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Research on hydric condition of drained soils in the Danube watermeadow, Năsturelu - Bujoru sector

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Abstract - The agricultural recovery of the Danube watermeadow, based on its specific hydrological and hydrogeological characteristics, results in the need for specialist studies highlighting the suitability of the morphological unit for a competitive sustainable agricultural unit. Research performed on the watermeadow of the Vedea river emphasize both the efficient underground drainage and the measures required to improve the collection of excess water at depths of 0.5 m.

1. INTRODUCTION

The agricultural use of the Danube watermeadow has generated intense disputes ever since the early 20th century, and is continued nowadays by some environmental organizations advocating the 'natural restoration' of the Danube watermeadow, which is a non-economic objective with no environmental future and, furthermore, unfavourable to the economic and social development of Romania. Therefore, we are convinced that agriculture should continue in the Danube watermeadow under sustainable conditions, with the eventual planning of protected areas in the former location of drained swamps.

The complex plan for the Danube watermeadow development was approved by HGM No. 1050/1962, and founded the agro-forestry and fisheries recovery of the flooded areas on a total area of 575,850 ha. At the completion of the work, the total area of 442,606 hectares of sea-reclaimed land included 431,436 ha arable land organized in 56 dammed and drained precincts.

The area studied belongs to the lower sector of the Danube, i.e. 37.6% of the total length of the river overlapping with the Romanian sector. The relief and hydrography criteria in this sector result in three areas: the Iron Gates gorge, the Turnu Severin-Ceatal Izmail, and the Delta.

The most important is the Turnu Severin-Ceatal Izmail (the Danube bifurcation), further divided into several units, according to the natural flow of the river. Out of them, the natural unit no. 6 Zimnicea-Pietroşani was taken to study, owing to its special features.

River regulation and damming has led to dramatic changes in the hydrological condition of surface waters. From the Danube terrace, the river was dammed and regulated, and now runs perpendicularly to the Danube. The current flood of the Vedea river overlaps the Danube watermeadow on this route.

Our present study refers to this common watremeadow which used for agricultural purposes, and is characterized by particular pedo-climatic conditions.

2. MATERIAL AND METHOD

The location of the research point included an area of about five hectares, located in the former flood plain of the Vedea river, near its meeting point with the Danube. The area underwent surface and depth drainage works that have worked partially since 1989.

Land height varies between 18 and 19 m, with higher values in the hillocks near the shore. The studied area is perpendicular to the Vedea river, with its highest area located West.

Natural elements. The climatic data recorded at the Alexandria weather station show that the area is situated in a temperate climate characterized by short springs, relatively long and warm autumns, cold winters, and unevenly distributed rainfall.

In terms of climate, the studied area is characterized by:

- Average annual rainfall: P = 495.4 mm
- Multi-annual average evapo-transpiration: ETP = 731.0 mm
- Multi-annual average temperature T = 11.4C

Based on the above, the following climatic indices were calculated:

- hydroclimatic balance (B_h):

B_h = P - ETP= 495.4 – 731.0 = - 235.6 mm

- hydroclimatic index (I_h)

$$I_h = \frac{P}{ETP} x100 = \frac{495,4}{731} x100 = 67,7\%$$

- aridity index (I_a):

$$I_a = \frac{P}{T+10} = \frac{495,4}{11,4+10} = 23,15$$

According to the values of these indices, the studied sector is characterized by poor climate, moderately poor class which stresses the necessity of

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irrigation combined with drainage to ensure the hydrosaline stability of the soil.

The hydrogeological survey shows that groundwater can be found at depths ranging between 0.5 and 4.5 m. The granulometric curves of the soil area show the following value of the capillary rise:

$$H_{\max} = 0{,}45\frac{1-n}{n} x \frac{1}{d_{10}} (cm)$$

where: n – actual porosity,

d_{10} – equivalent diameter on granulometric curves

$$H_{\max} = 0{,}45\frac{1-0{,}16}{0{,}16} x \frac{1}{0{,}012} = 196cm$$

In practice, the above value should be assessed lower as the capillaries are discontinuous due to infestation with underground reed rhizomes. Considering that groundwater can cause excess moisture at a depth of 1-1.5 m, an importanr land surface (300 hectares) of the studied area suffers from excessive ground water.

Under these conditions, excess water that may occur due to the following factors: rainfall, groundwater, and irrigation.

The forecast included tracking soil characteristics and groundwater quality changes resulting from drainage. Thus, seven soil profiles were analyzed on the surface between four adsorbing drains discharging in ESC.

Soil and water sampling was performed for further testing at the Alexandria OSPA and Environmental Protection Agency.

The tests have made available the necessary elements for calculating the ecological, pedological and physical indicators that lead to relevant conclusions on the development of the area.

3. RESULTS AND DISCUSSION

The starting point in environmental studies is the current situation of the natural factors compared to the non-planned situation and the best features required by human needs. Therefore, extensive investigations were conducted on soil and ground water, which shows the effects of agroameliorative facilities.

The textural characterization of the soil on the active layer depth (Table 1) classifies all the six sections analyzed as fine textured loamy-clay, with an average content of clay (46.23%), dust (25.02%), and sand (28.75%).

Soil texture (0-75 cm)

Table 1

Profile	Earthy particles (%)			
	Sand		Dust	Clay
	Coarse	Fine		
Average	1.66	27.9	25.02	46.23
Class	Fine texture		Clayey	

Soil compaction (Table 2) shows a small change in the degree of compression, as samples from the six profile classe sindicate a non-to-moderate compaction. No highly compact profile was recorded in any horizon, therefore the general classification was low compaction.

Soil subsidence assessment

Table 2

Profile / Depth, cm	0-25	25- 50	50-75	Average 0-75	Compaction level
Media	5.2	6.38	3.00	3.13	Medium compact
Compaction level	Low			(1≤Gt≤10)	

The diagram shows that degree of compaction was about 9% non-compact (Gt>0), about 17% medium compact (Gt <10), and the bulk area was low compact (74%).

Total porosity (Table 3) recorded values of 9.05-50.95%, i.e. middle-low category, and the air porosity of 13-15% indicated the 'low' category.

Soil porosity
(total porosity/air porosity)

Table 3

Depth, cm	0-25	25-50	50-75	Average
Profile				0-75
Average	49.68/ 14.96	49.05/ 14.61	50.93/ 15.00	49.88/13.56
Class	Average	Low	Low	

The above highlight the unfavourable physical characteristics of the soil that, under the circumstances, cannot reach better production capacity.

Chemical soil composition. The main chemical characteristics of the soil are presented in Table 4.

Chemical composition of soil (0-75 cm)

Table 4

Profile	Content in:							
	Cl^-	SO^{-2}	Ca^{+2}	K^+	Humus	Total N	Mobile P	Mobile K
	mg	100g soil	me	100 g soil	%	%	ppm	ppm
Average	4.38	2.62	7.31	0.59	3.02	0.283	43.35	172.8
Class	Non-salinized		Very low		Low	High	High	Average

Soil seems non-salinized, with a lower content in calcium, potassium, and humus. The total N and P content ranges within the high mobile class and average K class,

Characteristics of ground and drained water

The analyses of water samples collected from the groundwater and drainage channels are shown in Table 5.

Ground and drained water

Table 5

	Um	Ground water	Quality class	Drained water	Qualty classi
Still waste	mg/l	717.06	III	1414.00	V
Sodium	mg/l	80.47	III	160.95	IV
Potassium	mg/l	4.00	I	4.00	I
Ammonium	mg/l	0.656	IV	0.530	III
Total ionic iron	mg/l	3.0	V	3.0	V
Total phosphorus	mg/l	0.593	IV	0.717	IV
Sulfates	mg/l	280.7	IV	585.7	V
Ca^{+2}	mg/l	109.4	II	248.5	IV
Mg^{+2}	mg/l	30.88	III	27.96	III

The contents in total ionic iron phosphates, total phosphorus and,, to a certain extent, sulfates exceed their classification as favourable.

The groundwater levels measured in the drills existing in the area gave rise to the drafted plans regarding hydrogeological situation.

Soil humidity rates. The variation of soil moisture reflects the total natural conditions and characterizes the soil production capacity.

Soil moisture rate was the basis of classification for the watermeadow Danube, upstream-downstream of Vedea river.

Hidrology of active soil layer

An active layer of soil is where the plants form the bulk root system. In agriculture, it does not exceed 0.8-1.0 m in field crops, and 1.2 m in orchards. Therefore, we followed soil moisture characteristics to a depth of 1.0 m in several instances.

The Danube watermeadow, Vedea-left bank area. The area located between the two secondary surface-drainage canals was included in a soil measuring network.

About 20 days since last significant rainfall (July), only a small fraction at a depth of 0-50 cm recorded moisture below the field capacity, while most of the top soil layer was in low-average excess moisture (Fig. 1).

The deeper soil layer (50-100 cm) redorded excessive moisture, reaching values above total water capacity in central and northeastern pilot area (Fig. 2).

Average humidity on a depth of 1.0 m (Fig. 3) is above the field capacity in several areas, depending on land height, reaching its almost full capacity for water.

The cross profile between the two channels (Fig. 4) shows that the upstream ends of the adsorbing drains (i.e., half distance between the channels), soil moisture increases from 25% (surface) to 70% (1.0 m depth) which means that it exceeds the total water capacity. Moreover, water meets the deep seas at this depth. Below 50 cm in depth, soil condition records excess water.

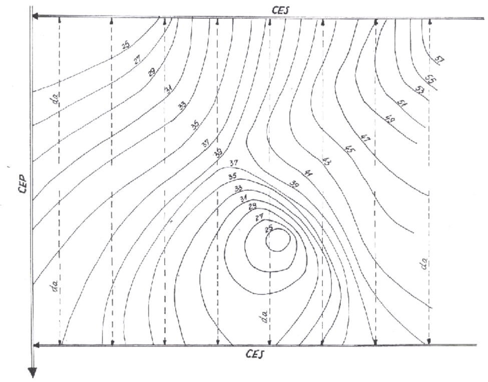

Fig. 1 Chronohydroisoplets – Vedea watermeadow, left bank, 0-50 cm depth, August

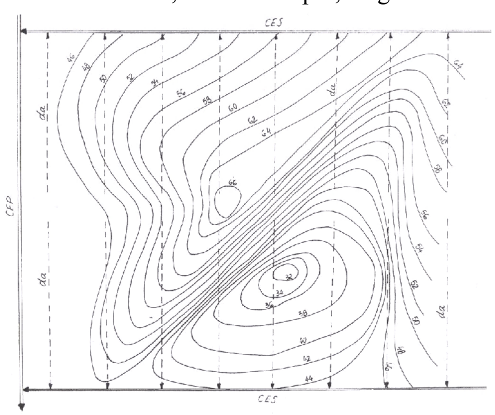

Fig.2 Chronohydroisoplets – Vedea watermeadow, left bank, 50-100 cm depth, August

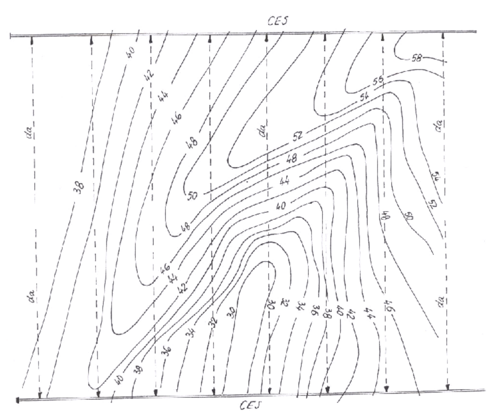

Fig.3 Chronohydroisoplets – Vedea watermeadow, left bank, 0-100 cm depth, August

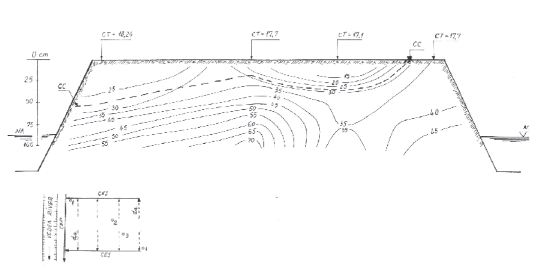

Fig. 4 Chronohydroisoplets – Vedea watermeadow, left bank, 0-100 cm depth, August

4. CONCLUSIONS

The Danube watermeadow in the Zimnicea-Pietroşani sector has very favorable conditions for agriculture, with limited variation in the hydric factor in discordance with plant needs and soil characteristics caused by changes in soil hydromorphism.

In the current situation, the meadow is a mix of agricultural, protection, and natural ecosystems, with joints that are often beyond human control.

The water-control measures may cause greater control over ecosystems, particularly the dominance in the agroecosystems where monoculture should be ensured by appropriate agricultural techniques.

The characterization of soils in terms of agricultural quality, based on soil anallysis, has shown that drainage should occur during spring and summer, since soil moisture is high even at the end of vegetation.

Hydrological assessment indicates excessive, differently spread ground water areas according to groundwater change.

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