ASPECTS REGARDING THE SAFETY IN OPERATION OF DRACSANI RESERVOIR

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Abstract

The dam of Dracsani reservoir, located on Sitna river, is an earth dam with a maximum height of 5.35 m that provides a global retention to the canopy of 23.053 hm^3. Dracsani reservoir is one of the hydrotechnical constructions that were built to protect the downstream villages against the floods. This paper presents a brief description of the dam and it also focuses on aspects regarding the behaviour monitoring of Dracsani reservoir, during the flood that occurred on Sitna river in June - July 2018. Several exceeding of critical rainfall thresholds were highlighted at the rain gauge from the Dracsani reservoir. The exploitation of Dracsani reservoir was done with an increased degree of attention. The paper concludes that the flood was transited through the reservoir without major incidents.

Key word: reservoir, flood, dam, infiltration, precipitation radar

Dracsani reservoir operated by Water Basinal Administration Prut-Barlad, is located on the territory of Dracsani and Sulita villages, Botosani county (*figure 1*).

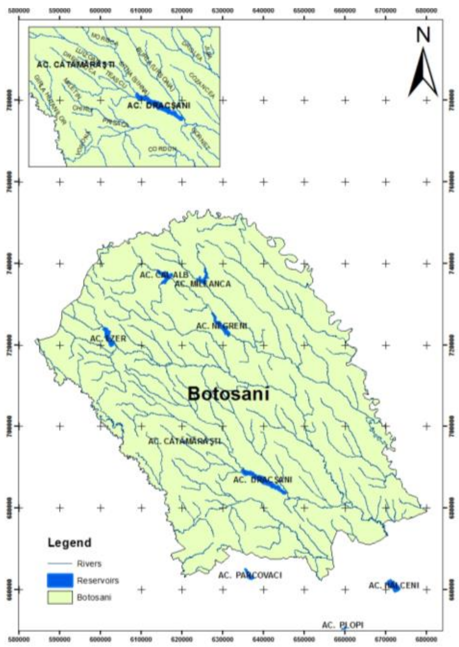

Figure 1 **Dracsani reservoir positioning map**

The retention dam is located on the upper course of the Sitna River (cadastral code XIII. 1.15.18), the left tributary of Jijia River, at about 22 km upstream of the confluence, in Dracsani village, Botosani County. The reservoir commissioned in 1996 was built on the site of an old dam and has the following functions:

- it contributes, along with other hydrotechnical works in the area, to the protection against floods for downstream settlements in the valleys of Sitna river;
- irrigation;
- fishing;
- salubrious flow downstream of the dam (***, 2014).

MATERIAL AND METHOD

The reservoir in question falls in the **III**nd class of importance and **B** category of importance. According to STAS 4068/2-62, Dracsani reservoir was sized using the flow with the probability of exceedance of 2% and was verified using the flow with the probability of exceedance of 0.5% with a 20% increase safety (***, 2014).

The special events recorded during the construction and during the operation of the dam have imposed the implementation of a systematic behaviour in time monitoring of the hydrotechnic constructions at Dracsani reservoir.

Sitna River has the following features (Ministerul Mediului, 1992):

- catchment area in Dracsani retention

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section = 605 km^2;

- river length from spring to dam L = 57 km;
- multiannual average flow Q_{mm} = 1.400 m^3/s

Characteristics of the floods are presented in *table 1.*

Table 1

Characteristics of the floods

No	***Characteristics of flood waves***	
1	1.2x0.5% probability flow – m^3/s	468
2	0.5% probability flow - m^3/s	390
3	2% probability flow - m^3/s	255
4	Total time – hours	79
5	Increase time - hours	20
6	Form factor γ	0.35
7	1.2x0.5% probability of exceedance volume – hm^3	46.58
8	0.5% probability of exceedanc volume – hm^3	38.82
9	2% probability of exceedanc volume – hm^3	25.40

GEOLOGICAL CHARACTERISTICS OF THE SITE

The site of the Dracsani reservoir is a part of the Moldavian Platform, which is characterized by uniformity of deposits that compose it. The foundation is made of clay and dusty clays with great consistency, at a depth of more than 7.8 m. The foundation is covered, in the basin, by sandy clay horizon and dusty clays (***, 2018).

COMPONENT WORKS OF DRACSANI RESERVOIR

a) The dam

Retention in Dracsani reservoir is made by a frontal dam made of sandy clays, with a canopy length of 610 m, and a width of 6.5 m.

The dam is provided with a drainage mattress of 7.0 m width, located in the downstream third of the footprint base.

Drainage culvert for water collection and drainage is 465 m long and consists of polyvinyl chloride pipes with D_n 200 mm.

The outlets of the dam are represented by: the high waters surface spillway, the medium water spillway and the bottom outlet in the shape of two squared orifices.

b) The surface spillway outlet has a trident shape and consists of the following parts:

- the weir has 2 threshold levels and a total length of 100.00 m spillway.

- the spillway channel is 70 m long and is made of reinforced concrete

- the fast channel has a 3.5% slope and a length of 70 m.

- the hydraulic energy dissipator chanel is 23 m long and has artificial macroroughness represented by reinforced concrete teeth.

- the transition channel is 18 m long and is made of reinforced concrete,

- the channel that connects with Sitna river is covered with stone, on the slopes and the bottom.

- bridge that connects the dam with the right embankment is 14.0 m long and 5,5 m wide

c) Bottom outlet is represented by 2 squared orifices 1,5 x 1,5 m each, that evacuate in the same channel as the surface spillway. *(figure 2*).

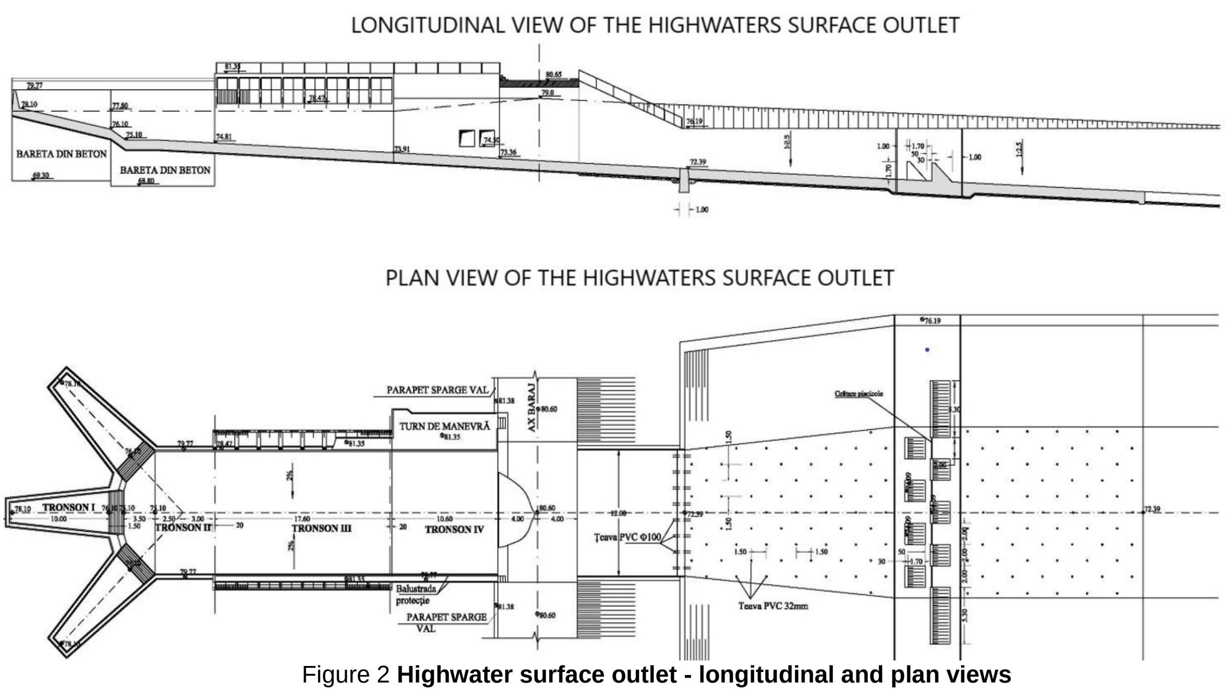

Figure 2 **Highwater surface outlet - longitudinal and plan views**

RESULTS AND DISCUTIONS

During June – July 2018, important quantities of rainfall, fallen in several stages of 2-3 days, were registered in Sitna river catchment.

The heavy rainfalls that were recorded at the rain gauge from the reservoir totals 245.8 mm in the period 15.06.2018 – 11.07.2018.

The following exceeding of critical rainfall thresholds were highlighted at the rain gauge from the Dracsani reservoir:

- „red code” in 28.06.2018 (59.2 mm between the hours 18^{20}-19^{40}).
- „yellow code” in 29.06.2018 (24.3 mm between the hours 10^{45}-11^{45}).

At the rain gauge of Catamarasi reservoir, located upstream of the Sitna river, the critical rainfall threshold "yellow code" was exceeded on 28.06.2018 (23.5 mm between the hours 18^{30}-19^{40}).

RADAR technology represents a fixed installation that uses electromagnetic waves and their reflection from different objects, to determine their relative position towards the antenna.

The meteorological radar can be used to determine location, movement and type of the precipitations and to estimate the future changes of position and intensity. The modern Doppler radar can not only detect the intensity of the rain, but also can detect the movement of the precipitations.

The information provided by the radar is analyzed in order to identify the structure of the rainfall and the possibility of weather changes.

The weather stations have their own data base with climate variables, that are stored in specific tables constantly update by the National Administration of Meteorology (Balan, 2015).

The values of the radar precipitations that occurred in the 28th of June 2018 were generated by the ROFFG (*Romanian Flash Flood Guidance*) software system in ArcGIS environment used to determine the areas affected by flash floods in small catchments throughout Romania.

From data processed by the *ROFFG* system, we used the product *Merged Map – medium precipitation accumulated in an hour*, based on the spatial and temporal estimations of the precipitations, corrected and/or based on the precipitations recorded on the ground, by the automated station (*figure 3*).

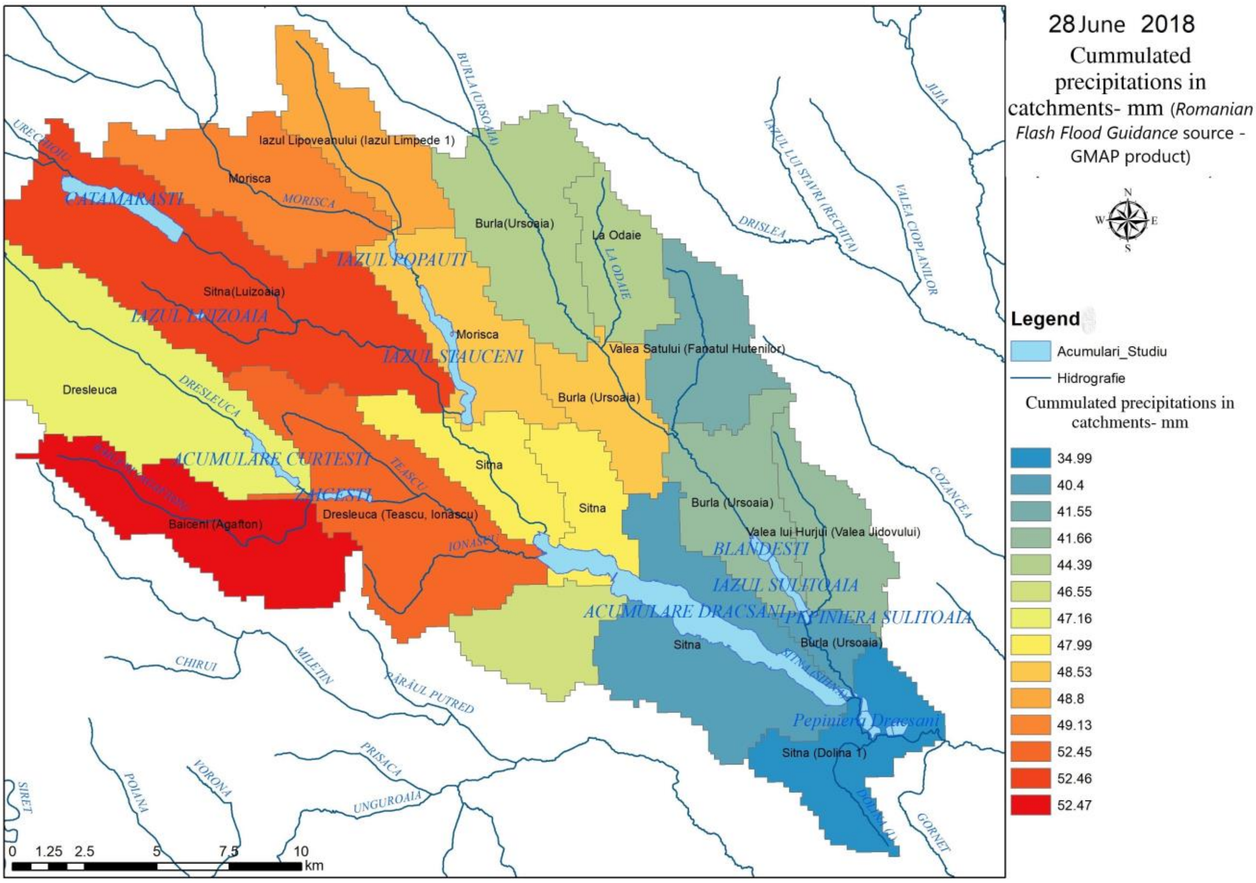

Figure 3 **Spatial distributions of the precipitations**

The rainfall produced in the catchment of Sitna river led to significant increases of the water level in Dracsani reservoir, starting with the date of 30.06.2018 - 12^{00} hours, when the Ist phase of defense = 78.47 maSL was exceeded and it began the water discharges, over the first threshold of the surface spillway.

The upward trend of the water level in the reservoir was kept during the next days, by successively exceeding the IInd phase of defense = 79.00 maSL in 01.07.2018 –04^{00} hour, then reaching the maximum flow level of 79.24 maSL in 01.07.2018 - 17^{00} hours, and maintaining it till 02.07.2018 - 11^{00} hours.

The table 2 and figure 4 present the extreme values of the water level registered in the period 30.06.2018 – 12.07.2018.

Table 2

Extreme values of the water level

Normal retention level (maSL)	Maximum level			Minimum level			Medium level	Previous hystorical maximum level	
	Level (maSL)	Date	Hour	Level (maSL)	Date	Hour	Level (maSL)	Level (maSL)	Date
78.00	79.24	01.07.2018	04^{00}	78.01	30.06.2010	12^{00}	78.98	78.93	02.07.2010

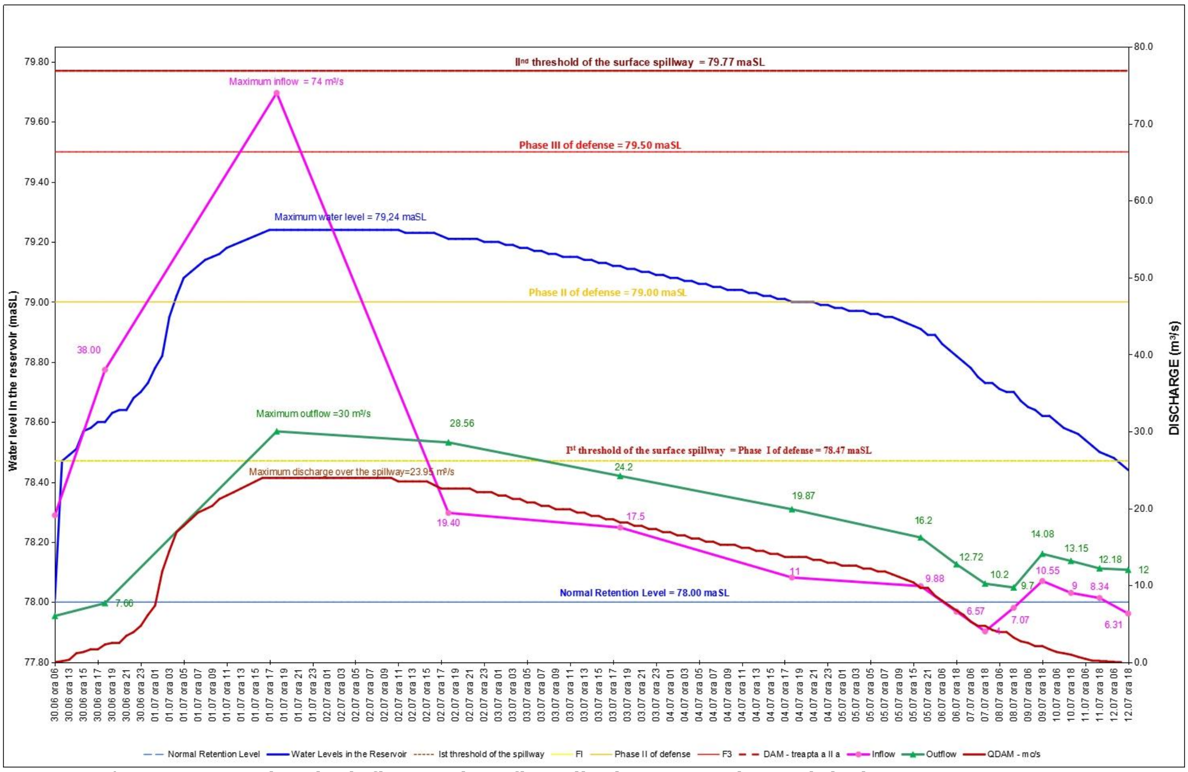

Figure 4 **Water levels, inflow and outflow discharges registered during 30.06-12.07.2018**

The maximum inflow was 74 m^3/s in 01.07.2018 - 18^{00} hour.The maximum level in the reservoir was 79.24 mdMN, so the surface outlet (Ist threshold level - 78.47 maSL) was put into operation.

On July 1st, 2018, the water level that was exceeding the Ist threshold of the surface outlet, reached the maximum level of 79.24 mdMN. The maximum height of the water discharged over the surface outlet was 77 cm. The maximum discharge over the spillway was 23.95 m^3/s for a time interval of 18 hours. The surface spillway was put in operation for a period of 12 days (*figure 5*).

Figure 5 **Dracsani dam – discharge over the surface spillway**

At 350 m downstream of Dracsani dam, the tributary Burla river flows into Sitna River and 600 m further downstream, there is a hydrometric station installed on Sitna River, where defense critical thresholds were exceeded during this flood period and a maximum discharge of 70.4 m^3/s, was registered in 30.06.2018.

The high level of water in Burla river caused a backwater volume to be accumulated immediately downstream of Dracsani dam, that inundated the downstream slope of the dam, on a 1.0-1.5 m height (*figure 6*).

The water withdrew after 4 days.

Figure 6 **Dracsani dam – inundated downstream slope**

Due to high levels of the water in the reservoir, the joints between the tiles in the downstream slope of the dam were partially affected.

On the downstream slope there were found three puddle areas, located in the lower portions, where the soil was overburdened with water from the abundant rainfall in the area, as well as from the backwater water produced by the tributary the Burla River in the previous period. The three pond areas were interfered with draining slits for collection and tracking the seepage. After several days, the areas were drained.

No other incidents or atypical aspects were ascertained.

CONCLUSIONS

The flood that occurred on Sitna River during the period June – July 2018 was transited through Dracsani reservoir without major incidents. The behavior in time monitoring performed by interpreting the visual observations and the measurement data from gauges, in relation to external stresses on the dam, allows rapid reporting of exceedances of critical thresholds at monitored elements and of the atypical behaviors of the dam.

The exploitation of Dracsani reservoir was done with an increased degree of attention and safety. The behavior monitoring of Dracsani reservoir is recommended to be continued accordingly to the "Project of special monitoring".

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