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THE RIVER DEPOSITS TRANSPORTATION FROM THE HYDROGRAPHIC BASIN GURGHIU – PR. SIRODUL MIC

Iulia Diana GLIGA, Maxim COROCHII, Maria-Olivia MOLDOVAN

Scientific Coordinator: Prof. PhD Eng. Marcel DIRJA

University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, 3-5 Calea Mănăştur St., 400372, Cluj-Napoca, Romania, Phone: +40-264-596.384, Fax: +40-264-593.792, Email: iulia.gliga@usamvcluj.ro , maria-olivia.moldovan@usamvcluj.ro, corochiimaxim@gmail.com

Corresponding author email: iulia.gliga@usamvcluj.ro

Abstract

The river deposits transportation prognosis is required to draft the improvement planning of the torrential hydrographic basin, considering that the basin torrential potential shall be established based on this hydrological dimension, together with the retention capacity of the transversal hydro-technical works and with an estimation of the hydrological and anti-erosion efficiency of all the measures and works which are to be applied within the basin. The hydrographic network of the torrential basin Gurghiu is mostly dominated by the river deposits erosion and transportation. In order to calculate the annual average transportation the method advanced by R.Gaspar and by A. Apostol was used, a method which is conceived for the specificity of the torrential basins of our country. To draw a conclusion, based on the previously made calculations, the annual volume of the basin river deposits is of 130 m3/year. The bank deposits retention in the earthworks shall determine a stabilization of the river beds in the hydrographic works emplacement region, thus reducing its slope and depositing the alluvial deposits quantities.

Key words: *river deposits, transport, earthwork/alluvial deposits, torrential hydrographic basin.*

INTRODUCTION

The bank deposits transportation is represented by the transported material quantity/mass, depending on the water speed, on the slopes inclination, on the riverbed or on its debit. Water torrents transport, from basins, large quantities of alluvial deposits, branches or even entire trees. During transportation, a torrent diminishes, after 10 km, pieces of granite of 20 cm in diameter into small pebbles of 2-3 cm in diameter, whereas after other 10 km they turn into sand. (Kiss et al., 1981).

The alluvial deposits form where the land slope becomes smoother, by depositing the transported materials on the thalweg or into the dejection cone. In the case of torrential watercourses/floods, the sand and the gravel are deposited first, then the rocks and the large stones, because of the driving speed (Baloiu, 1965; Bădescu, 1972)

The river deposits transportation prognosis is required to decide the torrential hydrographic basin improvement solutions, as it is based on this hydrologic dimension that the torrential potential of the basin is evaluated, the retention capacity of the transversal hydrographic works is dimensioned, the hydrologic, anti-erosion efficiency of all the measures and the works which are to be applied within the surface of the basin being therefore estimated.

The design of the basin retention functional capacity is based on knowing the river deposits quantity which may be stored under the form of alluvial deposits. In this case, the present volume shall be generated by both the annual average alluvial deposits transportation, and also by the alluvial deposits transportation during storms or rains.

MATERIALS AND METHODS

The river/alluvial deposits transportation calculus was performed within the hydrographic basin Gurghiu, on the river Siriodul Mic.

Based on the measurements performed and based on direct observation, we shall retain that a significant quantity of river deposits is transported during the process of the torrential floods flow.

The torrential basin under research, measuring a surface of 44,347 ha, is classified within the small basins category, with $F \le 100$ ha.

The basin hydrographic network is mainly subject to erosion and to the alluvial deposits transportation. The lands on the slopes are distributed on erosion degrees as follows:

Weak erosion E1 for unit 2 measuring a surface of 7,235ha, 16,3%,

Average erosion E2 for unit 1 measuring a surface of 15,881ha, 35,8%,

Powerful erosion E3 for unit 4 measuring a surface of 15,323 ha, 34,6%,

Extremely powerful erosion E4 for unit 3 measuring a surface of 5,908 ha 13,3%.

The calculation of the annual average river alluvial deposits transportation used the method advanced by R.Gaspar and A. Apostol, a method which is conceived for the specificity of the torrential basins of our country. To be able to calculate the transported alluvial deposits quantity, the following parameters of the hydrographic basin were determined: the basin surface, the basin average length, the average slope, the slopes average length.

The measurement of the slope of the alluvial deposits already formed or which is about to form used the hypsometer Silva ClinoMaster, the length consolidated by these alluvial deposits (Lat) being measured by the help of the 50 m ruler, whereas the surface consolidated by the alluvial deposits was calculated by multiplying the length of the alluvial deposit with its width in the area of the hydro technical work emplacement, at the level in which this was in that specific section.

RESULTS AND DISCUSSIONS

For the evaluation of the annual average volume of the river deposits resulted following the slopes erosion, Wav (m3/year), the following formula was used:

$$W_{av} = a \cdot b \cdot \sqrt{I_V} \cdot \sum F_i \cdot q_{1i} = 22 \text{ m}^3/\text{a}$$

Table 1. Elements used to calculate the river deposits volume transported on the slopes

U.S.H.	1	2	3	4	Total
F_I	15,881	7,235	5,908	15,323	44,347
Land categ.	11	10	6	2	
q_i (m^3/an · ha)	0,1	0,2	0,8	1,2	
z_i (mm)	17	15	8	4	
$F_I \cdot q_{Ii}$	1,588	1,447	4,726	18,388	
$Z_i \cdot F_I$	269,98	108,53	47,26	61,29	
a =1,4; b= 0,90; $\sqrt{I_V} = 0,677$; $\sum F_i \cdot q_{1i}$ =26,149;					
Results W_{av} = 1,4·0,9·0,677·26,149=22 m^3/year					
$Z = \frac{\sum Z_i \cdot F_i}{F} = \frac{487,06}{44,347} = 10,98$					

a – a-dimensional coefficient with values ranging between 0,7 and 2,2 based on the average length of the slopes. We shall consider/adopt a = 1.40

b- a-dimensional coefficient for the diminution of the volume of the river deposits rolled down from the slopes, whether they are formed of a succession of terraces or whether their lower part is a smooth slope, backgrounds in which the river deposits sedimentation and local consolidation becomes possible. In the case of this coefficient, values ranging between 0,5 and 1,0 shall be used. We shall use b = 0,9.

Iv – the average slope inclination

q1i – the erosion specific index in surface of a certain land category of the basin (m3/year·ha).

Fi – the surface in ha of that specific land category

Figure 1. Silt/river deposits and floats carried in the torrential valleys

The river deposits transportation from the river beds is generated by the riverbeds erosion W_{aa} (m^3/year), the results being got by applying the relationship:

$$W_{aa} = b \cdot \sum (L_i \cdot q_{2i}) \cdot \sqrt{\frac{I_a}{i}},$$

L_i – length of the hydrographic network sectors, mainly developed within unconsolidated river deposits, which might be slightly eroded, expressed in km

q_{2i} – the specific depth erosion index alongside the length sector L_i, in m^3/year/km;

I_a – the average slope of the mail bedside alongside the length sector L_i;

i - the "standard" value of the slope of the bedsides of a certain width, taken into consideration while establishing the values of the index q_{2i} , i = 0,135.

As, in the given situation the hydrographic network could not be mapped directly in the field, we shall consider in a first stage that the hydrographic network shall provide river deposits from the entire river network. The result thus obtained (Waa100%) shall be further on corrected by a subunit coefficient of the river deposits influx (ca), a coefficient which approximates the participation degree of the basin network to the genesis of the annual average river deposits transportation. In the present situation we shall define the above-mentioned coefficient in correlation with the state of decay of the fields on the corresponding slopes. We shall therefore have:

$$\varphi al = \frac{F_{e3} + F_{e4}}{F} = \frac{15{,}323 + 5{,}908}{44{,}347} = 0{,}48$$

Considering the given specifications, the above relation can be further on applied under the form:

$$W_{aa} = \varphi al \cdot W_{aa}^{100\%} = \varphi al \cdot b \cdot \sum (L_i \cdot q_{2i}) \cdot \sqrt{\frac{I_a}{i}},$$

For the erosion index prognosis q_2 (m^3/year·km) one of the diagrams recommended by the authors shall be used, the following remarks being taken into consideration:

1. As, based on the previous calculations, the average retention at the level of the basin has the value Z=10,98 mm for the prognosis we shall use the diagram corresponding to the case 10 mm < z < 15 mm;
2. The average width of the basin riverbeds can be differentiated based on their hydrographic order and on their surface, in the following way:
 - order I $l_I = 0{,}1 \cdot F - 0{,}4 = 0{,}1 \cdot 44{,}347 - 0{,}4 = 4{,}03$m ,
 - order II $l_{II} = 0{,}1 \cdot F + 1{,}8 - I_{aver} = 0{,}1 \cdot 44{,}347 + 1{,}8 - 0{,}46 = 5{,}77$ m,
3. From the point of view of the size composition the network deposits can be classified as follows:
 a. the first order/I riverbeds under the category of river deposits over 7 mm ;
 b. the second order riverbed/II under the category of river deposits between 1-7 mm .

Table 2. Elements for the calculation of the river deposits transported alongside the riverbeds

	I	II	Calculations
The riverbed length L_i(km)	0,752	0,478	φ_{al}=0,49;b= 0,9 $\Sigma L_i \cdot q_{2i}$ =142,507; I_a = 0,41 ; i = 0,132 ; $\sqrt{\frac{I_a}{i}}$ =1,76
The riverbed width l_i (m)	4,03	5,77	
The river deposits diameter	>7	1 - 7	
Erosion index q_{2i} (m^3/an ·ha)	90	160	
The standard slope	-	1,32	
$L_i \cdot q_{2i}$	67,707	74,800	
Results : W_{aa} = 108 m^3/year			

In conclusion, based on the above calculations, the annual volume of the basin river deposits can be: $W_a = W_{av} + W_{aa} = 22+108 = 130$ m^3/year.

Figure 2. River deposits transported along the river Siriodul Mic

By determining the river deposits volume of the alluvial, we shall be able to design the basin functional retention capacity, as it is based on information relative to the river deposits quantity which can be stored under the form of alluvial deposits. This volume shall be generated by both the annual average river deposits transportation, and also by the river deposits transportations during insurance rains. For an indicative estimation of the annual average volume of river deposits which might form alluvial deposits, R. Gaşpar and A. Apostol recommends, for riverbed slopes of at least 3% and heights of the dam elevation of up to 6 m, the application of the formula:

Waater $= A \cdot W_{av} + B \cdot W_{aa}$ =4,4 +64,8= 69 m3/an,

Wav –the annual average river deposits volume generated by the slopes erosion [m3/year]

Waa- the annual average river deposits volume generated by the river beds erosion [m^3/year]

A and B – table coefficients depending on the diameter of the river deposits generated by the slopes erosion and therefore by the erosion of the riverbeds.

As, in the present situation, the hydro technical works shall be emplaced on a 2nd degree riverbed, the correction coefficients shall have the values: A=0,2; B = 0,6

$W_a^{ater} = A \cdot W_{av} + B \cdot W_{aa} = 0{,}20 \cdot 34 + 0{,}60 \cdot 159 = 102{,}4$ m^3/an.

$K_a^{ater} = W_a^{ater}/W_a = 38/70 = 0{,}53$ (53%)

We shall note that only 53% of the initial river deposits quantity entrained within the basin space shall be stored in the alluvial deposit.

Figure 3. Alluvial deposit formed and volume of the captured river deposits

We shall note that, the bigger the volume of the river deposits directly caught by the transversal hydro technical works, the higher the volume of river deposits consolidated along the torrential valleys, a thing also contributed to by the number of hydro technical works executed on each single torrential valley.

CONCLUSIONS

By determining the river deposits volume of the torrential hydrographic basin we shall be able to identify solutions to improve the basin by a set of measures and biological works, biotechnical and hydro technical works the purpose of which is the diminution of the river deposits transportation.

The retention of the river deposits shall determine a consolidation of the banks of the riverbeds in the hydro technical works development region, a diminution of its slope and a river deposits quantities storing.

The estimation method of the river deposits volume reveals the approximate quantity of the river deposits which might have been transported alongside the torrential network, respectively the evolution in time of the event.

In order to reduce the river deposits transportation we shall have to intervene by works of afforesting the river deposits sources, if they are unstable or by using timber vegetation provided that this kind of vegetation is unlikely to be planted in a natural way.

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