of the flood was 7,136 million m^3.

Tabel 1 shows the comparative analysis for the parameters of the flood waves:

Table 1. Parameters of the flood waves:

Flood wave	Maximum discharge (m^3/s)	Total time (hours)	Increase time (hours)	Shape coefficient	Volume (million m^3)
June – July 2013	177	72	7	0.25	3.823
June 2016	236	70	22	0.35	7.136
May 2019	237	72	16	0.25	5.119

The comparative analysis of the floods waves that were registered in June-July 2013, June 2016 and May 2019 show that the Vulturesti polder comes into operation only when the Bârlad river transits flood waves with a maximum discharge of over 200 m^s/s.

The discharge limiter has three oversized rectangular outlets that allow too much flood wave to be transited downstream, compared to the initial designs. Also, the canopy of the lateral surface spillway was built a few centimeters higher than the initial designs. In order to restore the polder to its initial function and parameters, construction interventions are required, to decrease the area of the outlets.

4. Conclusions

The Vulturești polder was included in the investment "Hydrotechnical Works in the Bârlad river catchment for the defense against floods of Vaslui county and of agricultural lands" and has an important role of attenuating the flood waves on the Bârlad river, for the defense of the municipality of Vaslui according to the second class of importance, corresponding to the probability of exceedance of 1% (in the Vaslui city section).

The floods that occurred in June 2016 and May 2019 were transited safely through Barlad river and the Vulturesti polder.

During the flood that occured in June-July 2013 the Vulturești polder did not come into operation.

In order to be also prepaired for a more significant flood, construction interventions are required in order to restore the polder to its initial function and parameters.

5. References

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