

Researches regarding the flood waves attenuation through the Taga Marea accumulation, Fizes Mijlociu hydrographical basin, Cluj county

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Abstract:

The passage of the flood wave through the accumulation leads to their attenuation, creating in the downhill sections of the barrage, much smaller attenuated flow rates and levels than the outrush ones, which lead to the important diminishing of the potential damage that could occur in the absence of those works on the water courses. In addition, the existence of those accumulations leads to the much more reduced dimensioning of hydrotechnical works in the downhill because of the attenuations in the lakes. Through the attenuation of flood waves in these accumulations, both the direct and indirect damages are avoided: the direct damages representing the value of the destructions or damages of the affected objectives and the value of the expenses made with the intervention operations for defending the endangering, evacuation and population help areas; indirect damages given by the losses registered in the economy. In this paper talking about from accumulations with piscicultural role in accumulations used for sportive fishing, thus managing the significant corroboration of the minimum piscicultural exploitation level and implicitly increasing the attenuation volumes. As a result of the transiting of the flood wave through Taga Mare accumulation, the effluent flow rate when ensuring the calculation have values of 25.69 m³/s compared to the calculation affluent flow rate of 31.3 m³/s, achieving an attenuation coefficient of 0.179. In addition, the effluent flow rate in the case of insuring the checking is of 43.671 m³/s compared to the affluent debit of 51 m³/s, achieving a value of the attenuation coefficient of 0.144.

Keywords: flood wave, attenuation, agro-piscicultural accumulations.

1. INTRODUCTION

Accumulations represent the works of water management which ensure the modification of the temporary regime of water flows by retaining a part of the inflow in certain periods and increasing the deflux in other periods. In this sense, we consider as accumulations: the set of artificial lakes and ponds created on the water courses, the non-permanent retentions for floods created both on the water course, the non-permanent retentions for the floods achieved both on the water courses and laterally (attenuation enclosures), the naturally created lakes so that the flow regime downhill and the alluviums retention

works on the torrents can be managed.

Accumulations represent the fastest and most efficacious way of flow rates regularization, regarding the water uses they comply with their requirements the best, and regarding the fight against the floods, accumulations present the advantage that they can control the flood flows from concentrated points [1].

The accumulations from the meadow area have barrages of small heights and large lengths usually built from earth and present the advantage that they are near the populated centres and the irrigated lands, but also the disadvantage that they require large barrage lengths and have great water losses through the evaporation and infiltrations; for attenuating the flood waves in the meadows of the large rivers people create accumulations through banking, called polders that have the shape of floodable enclosure compartments.

If we refer to the accumulations placed on the surface running waters, then we ascertain that they are water management establishments that create aggradations of levels and at the same time modify the distribution in time of the river flow rates where they are situated through the water volume that they retain.

Thus, within a hydrographical basin, the accumulations achieve two types of modifications of natural conditions and namely: the modification of the levels and the modification of the flow rate regime.

The agro-piscicultural establishments are in majority frontal accumulations of small watercourses achieved in a cascade.

2. LOCALIZATION OF RESEARCHES

Fizeș plain is situated north-east from Gherla municipality on the administrative territory of Cluj county. It is a component part of Transylvania plain, comprises the central-southern part of Someșan plain and is situated between Cojocna-Sic and Ungurașului hills (in west and south), Lechinței hills (in the east) and the Someș-Mureș inter-river (in the North) [XX], (fig. 1).

In this context, the existence of lakes in Transylvania field is justified under both aspects. Without making an overview of the history of lakes

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formation, we must mention that the majority of researches accept their dual, natural and anthropic origin. Later, the artificial lakes also appeared. In time, the number of lakes fluctuated and it was determined by optimal natural conditions

(impermeable sublayer, permanent flow on the main valleys, small longitudinal backfalls, relatively flat floodable meadows, optimal temperatures etc.), of religious considerations (ensuring the food – the fish – for the long posts), of economic needs (temp melting plants, crushing mill, pisciculture)

Today, the majority of lakes are positioned along the rivers Fizes and Paraul de Camp

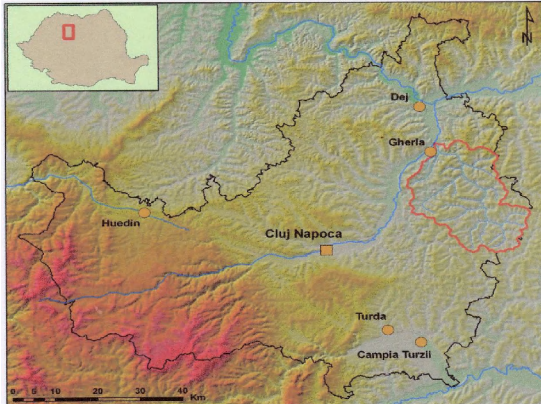


Fig. 1. The geographical position and the limits of the Fizes plain.

Fizes river has a total length of 40 km. The ponds studied are situated on the main course in the Puini left affluent and Ghiolt right affluent, in the middle sector of the river. In this area, the valley is characterized through the minor bed dug in its own alluviums, the floodable large meadow with local contractions, very small longitudinal backfall, less significant affluent (the most important one Sucioas). The 3 ponds have different ages. Without a doubt, Taga Mare is one of the oldest ponds from Transylvania Field.

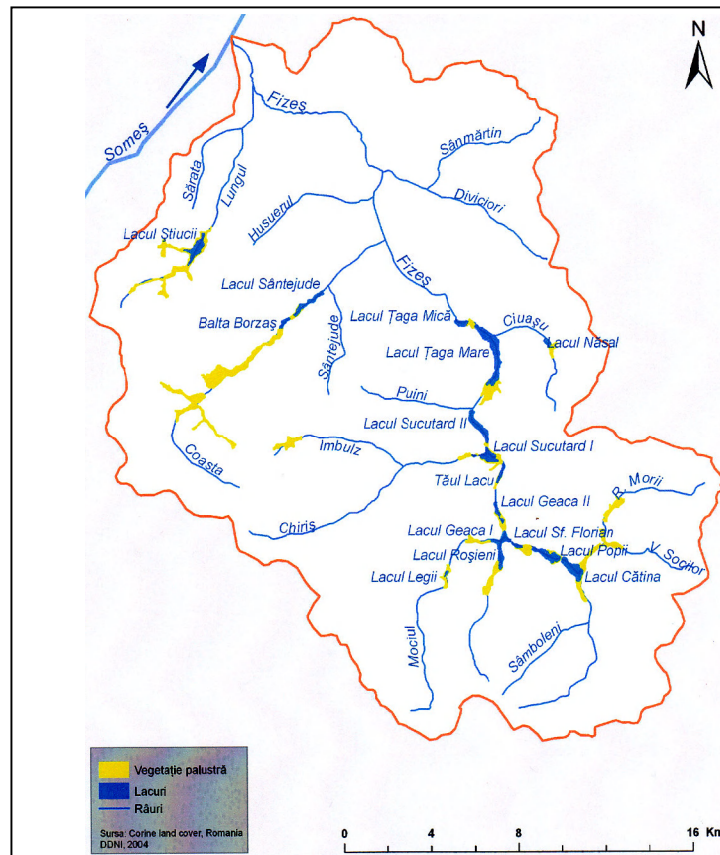


Fig. 2 – Hydrographical network in basin of Fizeș (position of the acumulation lakes).

In the hydrographical basin of Fizes, 11 ponds are positioned on the main course (Catina, Taul Popii, Sf. Florian, Geaca1, Geaca2, Geaca3, Sucutard1, Sucutard2, Taga Mare, Taga Mica, Ghiolt), and a few lakes are on the affluent (Rosieni on Ciortus, Nasal

on Sucioas, Santioana and Santejude on Sic, Stiucii on V.Bontului), (fig. 2). The piscicultural ponds from Fizes Valley have been executed on a hearth of lakes and existent ponds (Taul Popii, Geaca and Taga) between the years 1953 and 1985.



Photo. 1-2 -Overviews of Taga Mare accumulation, b.h. Fizes, Cluj county

3. RESEARCH METHOD

For understanding the manner of attenuation of the flood waves in an accumulation, we must know the constructive composition and the functioning of the respective accumulation.

The attenuation of the flood waves in a given accumulation is influenced by the following elements:

The curve of the lake capacity $V=f(Z)$;

The characteristics of the waste ways $qG=f(Z)$, $q_D=f(Z)$;

The level of the water in accumulation at the moment of the outrush production.

The manoeuvres of the high waters waste way regulating gate, if they expire.

Taking into account these elements, the attenuation calculations can be made taking into account different hypotheses of accumulations functioning. They can be hypotheses of functioning in a normal situation or functioning hypotheses in an accidental situation.

In the case of permanent accumulations:

- The lake is full at the maximum quota of the normal retention level and the waste ways function at the maximum capacity (normal hypothesis of functioning);

- The lake is full at a smaller quota than the maximum quota of the normal retention level as a result of the consume or an intentional pre-discharge; the waste ways function at the maximum capacity (the favourable functioning hypothesis)

- The lake is full at a larger quota than the maximum quotas of the normal retention level because of a previous outrush or the erroneous exploitation; the waste ways function at the maximum

capacity (the accidental functioning hypothesis).

The frontal accumulations modify the hydrograph of the flood wave from the basic area. The calculation hypotheses will be established taking into account the most difficult situations of accumulation functioning without exceeding the calculation probability and normal check. Their simulation in attenuation calculations is achieved by constructing the waste ways characteristics in accordance with the simulated hypothesis.

When passing through a frontal accumulation, a part of the volume of the flood wave is stocked in the accumulation lake, and a part is evacuated through the surface waste ways or through the bottom discharge. (fig. 3)

If the volume of the flood wave is high and the level of water in the accumulation lake exceeds the quota of the high waters waste way, then a part of the volume of the flood wave is evacuated through the high waters waste way.

When the level of water in the lake reaches the maximum quota, the maximum flow rate of effluent is achieved Q'_{max} and the maximum flow rate in natural regime Q_{max} (equation 1). The β attenuation degree is the ratio between the difference of the natural and effluent maximum flow rates $Q_{max} - Q'_{max}$ and the natural maximum flow rate Q_{max} .

The water volume stocked in accumulation is integrally evacuated downhill ($W_{ac}=W'_{ev}$). The maximum flow rate is displaced in time to the natural one ($t_c > t'_c$), and the total duration of the outrush is much bigger than that of the natural outrush ($t_t > t'_t$).

The attenuation achieved in a frontal accumulation mainly depends on the volume of the flood wave in natural regime and less on the value of the maximum natural flow rate.

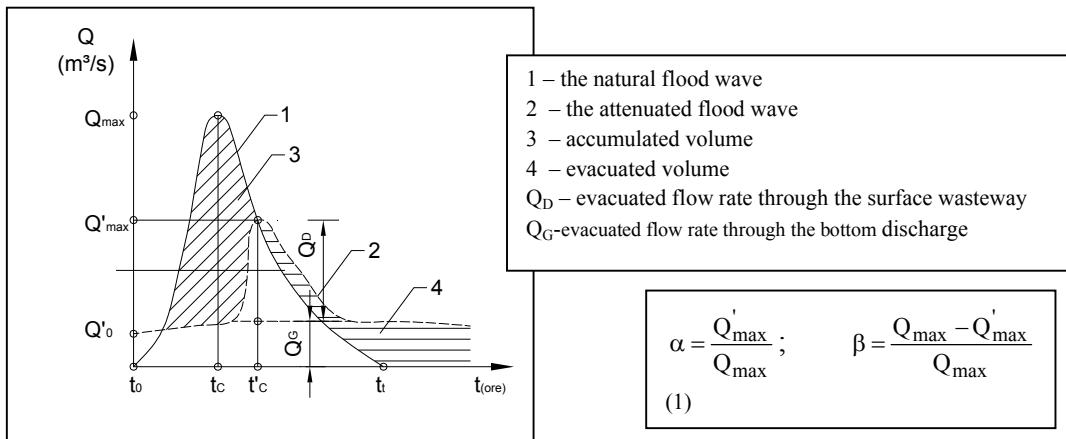


Fig. 3 – The effect of frontal accumulation on the flood wave

The passage of flood waves through Taga Mare accumulation (fig. 4) leads to their attenuation achieving in the downhill barrage sections much smaller attenuated levels and flow rates than the flood wave ones that lead to the diminishing in a great extent of the potential damages that could be produced in the lack of these works on the water courses. In addition, the existence of these accumulations leads to the much more reduced

dimensioning of hydrotechnical works downhill because of the attenuations in the lakes. Through the attenuation of the flood waves in these accumulations both the direct and indirect damages are avoided: the direct damages representing the value of destructions of the damages of objectives affected and the value of expenses made with the intervention operations for defending the endangered areas, of evacuation and helping the population; the indirect damages given by the losses registered in the economy.

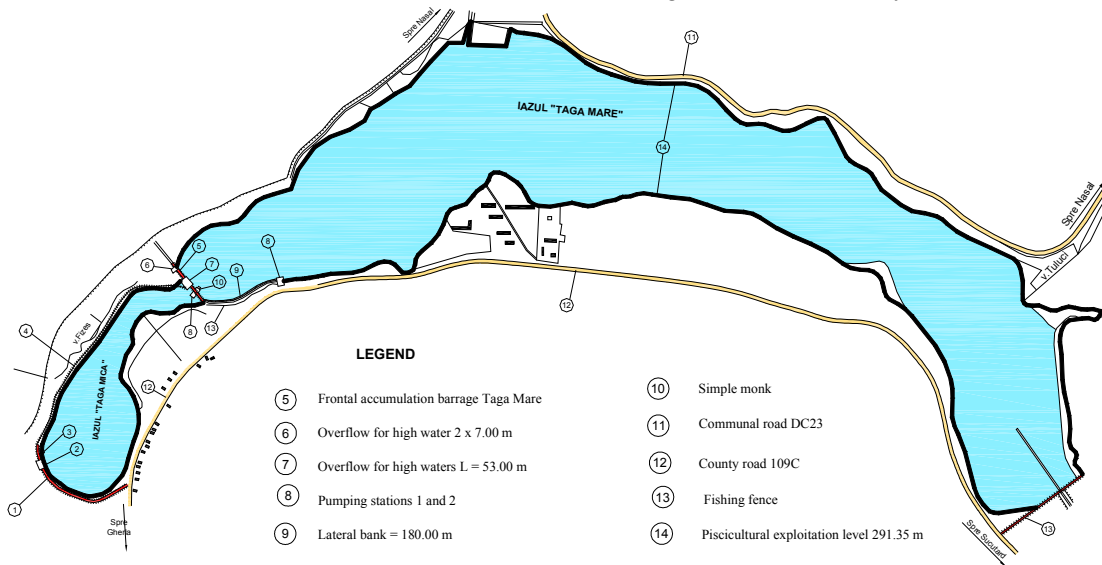


Fig. 4 – Taga Mare accumulation, Fizes hydrographic basin

4. CALCULATION/SIMULATION PROGRAM. RESULTS OBTAINED.

The research method approached in the present thesis is the graphic-analytical methods of attempts. This is based on knowing the following elements: the hydrograph of the affluent debits in the calculation section $Q_a=f(t)$; the superior part of the lake's capacity curve and namely $W_{at}=f(h)$, taking into account that the lake is full until the overflow crest (NNR); the overflow key $Q_d=f(h)$, built when we

know the length of the overflow, giving values to "h" and calculating the " Q_d "; the key of the bottom discharge $Q_g=f(h)$, built when we know the section of the bottom discharge and the depth of the weight centre of the section; from the last three curves, the curve $Q_{def}=f(W_{at})$ is built.

The calculation operations are presented in the following manner:

- the duration of the outrush is divided in time intervals " Δt " whose value is chosen according to the precision desired

- it is considered that the outrush finds the lake full until the crest of the overflow (NNR) and the bottom slide valve is closed (blocked), although the lake attenuation capacity is formed of the own attenuation overflow volume (W_{at})

- we aim at the construction of the hydrograph of affluent flow rates (the blue interrupted line), which, at the intersection with the affluent flow rates hydrograph gives us the value of Q_{dmax} , and the surface comprised between the 2 hydrographs represents exactly the searched W_{at} .

$F_{BH} = 283 \text{ km}^2$ – surface of the reception basin
 $k = 0,28 \text{ m}^3/\text{s}$ – transformation coefficient of the rain intensity
 $\alpha = 0,40$ – the global reduction coefficient
 $I_{60,1\%} = 115 \text{ mm/hour}$ – the maximum hour intensity of the rain with the exceeding probability 1 %
 $n = 0,50$ – reduction coefficient
 $p_{\text{calculation}} = 5 \%$; $p_{\text{verification}} = 1 \%$
 $Q_{1\%} = 216,293 \text{ m}^3/\text{s}$
 $Q_m = 2,83 \text{ m}^3/\text{s}$

4.1. Primary data of program entry

We will continue to present the results of the simulation with the program used in this application, software MathCAD 14.

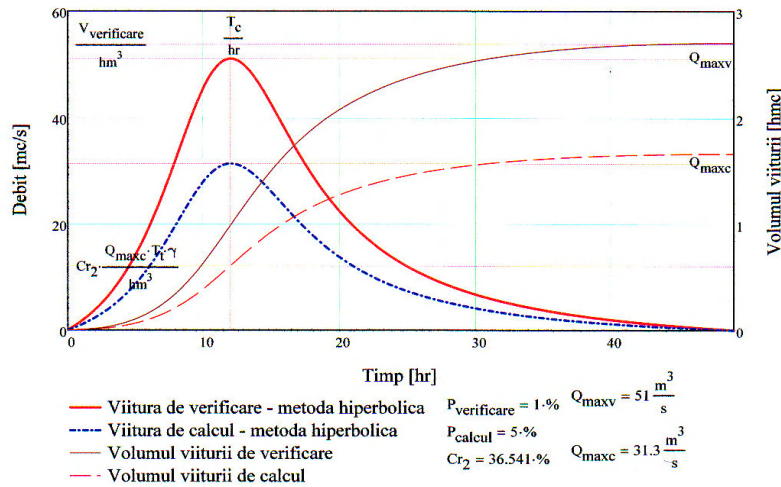


Fig. 5 – The hydrographs and the volumes of outrushes for Taga Mare accumulation

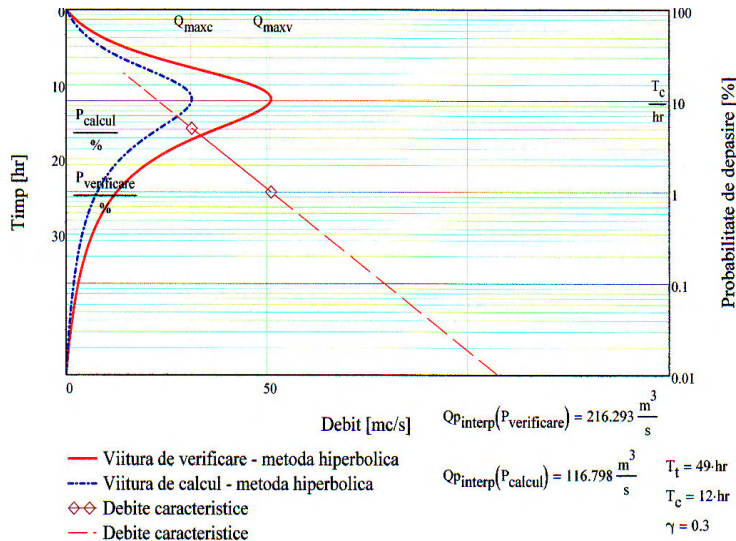


Fig. 6 –The hydrographs of the outrushes and the flow rates characteristics for the Taga Mare accumulation

4.2. Calculation of flood waves

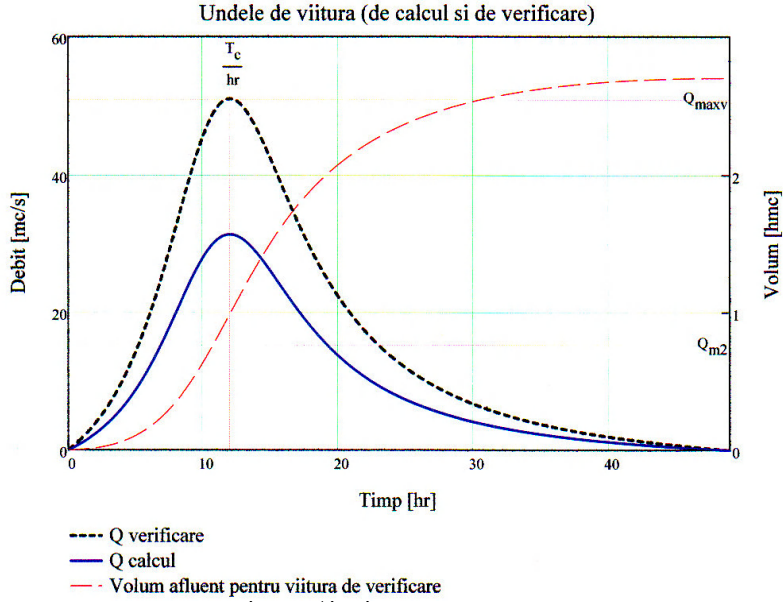


Fig. 7 – The flood waves (of calculation and checking) for Taga Mare accumulation

The i
f(Vol_{lac}).

:S {Cota_{lac} =

$$Cotalin_{lac}(vx) := \text{interp}\left(\frac{1}{hm^3}, \frac{1}{mdM}, \frac{1}{hm^3}\right) m$$

$$Cotaps_{lac}(vx) := \text{interp}\left(\text{pspline}\left(\frac{Vol_{lac}}{hm^3}, \frac{Cota_{lac}}{mdM}\right), \frac{Vol_{lac}}{hm^3}, \frac{Cota_{lac}}{mdM}, \frac{vx}{hm^3}\right) m$$

$$vx := 0hm^3, 0.0001hm^3 .. \max(Vol_{lac}) \quad Cota_{dev} = 282.55 m$$

$$Vollac(hx) := \text{interp}\left(\frac{Cota_{lac}}{mdM}, \frac{Vol_{lac}}{hm^3}, \frac{hx}{mdM}\right) hm^3 \quad NNR = 282.64 m$$

$$hx := \min(Cota_{lac}), \min(Cota_{lac}) + 0.1mdM .. \max(Cota_{lac}) \quad Cota_{coronament} = 284.87 m$$

$$V1x := 1000hm^3 \quad Cota_{pregolire} := NNR$$

Given

$$Cotalin_{lac}(V1x) = Cota_{pregolire}$$

$$V1xc := \text{Minerr}(V1x)$$

$$V1xc = 2.31 \cdot hm^3 \quad V1v_1 := V1xc - 0hm^3 \quad V2v_1 := V1xc - 0hm^3 \quad V3v_1 := V1xc - 0hm^3$$

4.3. The attenuation of the flood wave in the lake
We will determine the aspect of effluent wave's $q(t)$ when we know the dimensions of the overflow, the variation of the volume in the lake according to the height and the hydrographs of the affluent flow rates.

Based on the entry data, we draw up the graphs of the calculation outrushes as follows:

- we will analyze the attenuation effect for the calculation debit and the checking debit
 $(Q-q)dt = Sdh$, which shows the difference between the effluent and affluent volumes in a time interval dt , causes an aggradations dh of the lake level.

The linear and parabolic spline type interpolation of the affluent debits follows.

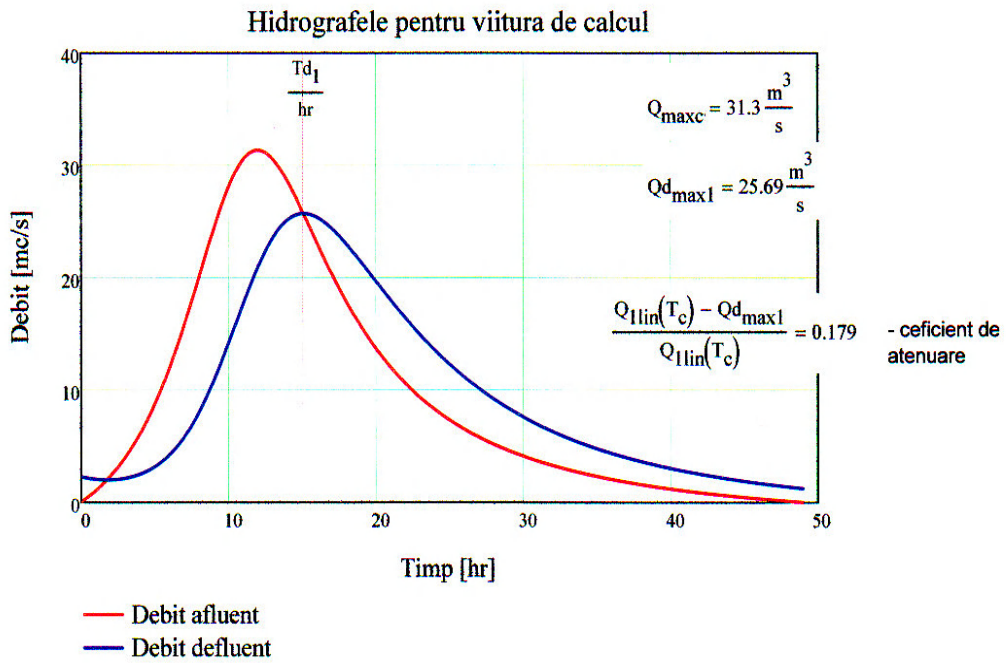
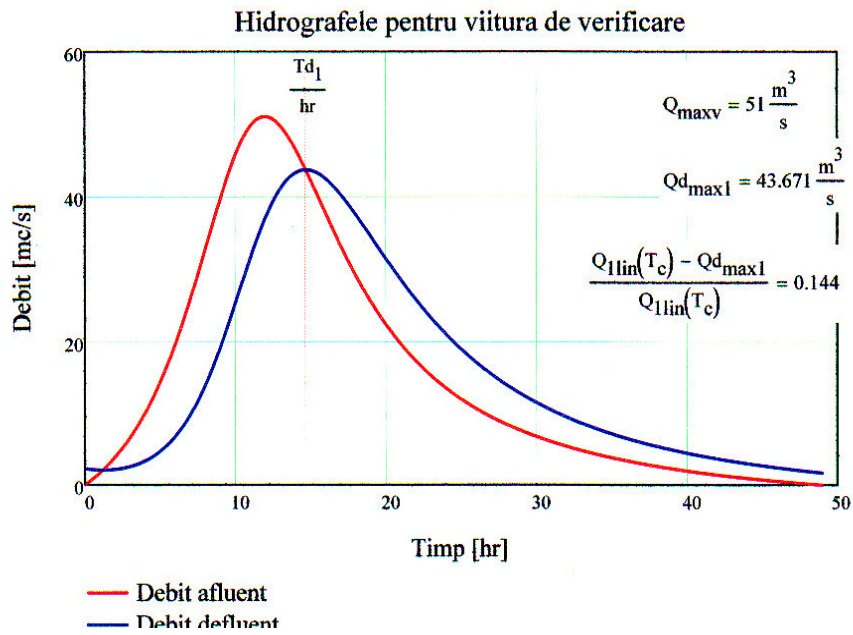


Fig. 9 – The hydrographs for the calculation outburst for Taga Mare accumulation

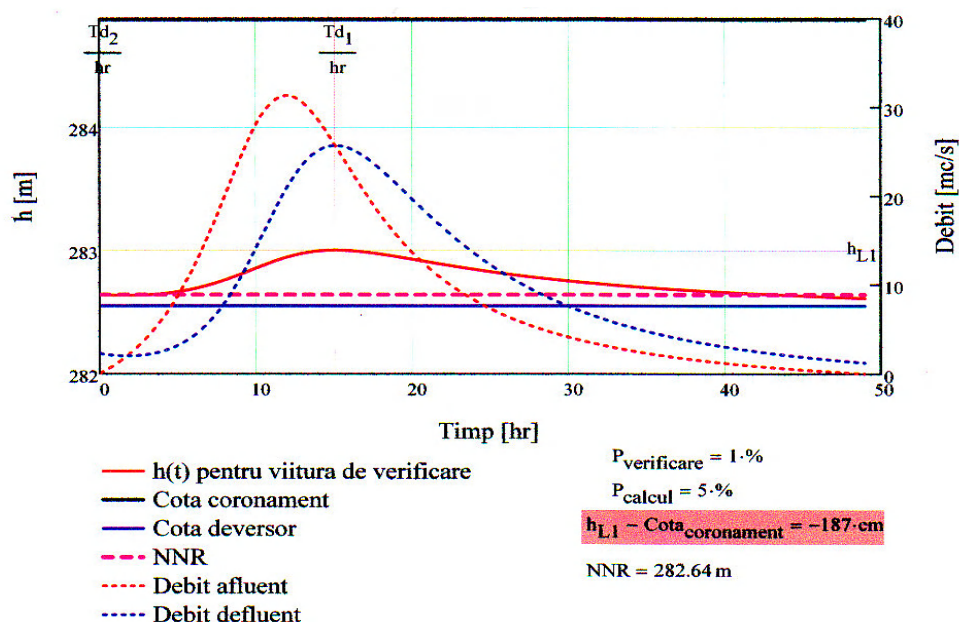


Fig. 10 – The evolution of the water quota in Taga Mare lake

5. CONCLUSIONS

Taga Mare accumulation, taken in the study, ensures through the barrier of the Fizes valley, the fastest and most efficient method of regularizing the outrush flow rates. In addition, it ensures a water glitter for the piscicultural activity.

The water quantity stocked in the accumulation can also be used for other purposes, such as: the irrigations, the water supply, leisure activities etc.

Within the design, the result of these researches can be applied to these researches to the dimensioning of these hydrotechnical constructions both for the piscicultural activity and for regularizing the outrushes flow rates.

Through the exploitation in conformity with the exploitation regulations and having at the disposal an efficient information flow, pre-discharges of these accumulations can occur until the minimum piscicultural level, creating the possibility of achieving higher attenuation capacity and implicitly achieving a higher attenuation coefficient of the effluent flow rates from the accumulation.

This exploitation takes into account as well the possibility of using these accumulations, from accumulations with piscicultural role in accumulations used for sportive fishing, thus managing the significant corroboration of the minimum piscicultural exploitation level and implicitly increasing the attenuation volumes.

As a result of the transiting of the flood wave through Taga Mare accumulation, the effluent flow rate when ensuring the calculation have values of $25.69 \text{ m}^3/\text{s}$ compared to the calculation affluent flow rate of $31.3 \text{ m}^3/\text{s}$, achieving an attenuation coefficient of 0.179.

In addition, the effluent flow rate in the case of insuring the checking is of $43.671 \text{ m}^3/\text{s}$ compared to the affluent debit of $51 \text{ m}^3/\text{s}$, achieving a value of the attenuation coefficient of 0.144.

6. REFERENCES

- [1] Băla M., (1977), *Baraje din materiale locale*, Editura Tehnica Bucuresti.
- [2] Cretu Gh., (1976), *Economia apelor*, Editura didactica si pedagogica, Bucuresti
- [3] Giurma I. (2000), *Sisteme de Gospodarire a apelor*, Editura Cermi Iasi
- [4] Hâncu S., s.a. (1971), *Hidrologie agricola*, Editura Ceres, Bucuresti
- [5] Podani M., 1993, *Apararea impotriva inundatiilor*, Editura Tehnica Bucuresti
- [6] Popovici A., (2002), *Baraje pentru acumulari de apa*, vol. I, Editura Tehnica Bucuresti
- [7] Popovici N.C. (1993), *Regularizari si gospodaria apelor*, Institutul Politehnic Iasi, Facultatea de Hidrotehnica
- [8] Serban P. s.a. (1989), *Hidrologie dinamica*, Editura Tehnica Bucuresti
- [9] Sofronie C. (2000), *Amenajari hidrotehnice in bazinul hidrografic Someș Tisa*, Casa de editura Gloria