Technical remediation and improvement activities of land use based on deforestation and levelling-modeling in the Republic of Moldova

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ABSTRACT: Land improvement activities contribute to soil protection, create conditions to boost soil fertility and encourage more rational use of water resources. The paper is focused on investigating, planning, performing and maintaining the constructions related to water use or protection against destructive actions. The soil – being the main natural source of the Republic of Moldova and forming the base of its food security, economic potential and people welfare – becomes increasingly the subject to severe degradation processes in recent years. One of the main degradation processes is land erosion. This paper provides technical remediation and improvement activities for agricultural land use in the village Parcani, Soroca district.

KEY WORDS: land improvements, soil protection, reasonable water use.

1. Introduction

Soil is the main natural wealth of the Republic of Moldova and the most important means of production in agriculture. Country's climatic conditions in terms of agriculture development determine an imbalance between the abundance of heat and light that favours plant growth and development and periodic rainfall shortage causing considerable drought conditions and consequently the decrease or even sharp drops in agricultural crop productivity. Among soil degradation processes, water erosion should be considered first. One of the main degradation processes is rainwater erosion.

The purpose of this paper is to establish methods to remedy the agricultural land in the village Parcani, Soroca district. The land will be remedied due to the construction of the anti-erosion pond, which will prevent farmland erosion and flooding. Another measure is to plan the reconstruction of the existing earth dam and the construction of the stepped spillway, which will prevent the processes of agricultural land erosion ans degradation.

2. Methods

The research was conducted based on the methods of field research and laboratory data analysis. In order to argue technical remediation and improvement activities of land use based ondeforestation and levelling-modeling within the administrative - territorial boundaries of Parcani Mayoralty, Soroca district, geological prospecting was carried out.

In September 2010, geological prospecting and exploration activities were conducted on the land intended for pond construction, and in September 2014, on those intended for the construction of bridges and culverts over Camenca River and over some of its tributaries in order to study the technical-geological and hydrogeological conditions. For this purpose, visual researches were conducted at the scale 1:10000 and 21 wells were manually drilled at depths ranging from 2.5 to 7.0 m,on the lands intended for pond construction (total volume of 98.0 m^3) and under culverts without taking samples for laboratory analysis. Other engineering-geological prospecting was not previously made on these lands.

Geological prospecting and geological prospecting report were carried out in 2010 by the geologist G. Gudjabidze and those dating of 2014 - by the geologist E. Ciobanu.

Average statistical lab data for uncovered soil layers obtained from the wells drilled in 2014 are taken from the report of geological and hydrological prospecting for the “Pond construction in the sovkhoz-factory Stefan Voda” conducted within the boundaries of the Mayoralty Tatarauca-Veche, Soroca district in 1991.

3. Results

Pond construction design was performed based on the urbanism certificate, topographic records and pedological and geological researches.

The following normative and technical documents were used for project drafting:

a) STAS 2.06.01-86 “Hydrotechnical constructions. General design requirements”.

b) Project-type 820-023.86 “Earth-filled dams up to 12 meters in height and upstream inclined slope”.

According to STAS 2.06.01-86, the Hydrotechnical constructions construcțiile hidrotehnice included in the project refer to the IVth category.

Parcani village is located in Soroca district. The localities Parcani and Voloave are part the village Parcani. It is situated at the distance of 23 km from Soroca town and at 150 km from Chisinau.

This project includes the reconstruction of a pond located on the Dniester River for antierosion purposes. An anti-erosion pond is a catchment basin built for anti-erosion purposes.

The work intended for cleaning the pond helps to determine topographic feature of the pond. Topographic feature of the pond is represented in Table 1.

Using the obtained values, we can build the specific topographic curves of the pond depending on the depth: ω-f(H) and W-f(h). Topographic feature of the pond consists of:

- ✓ Morphometric parameters of the pond;

✓ Water levels of the pond, which are determined as follows: a) Normal retention level (NRL) is 194,5 m.

Figure 1 Anti-erosion pond Nr.3.

b) Forced level with the frequency of 1% (NF1%) will be determined based on the hydraulic calculations and values of the existing stepped spillway.

Hydraulic calculation to determine stepped spillway.

The stepped spillway has the following construction:

1. Top of dam. Stepped spillway build of monolithic reinforced concrete;
2. Pipe without pressure;
3. Energy dissipation chamber;

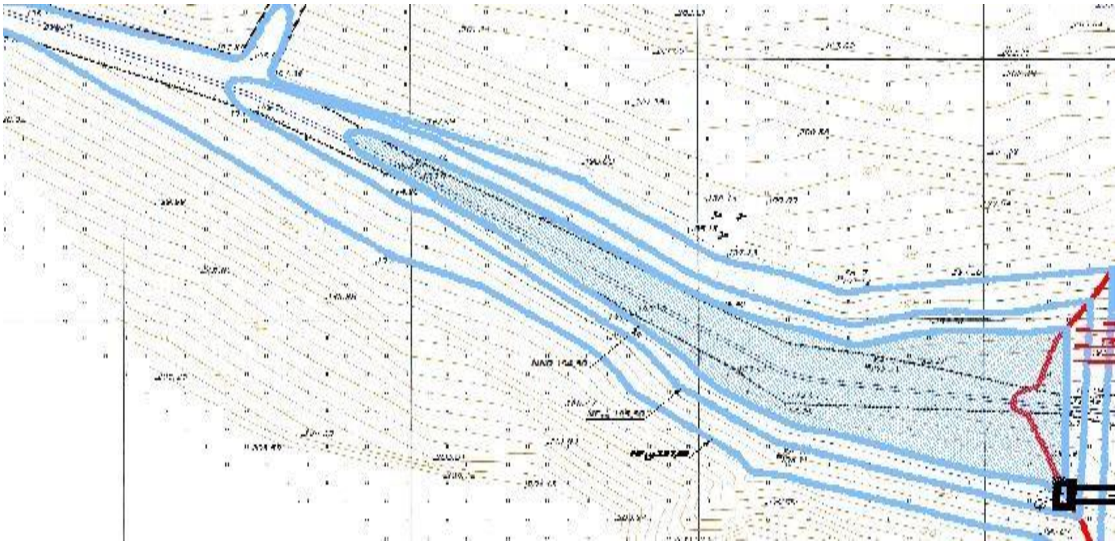

Figure 2 Location of the anti-erosion pond.

Table 1 Topographic features of the pond.

Water level	Surface ω, ha	Average surface $\bar{\omega}$, ha	Depth h,m	Water volume, $W \cdot 10^3$	$\sum W \cdot 10^3, m^3$
1	2	3	4	5	6
191,3				0	0
		0,025	0,7	175	
192	0,05				175
		0,070	1	700	
193	0,09				875
		0,14	1	1400	
194	0,19				2275
		0,265	1	2650	
195	0,34				4920
		0,43	1	4300	
196	0,519				9225
		0,38	1	3800	
197	0,725				13025
		0,84	1	8400	
198	0,94				21425
		1,07	1	10700	
199	1,20				32125
		1,34	1	13400	
200	1,48				
201	1,70	1,59	1	15900	61425

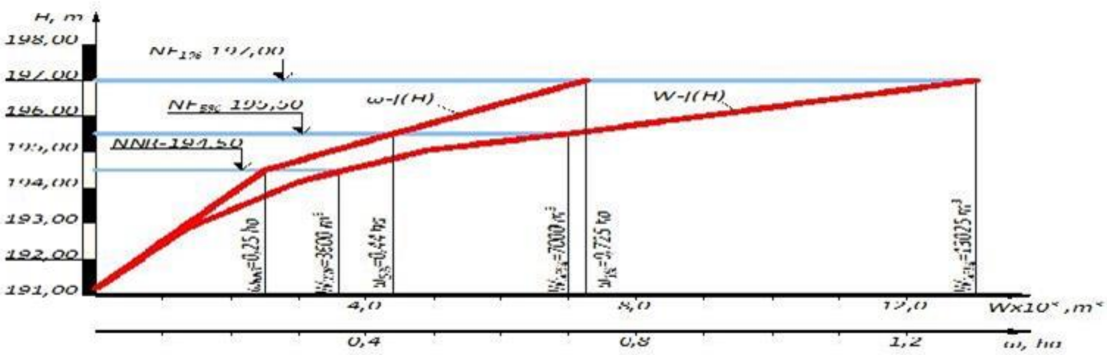

Figure 3 Bathygraphic feature of the pond.

In order to determine the volume flow rate that will pass through the existing offtakes, we must determine the volume flow rate in the pond bed after pond cleaning.

In order to determine the flow the author used the method D. I. Kocherin, which allows to find out the forced layers at normal retention level, from 0 m to 3,5 m height, located on the bathygraphic feature of the pond (Figure 4).

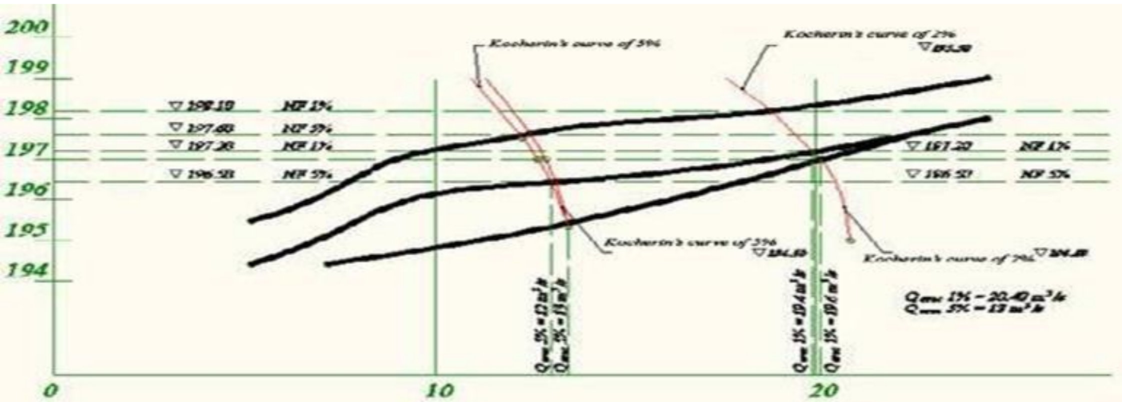

Figure 4 The scheme to calculate the flow according to Kocherin method.

Based on the above presented diagram we can determine volume levels from 0 to 3.5m and introduce them in the Tables 2 and 3 respectively using the following formula:

$$Q_{ev} = Q_{p\%} \left(1 - \frac{W_{reg}}{W_{p\%}}\right),$$

$$Q_{5\%} = 13{,}6 m^3;\ W_{5\%} = 121 \cdot 10^3 m^3; \qquad (1)$$

Table 2 Calculation of the evacuated volume flow rate of 5% according to Kocherin’s method.

H	$W_{reg}\, 10^3$	$\frac{W_{reg}}{W_{5\%}}$	$1 - \frac{W_{reg}}{W_{5\%}}$	Q_{ev}
194,50	0	0	1	13,6
195,00	1322	0,01	0,99	13,46
196,00	5627	0,05	0,95	12,92
197,00	9427	0,08	0,92	12,5
198,00	17827	0,15	0,85	11,2

$$Q_{1\%} = 21{,}2 m^3;\ W_{1\%} = 189 \cdot 10^3 m^3;$$

Table 3 Calculation of the evacuated volume flow rate of 1% according to Kocherin’s method.

H	$W_{reg}\, 10^3$	$\frac{W_{reg}}{W_{1\%}}$	$1 - \frac{W_{reg}}{W_{1\%}}$	Q_{ev}
194,50	0	0	1	21,20
195,00	1322	0,01	0,99	21,00
196,00	5627	0,03	0,97	20,56
197,00	9427	0,05	0,95	20,14
198,00	17827	0,10	0,90	19,08

After the calculation for determining the evacuated volume flow rate Qev, according to Kocherin’s method, the curves are drawn depending on the frequency. The work graph of drainage constructions connects the determined curves depending on the calculations perfomed according to Kocherin’s method and the curve of volume flow rate capacity of the stepped spillway. After making the calculations we introduced the obtained data in Table 4.

Table 4 Determining the flow rate.

Water level	H,m	z, m	$\sqrt{z}$, m	μ	ω_t, m^2	$\mu \cdot \omega \cdot \sqrt{2g}$	Q_{ev}, m^3/s
194,5	2,0	0,3	0,55				7,15
195	2,5	0,8	0,89	0,59	5,0	13,00	11,57
196	3,5	1,8	1,34				17,42
197	4,5	2,8	1,67				21,70

The execution of construction activities should be performed according to the following technological order:

a) Implementation of construction activities of the earth dam;

b) Implementation of construction activities of the stepped spillway:

- ✓ Pipeline unit;
- ✓ Energy dissipation chamber;
- ✓ Diaphragm; Rock toe.

The dam represents a hydrotechnical construction, which is located in the bed of a river to raise the upstream water level.

The construction of the earth dam is of gravitational type designed according to the normative requirements in force.

Transverse section of the dam is designed taking into account the following parameters:

1. Crest lenght- 6,5m
2. The slope – upstream 1:3 downstream 1:2
3. Crest of dam, 198,20m

The reserves of mineral soil for the construction of the dam could be found on the banks of valleys. The length of the dam is 72m, maximum height 3,3m.

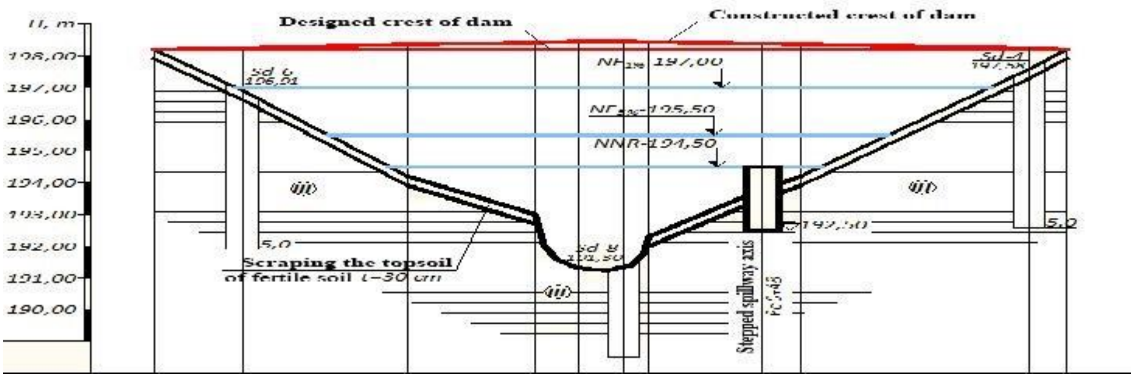

Figure 5 Longitudinal profile on the dam axis.

Stepped spillway represents a construction that is situated outside the dam, its overflow hose being in a funnel-like form.

The stepped spillway has the following constructions:

1.Pipeline unit;

2.Energy dissipation chamber;

3.Diaphragm;

4.Rock toe.

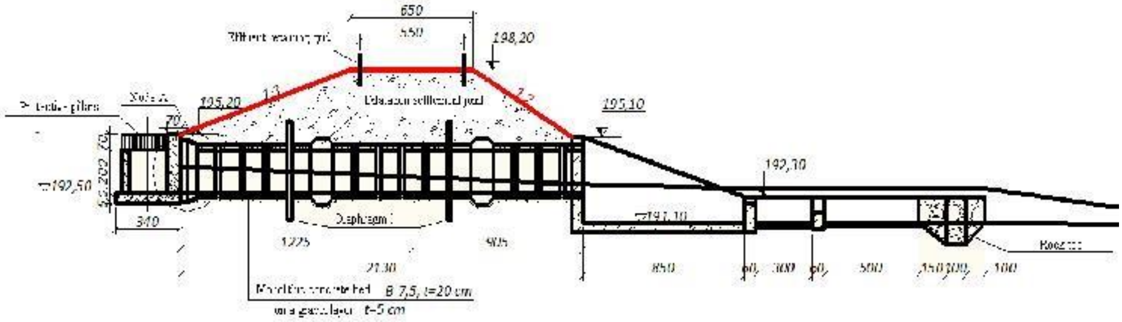

Figure 6 Transverse section of the stepped spillway.

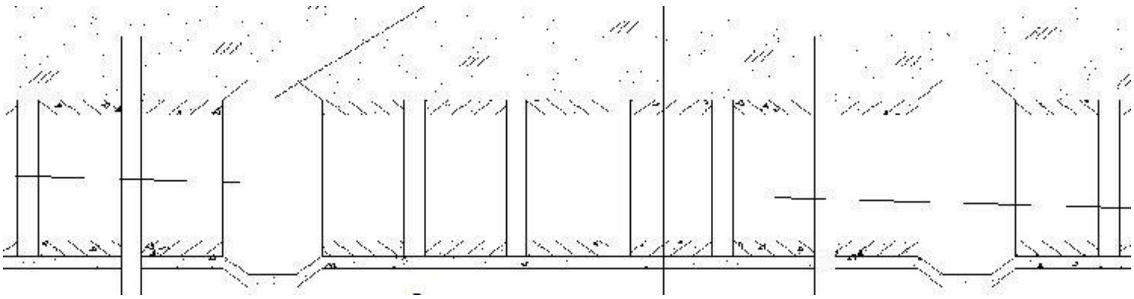

Figure 7 Pipeline unit Energy dissipation chamber is a hydrotechnical construction, which reduces the speed of water currents.

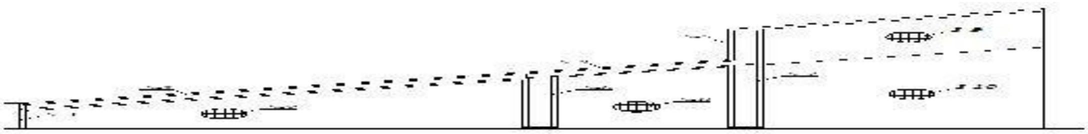

Figure 8 Energy dissipation chamber.

The diaphragm represents an element designed for hydraulic construction stiffening, which is less thick than other constructions and it usually represents a vertical flat plate or a screen.

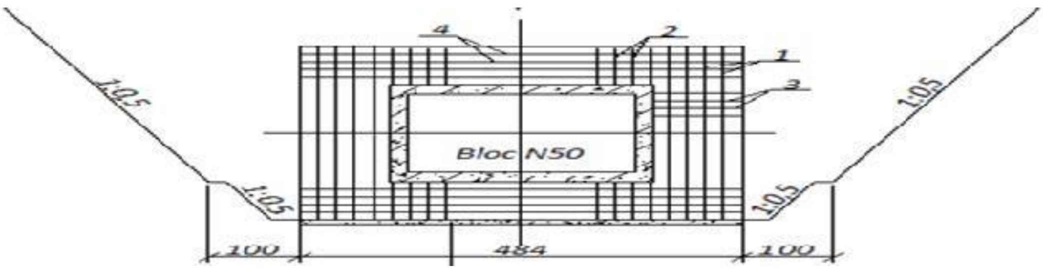

Figure 9 Diaphragm.

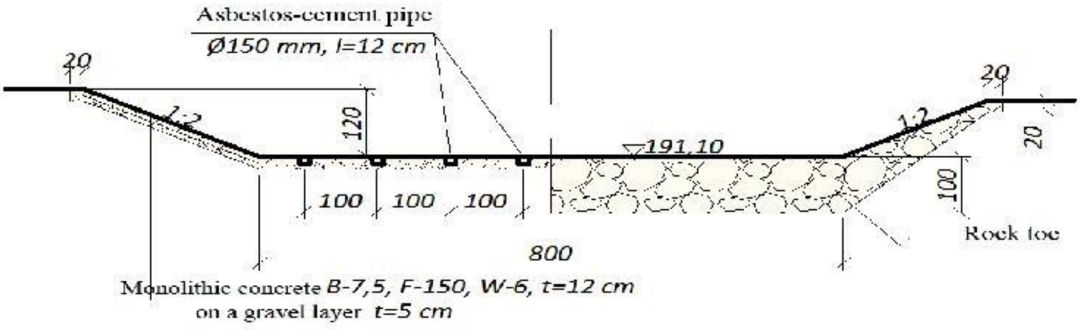

Figure 10 Rock toe.

4. Conclusions

Republic of Moldova is a predominantly agrarian country. Approximately 70% of country's population activate in the agricultural sector.

There are a number of conditions and factors that have an adverse impact on the soil. Among these we can mention soil erosion, floods, heavy rains and frosts.

This project had the purpose to establish methods to remedy the agricultural land in the village Parcani, Soroca district. Land remediation is done due to the construction of the anti-erosion pond, which will prevent farmland erosion and flooding. This project is also focused on the reconstruction of the existing earth dam and construction of the stepped spillway, which will prevent the processes of agricultural land erosion ans degradation.

Once the pond is built, it will serve a protective shield against soil erosion and floods. In the long term, the anti-erosion pond can become silted-up. Once siltation, agricultural land forms.

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