ESTIMATION OF THE VOLUME OF SILT CAUSED BY TORENTIAL RAINS ON IZVORUL FERICELE BROOK

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Abstract

The present paper intends to establish the volume of silt, which come from the small basin, as a consequence of the torrential rains, as well as the estimation of the quantities of silt capable of forming sediments deposits.

The method through which it is done the prognosis of the volume of silt has as a principle the separate calculation of the silt volume dragged along from the mountain side, as well as the silt volume produced by the bed of the river.

In order to estimate the silt quantities, which form sediment deposits, it is intended to establish the volume of sediments from the yearly average transport, as well as the volume of sediments from a torrential rain.

Key words: silt, torrential rains

INTRODUCTION

The hydrographical sub-basin of Izvorul Fericele Brook is a component of the hydrographical basin Gârda Seacă and Arieşul Mare. From a territorial point of view the studied basin is part of U.P. V Arieşeni O.S. Gârda.

This sub-basin occupies a 97,2 Ha surface, this being covered by forest and constitutes 2 HSUs (Hydrologic Study Units) with the composition 10Mo, but of different ages.

The entire length of the hydrographical network in the sub-basin is 3880 meters, of which the main riverbed has a 1420 m length.

- HSU 1 – has a 47,4 Ha surface for which we have a hydrological efficiency situated in the category and sub-category B_1;

- HSU 2 – has a 49,99 ha surface for which we have established a B_3 category of hydrological efficiency .

MATERIAL AND METHODS

CALCULATION OF THE SILT TRANSPORT THE AVERAGE ANNUAL SILT TRANSPORT

For the hydrographical basin Izvorul Fericele Brook, which is a small basin, one may apply the method elaborated by R. Gaspar and Al. Apostol obtaining good results. By means of this method, one forecasts individually the silt volume formed by the dispersed drain from the hillsides and the silt volume formed by the concentrated drain from riverbeds and afferent banks.

The method may serve for:

- establishing the torrential potential of the small hydrographical basins;
- sizing of the retention capacity that the dams must assure in a given time span;
- estimation of the hydrological and anti-erosion efficiency of the designed works, before and after arrangement.

For a relatively long period the Gaspar-Apostol method allows the informative evaluation of the average annual volume of silt, W_a (m^3/year), which traverses a given operational section of a torrential hydrographical basin through the formula:

$$W_a=W_{av}+W_{aa}$$

Where:

- W_{av} is the average annual volume of silt resulted from the erosion of hillsides (m^3/year)
- W_{aa} is the average annual volume of silt resulted from the erosion of riverbeds (m^3/year).

RESULTS AND DISCUSSION

THE AVERAGE ANNUAL SILT TRANSPORT FROM THE HILLSIDES

For the informative evaluation of the average annual silt volume caused by the erosion of hillsides, the following relation is used:

$$W_{av} = a \cdot b\sqrt{I_v} \sum F_i \cdot q_{vi}$$

where:

- a is the dimensionless coefficient (this coefficient is inserted in tables according to the length of the hillsides). For the hydrographical basin of Izvorul Fericele Brook, this coefficient's value is 1.17;
- b is a volume deduction coefficient for the silt formed by the hillsides, when they are built in a row of terraces or have the lower part in an easy slope, conditions that make possible the local settlement and consolidation of silt. For the basin of Izvorul Fericele Brook the value of this coefficient is 0.77986
- I_v is the average slope of the hillsides, it assimilates with the average slope of the basin
- q_{vi} is the specific erosion coefficient on surface (m^3/year/Ha) of HSU

- the erosion values on hillside, specific on land categories, are given in the following table (table 1):

Table 1

The erosion values on hillside

HSU	q_v(m^3/an/ha)	F	F*q_v
1	0.5	47.26	23.63
2	0.1	49.99	5.00
Total			28.63

The average annual silt volume caused by the erosion of hillsides is: W_{av}= 20.88 m^3/an

THE AVERAGE ANNUAL SILT TRANSPORT FROM THE RIVERBED

To evaluate the average annual volume of silt caused by the erosion of riverbeds and of the afferent banks, the following formula is used:

$$W_{aa} = b \cdot \sum (L_i \cdot q_{ai} \cdot \sqrt{\frac{i_{ai}}{i_i}})$$

where:

- b is the dimensionless reduction coefficient of the silt volume formed from riverbeds. It has the same value with coefficient b from the previous point;
- L_i is the length of the „i" riverbed area having the same characteristics as its entire length;
- q_{ai} is the erosion coefficient in depth for the „i" area, graphically determined according to the width of the riverbed and the predominant grainmetry of the silt;
- i_{ai} is the average slope of the „i" area, calculated according to the situation plan;
- i_i is the standard value for the slope of the riverbeds having a certain width, considered for the establishment of the specific erosion coefficient, also graphically determined

All these factors have been centralized in the following table(*Table2*):

Table2

The average annual volume

Category	Li(km)	Δhi (km)	I_{ai}	l_i	L_{ic}	i_i	q_{ai}	Lic*q_{ai}*(I_{ai}/Ii)$^{0.5}$
I	2.83	2.83	1.00	5.5	2.264	0.142	250	1502.01
II	0.515	0.52	1.00	7.5	0.38625	0.135	275	289.09
III	0.535	0.54	1.00	8.5	0.3745	0.124	300	319.05
total	3.88	3.88	3.00		3.02475			2110.15

Considering that the silts are not supplied by the entire length of the riverbeds, the operational lengths for the silt transport will diminish cu 20%

for the 1st category of riverbeds, with 25% for the riverbeds in the 2nd category, with 30% for the riverbeds in the 3rd category.

The value of the specific erosion coefficient q_{ai} for the average diameter of the silts, between 1 and 7 cm, and of the „standard" slope, have been taken from their diagram, the case 5<Z<10 mm.

The value of retention has been calculated as a balanced mean with the surface, as it may be seen in the following table (Table3):

Table 3

The value of retention

USH	F	Z	F*Z
1	47.26	17	803.35
2	49.99	15	749.91
total	86.50		775.88

For the basin of Izvorul Fericele Brook has been obtained the retention value of:

W_{aa}=640,61 m^3/an

In the hydrographical basin of Izvorul Fericele Brook the average annual silt volume is:

W_a=661,489 m^3/an

THE SILT TRANSPORT ON A TORRENTIAL RAIN

For the informative evaluation of the silt transport caused by a torrential rain, with the assurance p%, $W_{al}^{1\%}$, it is recommended to apply the formula of I.I. Herheulidze, which for p%=1% has the following formula:

$$W_{al}^{1\%}=10\ b\ c\ F\ H_{1\%}$$

where:

- b is a coefficient depending on the percent of the degraded surface from the entire surface of the basin and on the average slope of the main riverbed;
- c is the average drain coefficient per basin;
- F is the surface of the basin in km^2;
- $H_{1\%}$ is the height of the precipitation layer with the assurance 1%, in mm, for the concentration period of the basin drainage.

Excessively abraded lands are considered to be the torrents' beds and the base of the banks. The surface is calculated by multiplying the degraded lengths of the riverbeds of different categories with their width, to which is added 50%, considering the degradation at the base of the banks.

The determination of the silt transport for a rain having another assurance is made by means of the correction coefficient Kritki-Menkel.

Table 4

The table with the degraded surfaces of the riverbeds

category	Li (m)	li	Sa	Sa+m (mp)
1	2830	5.5	15565	23347.5
2	515	7.5	3862.5	5793.75
3	535	8.5	4547.5	6821.25
total	3880		23975	35962.5
F				972500
% degraded surface				4.2

It results that the percent of the lands affected by excessive erosion is of 4,2%.

Therefore we have:

- b=25,09
- $H_{1\%}$=29,06
- c=0,341

For the torrential basin of the Izvorul Fericele Brook has been obtained a silt transport for a torrential rain, with the assurance of 1%, of :

$W_{al}^{1\%}$= 2418,70 m^3 .

THE SILT VOLUME CAPABLE OF FORMING ATTERISMENTS VOLUME PRODUCED BY THE AVERAGE ANNUAL TRANSPORT

For the informative estimation of the silt volume that may form atterisments (W^{ater}_a), the authors R. Gaspar and Apostol recommend the appliance of the formula:

W^{ater}_a=A W_{av}+B W_{aa}

Where A and B are coefficients given in tables according to the diameter and the origin of the silts from hillsides or riverbeds. For the basin of Izvorul Fericele Brook these coefficients are:

A=0.20

B=0.60

W^{ater}_a= 388,54 m^3

THE VOLUME FORMED AFTER A TORRENCIAL RAIN

The informative estimation of the silt volume that might form atterisments after a rain having the assurance p% uses the relation:

$$W_{p\%}^{ater} = \frac{W_a^{ater}}{W_a} \cdot W_{al}^{p\%}$$

It is calculated for the assurance of 1%.

$W_{1\%}^{ater}$ = 1420,68 m^3

CONCLUSIONS

The hydrotechnical solution of arranging the hydrographic network will be conceived from several other transversal hydrotechnical works (dams) connected to the pond downstream of the first dam through an evacuation channel.

These works that will be accomplished in the hydrographical basin of Izvorul Fericele Brook will have the following functions:

- regularisation and reinforcement of the riverbed;
- reduction of the high floods and retention of the silts brought by floods;
- creation of favourable conditions for the installation of the forestry vegetation on the atterisments between the works and on the lands that are silt sources on the bank;

These works help substantially to the restoration of the environment, especially within those “areas” that have been mostly “decomposed” by the torrential processes in the basin. Practice has demonstrated that the installation of provisory forestry cultures on the lands, which are the source of silts, represents the first step – possible and necessary- in reaching this objective. By ulterior artificial intercessions – correlated to the improvement degree of the soil conditions – one may assure the gradual transition to the area forestry eco-systems or close to the areal ones, the only capable to value the entire production capacity of the lands in the basin and to assure the exercitation/maintenance of the eco-productive characteristics at the highest level.

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