INFLUENCE OF THE ANTHROPIC FACTOR OVER THE MODIFICATION OF GEOMETRIC AND HYDRAULIC ELEMENTS OF THE DRAINING NETWORK OF THE ROTOPĂNEȘTI-RĂDĂȘENI-FÂNTÂNA MARE SYSTEM, SUCEAVA COUNTY

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Abstract: *The drainage-desiccation developments on the Moldova river meadows in Suceava county were built for the purpose of eliminating the excess water from both the terrain's surface and from its higher levels, origination from rainfall, ground water, from the surface flow and from the surrounding higher ground. After constructing the hydro-ameliorative improvements, special attention must be given to the operation method and to its behavior over time. By operating and using the draining network, mainly shores erosion and bottom of canal clogging occurs, that may be caused by both natural and human factors. In order to determine the geometric and hydraulic parameters of the draining system, an accurate elevation-height topographic survey was conducted by the method of radiation and leveling traversing combined with radiations, based on which the transversal and longitudinal profiles were drawn. The leveling survey data were gathered using an average precision Zeiss Ni-025 level and the surveying rod with centimeter marks, and the level differences were determined bases on two levels of the surveying instrument. Waste disposal, vegetal waste and various packaging materials thrown into the canal, generally beside bridges, speed the process of clogging and shuttering, causing, in upriver, the decommissioning of canals, the overflow of waters accumulated during heavy rain, the flooding of nearby areas, and the malfunction of the desiccating- drainage network. Also, the shore erosion and canal clogging is largely influenced by the lands serviced by the canal category of use. The shore erosion and the canal clogging is greater upon the areas used as pastures, due to a low degree of embankment grassing, to total lack of grassing on some sections, caused by irrational grazing and by the repeated and uncontrolled animal crossing. On arable surfaces, canals generally present well grassed embankments, fact that diminishes riverbanks erosion, yet in time, for lack of maintenance works, cause water flow slowdown and stagnation, the appearance of hydrophilic vegetation and shrubs, favoring silt sedimentation and clogging.*

Key words**:** *humidity in excess, canal clogging, geometric and hydraulic components of the drainage network.*

INTRODUCTION

The rational use, protection, improvement, and conservation of the soil makes a constant preoccupation of contemporary engineering, successful development relying completely on that. The natural resources of the soil, together with the other components of the soil, are either directly or circumstantially involved in every aspect of development, exerting an impact over each country's economic strength, at every level of development.

Among the main limiting factors of the agricultural production, which occur depending on the local pedoclimatic conditions, we could mention excessive humidity, floods, low permeability and soil compaction, erosion, sliding and others. These restrictions are caused by either natural factors, or human agricultural and industrial operations, that may act negatively in a synergic fashion.

For the proper excessive water removal after the construction of the drying-draining systems, special attention should be paid to their operation and behavior over time, also considering the new private land ownership conditions.

MATERIAL AND METHODS

The excessive humidity, which occurs in the Moldova River basin and which is due to rain and/or ground water and to water system overflows, has manifested itself under various forms and at different intensities, on both horizontal and sloped land.

The natural conditions of the Baia piedmont plain support the occurrence and maintenance of excessive underground and surface humidity. The Moldova River meadow and 1.5 km-wide slip-shaped terraces, which are almost parallel with the Moldova River bed and which run north-west and south-east, with small 1-5 % slopes, with flat areas and many small depressions, facilitate water stagnation.

In the wet climate of the Moldova River basin, the heavy precipitations fallen over 1-5 consecutive days and the low evapotranspiration rate make up the main excessive humidity cause in low permeability soils (Nitu T. et al., 1985).

The precipitations fallen throughout the year exhibit an uneven distribution, with considerable amounts fallen in 24 hours or after long-lasting heavy rains, which cause surface overflows that carry along soil particles, thus enhancing bank erosion and hence clogging the channels (Radu O., 2009).

The desiccation- drainage system Rotopănești-Rădășeni-Fântâna Mare (figure 1), is located on the left riverbank of Moldova river, and encompasses both its meadow and terraces, as well as its tributaries, Șomuzul Băii and Șomuzel. The first improvement works carried out between 1959 and 1960 included the regularization of Șomuzul Băii and Șomuzel creeks, as well as the draining of 1697 hectares. For the purpose of improving the process of water excess disposal, the latter deriving from both precipitation and ground water, completion works were carried out throughout the period 1978-1980, as well as new work of desiccation-drainage, and reshaping main collector canals. For that purpose, drainage works were undertaken on a 5527 ha surface, 1806 ha out of which were fitted with underground drainage systems. Drainage works were objectified in a systematic drain and exhaust canals network, spaced 300-400 m apart, of a total length of 168.10 km, including a regularization- desiccation complex.

The actual drying channels network includes master collecting channels, secondary collecting channels, sector collecting channels and belt channels. The 1.5-2.0 m deep belt channels were located 20-50 m from the edge of the slopes, their role being to protect the dried-drained surface by catching the overflows from the higher neighboring areas.

The present paperwork is studying the ring canal, (CC_1), of the Rotopăneşti-Rădăşeni-Fântâna Mare, Suceava county, system, of some 3000 m overall length, canal that is collecting the waters originating from a North-East slope, on the side of the village Rotopăneşti, of an approximately 37.50 ha surface area, whose present use is pasture, some 23.00 ha out of which being used as either agricultural land or hayfield.

In order to determine the geometric and hydraulic parameters of the belt channel (CC_1), high precision geometric leveling survey measurements were conducted using the radiation and the traversing combined with radiation methods, these measurements enabled us to draft transverse and longitudinal profiles. The leveling survey data were gathered using an average precision Zeiss Ni-025 level and the surveying rod with centimeter marks, and the level differences were determined bases on two levels of the surveying instrument.

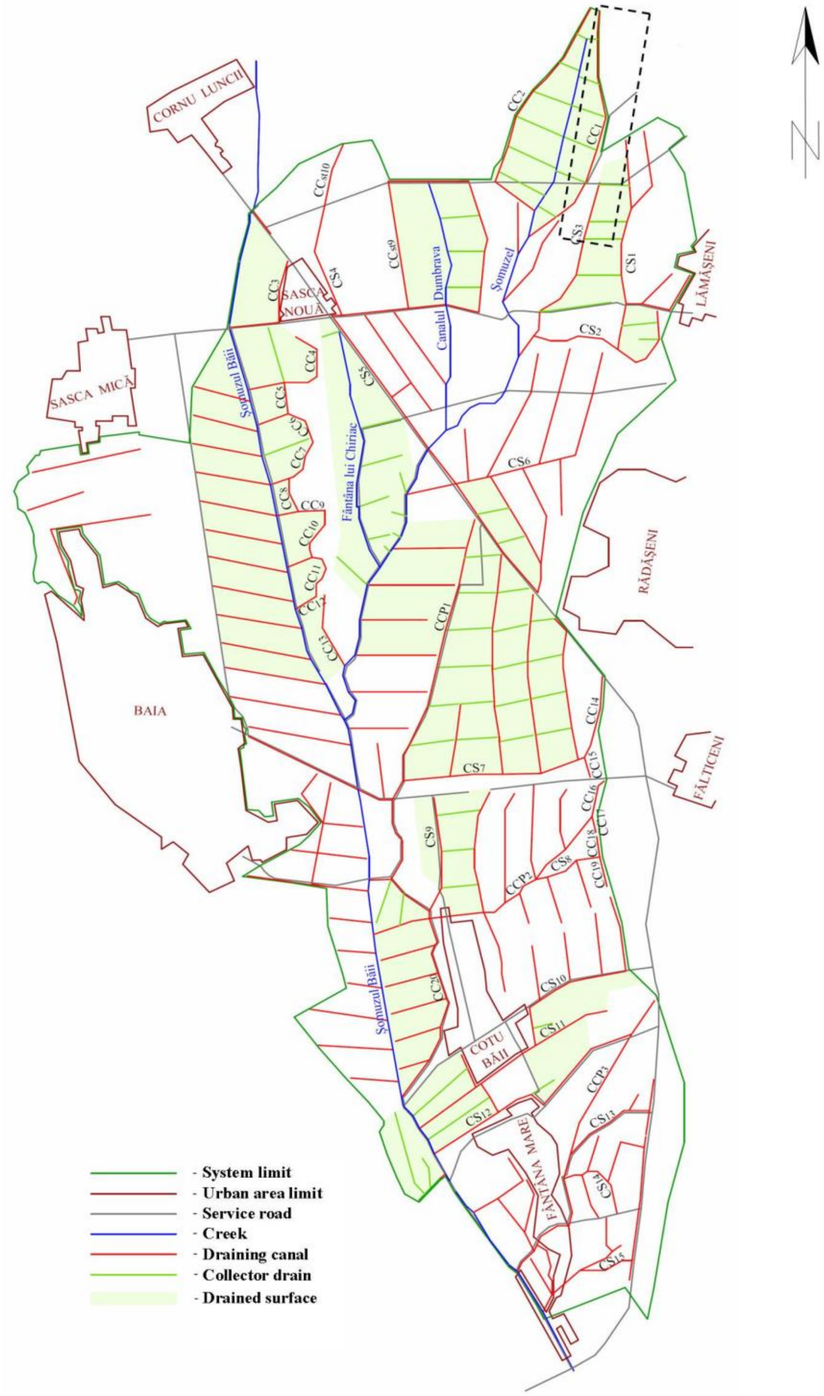
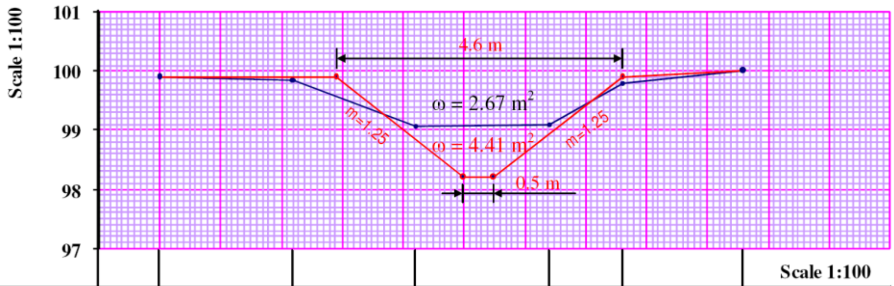


Figure 1: Drying-drainage systems from Rotopăneşti-Rădăşeni-Fântâna Mare

RESULTS AND DISCUSSIONS

Upon the upriver sector of the CC_1 ring canal, of a 2100 m length, serving a 37.50 ha area that has been a pasture since 1992, having been used as hayfield since the completion of works to this day, measurements carried out in 2012 highlighted the changes in the geometrical and hydraulic features of that canal.

The CC_1 ring canal, at approximately 700 m downstream from its end, initially featured the following geometric and hydraulic characteristics: average depth 1.73 m, width at bottom 0.50 m, canal light 4.60 m, slope coefficient 1.25, and canal sectional area of 4.41 m^2 (figure 2). The measurements on the average transversal sections carried out in the area in 2012, on a 100 m length at every 25 m, reveal an increase in canal light of a mean value of 0.80 m, an increase in the width at bottom of 1.70 m and a reduction in depth of circa 1.00 m. These changes are due to both bank erosion and canal clogging caused by grazing on the canal section and repeated animal crossing, especially that of cattle, adjacent areas being used in summer for cattle grazing and in the rest of the year for sheep grazing. The bank erosion and bottom clogging caused by repetitive and uncontrolled animal crossing through areas unfitted with proper crossings is evident by the reduced flow sections in that sector of the canal, showing values between 2.27 and 2.97 m^2, the average flow section being 2.67 m^2, by approximately 40% less than the initial flow section value (figure 2).



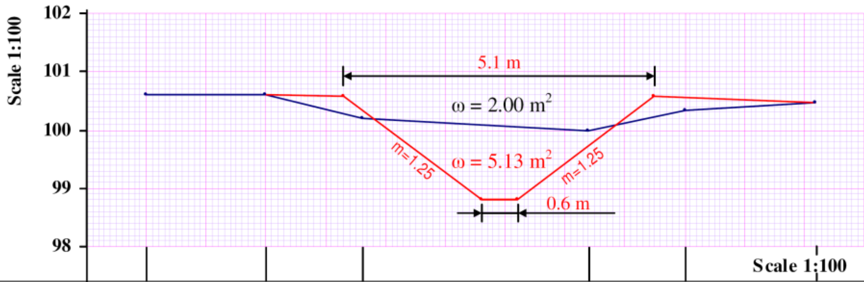
Point number		1		2		3		4		5		6
Land elevation (m)		99.902		99.854		99.145		99.105		99.804		100.000
Level differences (m)			-0.048		-0.709		-0.040		+0.699		+0.196	
Distances (m)	partial		2.2		2.0		2.2		1.2		2.0	
	total	0		2.2		4.2		6.4		7.6		9.6
Slope (%)			2.2		35.5		1.8		58.3		9.8	

Figure 2: Cross section in the CC_1 belt channel, 700 m downstream from the end of the channel, on its completion and in 2012

At approximately 1800 m from the upriver end, the measured geometric and hydraulic characteristics were: depth of the canal 1.80 m, width at bottom 0.60 m, canal light of 5.10 m, slope coefficient 1.25 and flow section 5.13 m^2 (figure 3). Following 32 years of exploitation, measurements revealed a canal clogging of some 1.43 m and a flow section of 2.00 m^2, the latter having diminished by 61% by comparison to the as-built value. Also in this transversal section, a significant enlargement of the width at bottom was observed, from an initial 0.60 m to 3.80 m, as well as an increase in the canal light, from 5.10 m to 7.00 m.

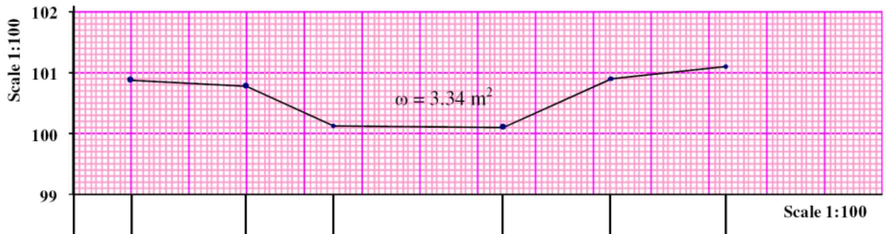
On the 100 m ring canal portion length, section located at the limit of the pasture, at 2000 m from the upriver end, the mean value of the flow section measured every 25 m was 3.34 m^2 (figure 4), the values recorded being in-between 2.72 m^2 and 3.89 m^2. The great difference in the flow section, that of 1.17 m^2, recorded in transversal sections spaced 25 m apart, verify once more the bank erosion and canal clogging caused by repeated and uncontrolled animal crossing over the section of the canal, the area under monitoring being located in the animal return from grazing path.

The changes in the geometric and hydraulic characteristics underwent by the CC_1 ring canal, caused by irrational grazing, is also being sped up by household waste and vegetal debris dumped in the canal, especially in the areas nearby culverts.



Point number		1		2		3		4		5		6
Land elevation (m)		100.616		100.604		100.192		100.000		100.330		100.477
Level differences (m)			-0.012		-0.412		-0.192		+0.330		+0.147	
Distances (m)	partial		2.0		1.6		3.8		1.6		2,2	
	total	0		2.0		3.6		7.4		9.0		11.2
Slope (%)			0.6		25.8		5.0		20.6		6.7	

Figure 3: Cross section in the CC_1 belt channel, 1800 m downstream from the end of the channel, on its completion and in 2012

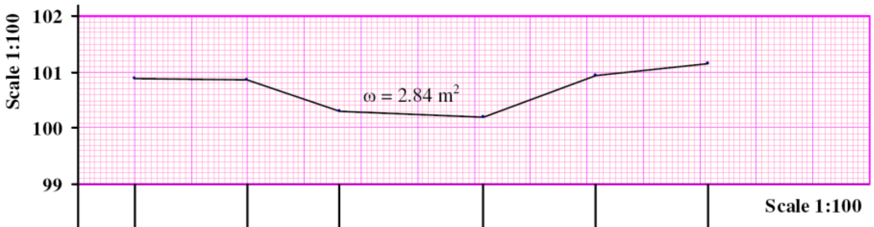


Point number		1		2		3		4		5		6
Land elevation (m)		100.858		100.758		100.125		100.093		100.900		101.099
Level differences (m)			-0.100		-0.633		-0.032		+0.807		+0.199	
Distances (m)	partial		2.00		1.49		2.96		1.87		2.00	
	total	0		2.00		3.49		6.45		8.32		10.32
Slope (%)			5.00		42.48		1.08		43.16		9.95	

Figure 4: The middle section of the channel CC_1, the length of 100 m, blocked upstream of the culvert

At the transversal profile drafted upstream from the culvert, located at the demarcation line between the pasture and the area used as agricultural land and hayfield, the flow section is 2.84 m^2 (figure 5). The squeezing in the canal flow section is caused by both water-carried deposits, and by dumping household waste and vegetal debris nearby culverts, the aforementioned activities causing, over time, the complete clogging of the tube section of the culvert (figure 6).

The mean value of the flow section on a 100 m length of the canal, measured at every 25 m, upstream from the clogged culvert, where the land use is agricultural and hayfield, was about 4.49 m^2 (figure 7), recording values that soar from 3.75 m^2 nearby the clogged culvert (figure 8), to 5.09 m^2 at a point located 100 m downstream from the culvert, larger by approximately 1.00 m^2 than the one recorded upstream. Also, the recorded canal flow section nearby culvert and downstream, was greater by some 1.00 m^2 than the one recorded upstream from culvert section, the latter section being only partially clogged at its upstream end.

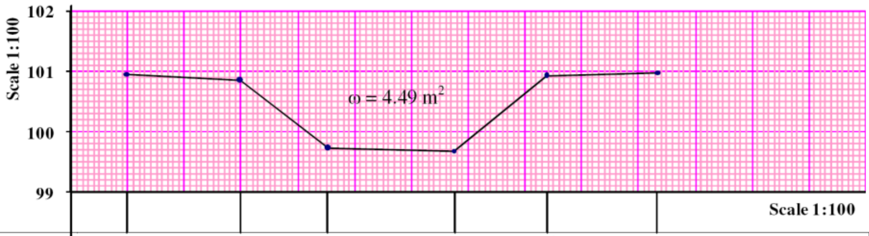


Point number		1	2	3	4	5	6
Land elevation (m)		100.891	100.860	100.313	100.183	100.943	101.153
Level differences (m)			-0.031	-0.547	-0.130	+0.760	+0.210
Distances (m)	partial		2.00	1.63	2.55	1.97	2.00
	total	0	2.00	3.63	6.18	8.15	10.15
Slope (%)			1.55	33.56	5.10	38.58	10.5

Figure 5: Transversal section through the CC_1 canal, upstream, beside the blocked culvert

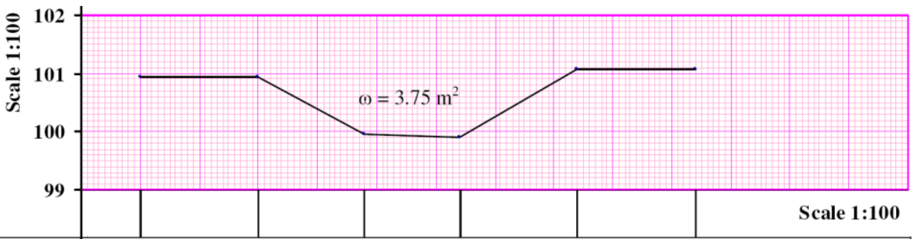
Figure 6: Clogged culvert showing vegetal and household residue within the canals

On the section of the canal that serves the areas used as agricultural land and hayfield, the slow section is getting generally enlarged as we move downstream. At the transversal profile made at 400 m, downstream from the clogged culvert, we noticed that the canal constructive features were modified to a lesser extent, the flow section being 7.75 m^2 (figure 9), fact that secures the transit of collected waters towards the main collector canal, the Șomuzel.



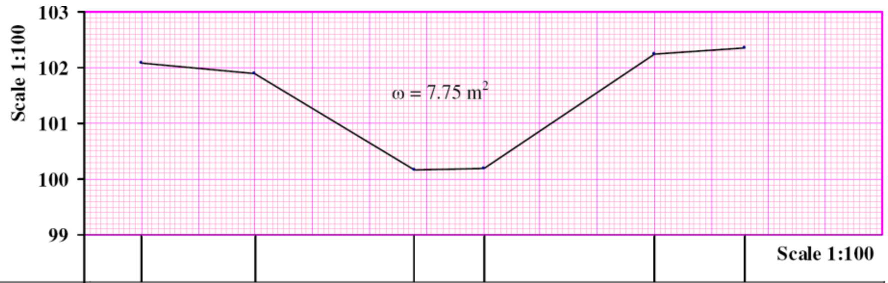
Point number		1		2		3		4		5		6
Land elevation (m)		100.951		100.842		99.712		99.677		100.915		100.981
Level differences (m)			-0.109		-1.130		-0.035		+1.238		+0.066	
Distances (m)	partial		2.00		1.54		2.20		1.64		2.00	
	total	0		2.00		3.54		5.74		7.38		9.38
Slope (%)			5.45		73.38		1.59		75.49		3.30	

Figure 7: The middle section of the channel CC_1, the length of 100 m in the downstream of the culvert blocked



Point number		1		2		3		4		5		6
Land elevation (m)		100.951		100.946		99.950		99.915		101.061		101.070
Level differences (m)			-0.005		-0.996		-0.035		+1.146		+0.009	
Distances (m)	partial		2.00		1.80		1.60		2.00		2.00	
	total	0		2.00		3.80		5.40		7.40		9.40
Slope (%)			0.25		55.33		2.19		57.3		0.45	

Figure 8: Transversal section through the CC_1 canal, downstream, nearby the clogged culvert



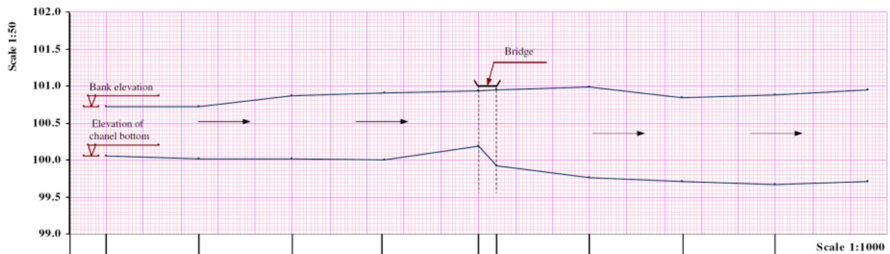
Point number		1		2		3		4		5		6
Land elevation (m)		102.072		101.881		100.165		100.177		102.241		102.355
Level differences (m)			-0.191		-1.716		+0.012		+2.064		+0.114	
Distances (m)	partial		2.00		2.80		1.20		3.00		1.60	
	total	0		2.00		4.80		6.00		9.00		10.60
Slope (%)			9.55		61.29		1.00		68.80		7.13	

Figure 9: The cross-section of the channel CC_1, 400 meters downstream of the culvert blocked

The clogging of the bottom of the canal and obstruction of the culvert lead to a change in the canal longitudinal slope. At the longitudinal profiling carried out on a 200 m length at every 25 m, (100 m upstream and 100 m downstream the obstructed culvert), one notices different longitudinal slope values and the creation of a counter-slope, with values in- between 0.02% and 0.76% (figure 10).

On the 100 m sector upstream from the obstructed culvert a 0.14% counter-slope is maintained, fact that causes, during times of torrential rain, as well as at the spring melt, the water to flow towards the upstream end of the CC_1 canal, overflowing at some 250 m, upstream from the obstructed culvert, in an area where the flow section measures the least value of 2.00 m^2, section shown in figure 3.

By analyzing the elevation heights on the bottom of the ring canal (figure 10), one notices that beside the culvert and downstream, the elevation was lesser by 0.30 m, by comparison to the one recorded nearby the culvert and upstream, the latter section being only partially clogged at its downstream end.



Point number		1	2	3	4	5	6	7	8	9	10
Bank elevation (m)		100.772	100.720	100.837	100.903	100.939	100.946	100.993	100.842	100.882	100.979
Elevation of chanel bottom (m)		100.053	100.007	100.012	100.000	100.191	99.915	99.757	99.701	99.673	99.702
Level differences (m)			-0.046	+0.005	-0.012	+0.191	-0.276	-0.158	-0.056	-0.028	+0.029
			+0.138					-0.213			
			-0.351								
Distances (m)	partial		25	25	25	25	5	25	25	25	25
	total	0	25	50	75	100	105	130	155	180	205
Slope of chanel bottom (%)			0.18	0.02	0.05	0.76	6	0.63	0.22	0.11	0.12
			0.14					0.21			
			0.17								

Figure 10: Longitudinal section CC1 channel upstream and downstream of the culvert blocked

By taking into consideration the elevation height on the bottom of the canal located upstream from the culvert, where the section of the tube is completely obstructed, there results that the clogging also took place on the 100 m portion downstream from the culvert, due to dumping household waste and vegetal debris into the canal, to the sedimentation of deposits carried by the water collected into the canal from the pasture areas, at a time when the culvert was still securing the transit of collected water flow.

Besides, even to this day, on the 100 m section and downstream, one notices the occurrence of a 0.12% counter-slope that causes the water to stale, and also the incidence of water vegetation, fact that stimulates the sedimentation of deposits and the clogging. On the overall 200 m longitudinal section length, a water flowing slope of 0.17% was determined, sufficient to secure the transit of collected water and its spilling into the main collector canal Șomuzel, had not the culvert acted as a dam.

The collected water overflow and the flooding of nearby fields causes a prolongation of excess humidity, the incidence of water vegetation and a disruption in the functioning of the desiccation- drainage network.

The clogging of the canal and the water overflow upstream from the culvert have caused the occurrence of a water surface whose stretch varies according to the season and the recorded rainfall or snowfall (figure 11), whereas throughout times of heavy rain, the water overflow is being collected in the main collector canal Șomuzel, whose path in the area is nearly parallel to the CC_1 ring canal, causing an increase in the bank erosion of the main collector canal (figure 12).

Figure 11: Water overflowing the canal and the subsequently formed pond

Figure 12: Taking poured water channel "Șomuzel"

CONCLUSIONS

On the desiccated-drained areas utilized as pastures, the bank erosion and canal clogging are particularly high, due to the low degree of grassing of the slopes, virtually absent on some sectors, caused by irrational grazing and by the repeated and uncontrolled animal crossing, on both the times of draught and times when the soil is over-humidified. Throughout the periods of severe draught, when vegetation is scarce, excessive grazing boosts the vegetation subsiding, through the destruction of less developed plants. Also, the grazing, especially that of cattle, at the time when the soil is over-humidified, causes the destruction of vegetation cover through both the sinking and asphyxiation of plants.

On arable areas of terrain the canals have well grassed embankments, fact that diminished the banks' erosion, yet over time, through lack of maintenance, cause the water flow to slow down and even stagnate, hydrophilic vegetation and shrubs to grow, favoring silt sedimentation and the occurrence of clogging.

Canal clogging and the appearance of hydrophilic vegetation cause the longitudinal slope to alter, presenting different values along canals, oftentimes creating counter-slopes which cause the water to stagnate and the depositing of silt, heightening the average canal clogging rate and accelerating their decommissioning.

The depositing of household residue, of vegetal residue, and of various packaging materials into the canals, generally nearby culverts accelerates the process of clogging and blocking.

The decrease in the canal transit section by some 60% compared to the initial value and the obstruction in some culvert flow section causes -throughout the times of heavy rainfall- water overflow and the flooding of nearby areas, a prolongation in the phenomenon of humidity in excess, a reduction in the quality of pastures by water plants reinstatement, and a boost in the downstream canals bank erosion, that play the role of overflow water collectors.

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