EVOLUTION OF THE GEOMETRIC AND HYDRAULIC PARAMETERS OF THE CHANNELS OF THE ROTOPĂNEŞTI-RĂDĂŞENI-FÂNTÂNA MARE DRYING-DRAINING SYSTEM OF SUCEAVA COUNTY, AFTER 27 YEARS OF OPERATION

EVOLUȚIA PARAMETRILOR GEOMETRICI ŞI HIDRAULICI AI CANALELOR, DUPĂ 27 ANI DE FUNCȚIONARE, DIN SISTEMUL DE DESECARE-DRENAJ ROTOPĂNEŞTI-RĂDĂŞENI-FÂNTÂNA MARE, JUDEȚUL SUCEAVA

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Abstract. *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. In order to achieve a maximum production capacity of the agricultural land and especially of the arable land, which stretches in Suceava county on an area of 178,502 ha (20.8% of the agricultural area), drying, damming-regulation, underground drainage, soil erosion control etc. works have been performed over time (Moca V. et al, 2000). According to the data from A.N.I.F., Suceava county enjoys an area of 44,904 ha with drying works, of which 27,455 ha with draining works. The drying channel network is 1875 km long, while the undergound draining network, which includes suction drains and collecting drains, is 11,909 km long. Over the 27 years of operation of the drying channel network, there have occurred changes in their geometric and structural parameters (depth, width at the bottom, slope coefficient and channel light).*

Rezumat. *Dintre principalii factori limitativi ai producției agricole ce se manifestă în funcție de condițiile pedoclimatice locale se menționează excesul de umiditate, inundațiile, permeabilitatea redusă şi compactarea solurilor, procesele de eroziune, alunecările şi altele. Pentru valorificarea capacității de producție a terenurilor agricole şi, în mod special, a suprafețelor de teren arabil, care ocupă în județul Suceava o suprafață de 178.502 ha (20,8% din suprafața agricolă) s-au amenajat în decursul timpului lucrări de desecare, de îndiguire-regularizare, de drenaj subteran, de combatere a eroziunii solului şi altele (Moca V. şi colab., 2000). După datele A.N.I.F., în județul Suceava există o suprafață de 44.904 ha cu lucrări de desecare, din care 27.455 ha cu lucrări de drenaj. Rețeaua de canale de desecare are o lungime de 1875 km, iar rețeaua de drenaj subteran formată din drenuri absorbante şi drenuri colectoare, are o lungime totală de 11.909 km. Prin funcționarea şi exploatarea rețelei de canale de desecare, timp de 27 ani, s-a produs o modificare a parametrilor geometrici şi constructivi ai acestora (adâncimea, lățimea la fund, coeficientul de taluz şi lumina canalului).*

MATERIAL AND METHOD

The Baia-Rădăşeni-Fântâna Mare drying-draining system is located on the left side of the Moldova river and includes its meadow and terraces, as well as its tributary streams Şomuzul Băii and Şomuzel. The surface of this system has a longish shape along the Moldova river and an average width of about 5 km and a length of 15 km.

The first land development works were performed in 1959-1960 and included the regulation of the Şomuzul Băii and Şomuzel streams and the drying of an area of 1697 ha. The regulation of the Şomuzul Băii stream was carried out on a 10.2 km long area, between the Cotu Băii and Cornu Luncii villages, being designed for a flow of 6.8 m^3/s at a speed of 1.5 m/s, while the regulation of the Şomuzel stream, tributary to Şomuzul Băii, was performed on a 8.2 km long area. The drying of the 1697 ha was performed by means of an open 21 km long channel network, the channels being located at 400-600 m from one another.

Between 1978-1980, in order to improve excessive precipitation and subsoil water removal, there were carried out works designed to complete the existing ones, namely new drying-draining and main collecting drain reshaping works. Therefore, drying works were performed on an area of 5,527 ha, of which 1,806 ha were fitted with underground draining facilities.

The whole drying network, both the one completing the existing one and the newly designed one, materialized in a systematic 168.10 km long drying and discharge channel network, the channels being located at 300-400 m from one another, which also included the regulation-drying network.

The actual drying channel network includes main collecting channels, secondary collecting channels, sector collecting channels and belt channels.

When designing the main and secondary collecting channels, there was considered the best use of the existing small waterfalls, valleys, depressions and network. The mean depth of the channels is 1.8 m, depending on the depth of the sector or draining network that open in them.

The sector collecting channel network has a less regular shape, depending on the configuration of the land, and the channels are routed approximately parallel with the level lines, at variable distances and depths, depending on the drained and undrained areas. In the drained areas, the distance between the channels is 400 m and the mean depth is 1.50 m, depending on the draining depth, so that the discharge openings be located above the highest channel level, while in the undrained areas, these are located at 300-350 m from one another at a mean depth of 1.30 m.

The belt channels are located at 20-50 m from the foot of the slopes, at depths between 1.5-2.0 m, and their role is to protect the dried-drained surface by intercepting the flows from the upper neighboring areas.

The cross-section of the drying channels is trapezoid shaped, with slopes of 1:1.25 for the channels, 1:1.5 for the Şomuzel stream and 1:2.0 for Şomuzul Băii, depending on the nature of the land (clay-bearing or lute-clay-bearing) and on their depths.

The sizing of the upper channels was achieved on sections, depending on the slope and the flow collected in that sector. The flows carried by the channels were determined depending on the area they served and on the specific drying flow, which was set to be 2.17 l/s/ha for the drying network and 9.40 l/s/ha for the belt channels.

In order to determine the geometric and hydraulic parameters of the drying network, high-accuracy geometric levelling topographic measurements were performed by the radiation method and by traversing combined with the radiation method. The level-related observations were performed by a medium-accuracy Zeiss Ni-030 level and centimeter surveying rods, while the level differences were determined based on two horizons of the level device.

Based on the data gathered, longitudinal and cross-section profiles were designed for the various size channels of the drying network, and result interpretation was achieved by comparing the channel profiles after 27 years of operation with the ones designed and performed upon their building.

RESULTS AND DISCUSSIONS

In the Rotopăneşti-Rădăşeni-Fântâna Mare drying-draining system, the Şomuzel channel has the main collecting role and was built by the reshaping of the natural river bed in 1978-1980. The building technical specifications show that the reshaping was performed on a 6975 m long area, the sizing being calculated on sections, in order to ensure a gravitational collection of the water flows with a 10% ensurance, coming from the collecting channel network and from the collecting and suction drain network.

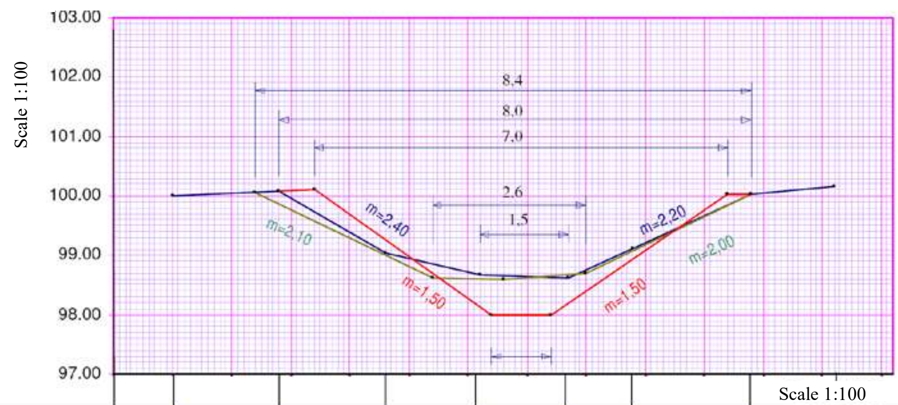
The following mean values of the building items were used for the reshaping of the Şomuzel stream on the studied section:

- channel depth H = 2.00 m;
- width at the bottom of the river bed b = 1.00 m;
- bank slope = 1/1.5;
- collecting channel light = 7 m.

In the studied section, located at about 1 km downstream from the origin of the channel collecting the waters on an area of about 80 ha, the following items, shown in figure 1, were determined by measurements in 2005:

- channel depth H = 1.40 m;
- width at the bottom of the river bed b = 1.50 m;
- slope of the left bank $m_s = 2.40$ and slope of the right bank $m_d = 2.20$;
- B collecting channel light = 8.00 m.

Further to these determinations, we found a 0.60 m silting, which resulted into an increase in the width at the bottom of the channel from 1.00 m to 1.50 m. At the same time, the bank erosion was found to be more marked on the left side (0.60m), since this side of the channel collects the surface water and the water from accidental spills from the CC_1 belt channel, located upstream, on the border of the dried area, located 400 m away. Bank erosion resulted into changes of the slope coefficient from 1.5 to 2.4 and 2.2, respectively, and also to an increase in the channel light from 7 to 8 m. As a consequence of these phenomena, the channel carrying capacity in this section decreased from 8 m^2 to 6.65 m^2.



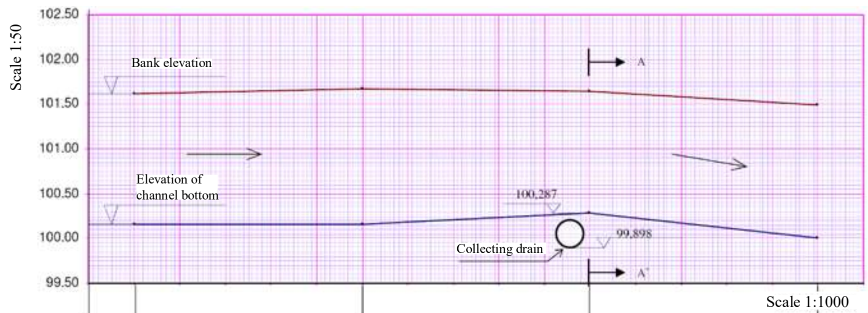
Point number		1	2	3	4	5	6	7	8
Elevation 2005 (m)		100,000	100,080	99,027	98,658	98,607	99,118	100,032	100,165
Elevation 2007 (m)		100,000	100,011	98,621	98,604	98,698	100,039	100,167	
Level difference (m)	2005	0,080	-1,053	-0,369	-0,051	0,505	0,920	0,133	
	2007	0,011	-1,390	-0,017	0,094	1,341	0,128		
Partial distances (m)	2005	1,8	1,8	1,6	1,5	1,1	2,0	1,4	
	2007	1,4	3,0	1,2	1,4	2,8	1,4		
Slope %	2005	4,4	58,5	23,1	3,4	45,9	46,0	9,5	
	2007	0,8	46,3	1,4	6,7	47,9	9,1		

Figure 1 – Cross-section in the „Şomuzel" main collecting channel

Based on the observations and measurements carried out in 2007 in the same location, we found significant changes to the shape of the cross-section, namely an increase of the width at the bottom from 1.5 to 2.6 m and of the channel light from 8.00 to 8.40 m. The changes occurred on the left side of the channel, since on this side continued the interceptions of the surface water flows from the upper neighboring areas discharged in the same CC_1 channel, which is unable to collect and discharge these flows.

In the longitudinal profile performed upstream and downstream from the cross section of this channel section (figure 2), we noticed a change in the longitudinal slope caused by channel silting, which produced a 0.25% and 50 m long counter-slope. Downstream from the section, the longitudinal slope increased to 0.57% due to the unevenness caused by the counter-slope. Due to this counter-slope, a hygrophilic vegetation grew upstream caused by stagnant water for a longer period of time. On the 150 m of the studied channel section, a mean flowing slope of 0.11% is however maintained, designed to provide water flow transfer along the channel during high-flow seasons.

In this section we noticed a discharge opening of a collecting drain with a nominal diameter of 200 mm, with the lower generator located at a depth of 0.39 m below the current level of the bottom of the collecting channel, in which it was actually supposed to discharge (photo 1 and 2). This obstruction of the collecting drain occurred because of the silting of the bottom of the channel further to the high flows of its 27 years of operation. Therefore, we may estimate a mean silting rate of about 2.4 cm/year, which would lead to the onset of the unsilting, cleaning and renewal works on the carrying section, after about 25 years of operation.



Point number		1		2		3		4
Bank elevation (m)		101,630		101,670		101,643		101,495
Elevation of channel bottom		100,165		100,160		100,287		100,000
Level differences (m)			-0,005		0,127		-0,287	
					-0,165			
Distances (m)	partial		50,0		50,0		50,0	
	total	0		50		100		150
Slope of channel bottom %			0,01		0,25		0,57	
					0,11			

Figure 2 – Longitudinal section through the „Şomuzel" main collecting channel

Photo 1

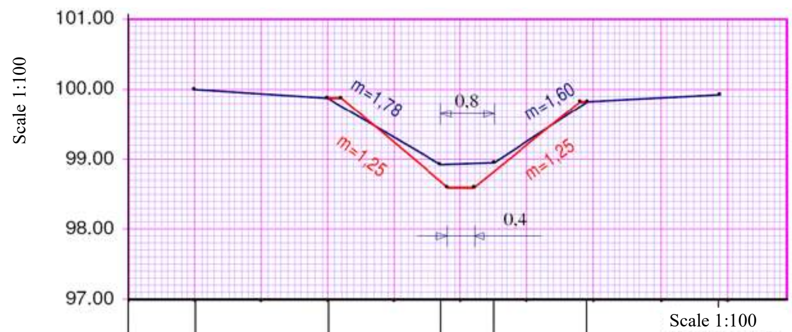
Photo 2

The ($CCst_9$) sector collecting channel is designed to collect the water flows discharged by a network of suction drains, on an area of 42.40 ha.

The geometric and structural parameters of this channel upon its building (figure 3), were: length = 1400 m, width at the bottom b = 0.40 m, slope coefficient m = 1.25, mean depth = 1.52 m (upstream = 1.30 m to ensure the discharge of the suction drains, and downstream = 1.74 m).

After 27 years of operation, the cross section in the A-A´channel section in figure 3 shows that a silting of about 35 cm also occurred here, which led to changes in the width at the bottom from 40 to 80 cm, and the slope coefficient changed from 1.25 to 1.78 on the left side slope and from 1.25 to 1.60 on the opposite (right) side. Due to collecting channel silting, the upstream discharge openings of the suction drains on this channel were completely covered, while downstream, due to the greater channel depth, the discharge openings are silted only partially and the water stagnates in the draining pipes.

Excessive humidity caused by precipitations extends both in the vegetation season and at its beginning, when spring land farming works are delayed, which led to hygrophilic vegetation areas in the dried-drained zone.



Point number		1		2		3		4		5		6	
Land elevation (m)		100,000		99,882		98,930		98,954		99,827		99,820	
Level differences (m)			-0,118		-0,952		0,024		0,873		0,007		
Distances (m)	partial		2,0		1,7		0,8		1,4		2,0		
	total	0,0		2,0		3,7		4,5		5,9		7,9	
Slope %			5,9		56,0		3,0		62,4		0,3		

Figure 3 – Cross section through the ($Ccst_9$) sector collecting channel

CONCLUSIONS

1. The operation and use of the drying-draining systems led to bank erosion and channel bottom silting. Therefore, we estimated a mean silting rate of about 2-4 cm/year, which would lead to the onset of the unsilting, cleaning and renewal works on the carrying section, after about 25 years of operation.
2. Channel silting and hygrophilic vegetation growths determine changes to the longitudinal slope, which has various values along the channels, sometimes even counter-slopes.
3. On dried-drained surfaces used as grazing fields, bank erosion and drying channel silting are more obvious, that is their mean annual rate is almost double as compared to that of the channels on the surfaces used as arable land and hayfields.
4. The silting and obstruction of a channel or a section of a channel lead to a higher excessive humidity in depressions and an inadequate operation of the neighboring drying network.

REFERENCES

1. **Moca V. et al,** 2000 - *Works of land improvement performed in Suceava county and their influence on the soil cover,* S.N.R.S.S. Publications, no. 30. „ A. I. Cuza" University Publishing, Iaşi.