CURRENT SITUATION AND FUTURE PERSPECTIVE OF LAND RECLAMATION (HYDROAMELIORATIONS) ARRANGEMENTS IN BANAT. CASE STUDY: ȚEBA-TIMIȘAȚ DRAINAGE ARRANGEMENT

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Abstract: *This paper presents briefly the evolution in time of land reclamation (hydroameliorations) arrangements in Banat (Caraş-Severin, Timiş and Arad counties), and the perspective of development that these arrangements have, and the requirements of this future evolution. This paper uses the case study of Ţeba-Timişaţ drainage arrangement for illustration. Banat was, approximately 200 years ago, a swamp, a situation that imposed some works of improvement (damming, water drainage, soil erosion control and irrigations). The climate changes (global warming) have led to the necessity of applying irrigation measures to the same region, in order to ensure the success of agricultural production, regardless of how the weather conditions will evolve.*

Key words*: land reclamation arrangements (damming, drainage, soil erosion control, irrigations), sustainable development, global warming*

INTRODUCTION

In 1900, the areas that had excessive moisture were reduced by 50% through land reclamation for agriculture, by works of drainage. The 190 million hectares surface was accomplished during two centuries, and the actual rate of expansion is 0.5-1.0 million ha/yr. Between 50-70% of the traditional irrigation and drainage works from around the world need modernization.

In Romania, the excess of moisture affects a total agricultural surface comprised between 5,530,000 and 7,470,000 ha, depending on the quantity of rainfall. In the figures below, we can observe the distribution of areas with excess moisture in Romania (figure 1), areas with a potential flood risk (figure 2) and various areas of hydrological interest (wetlands) under the Ramsar Convention (figure 3) [13].

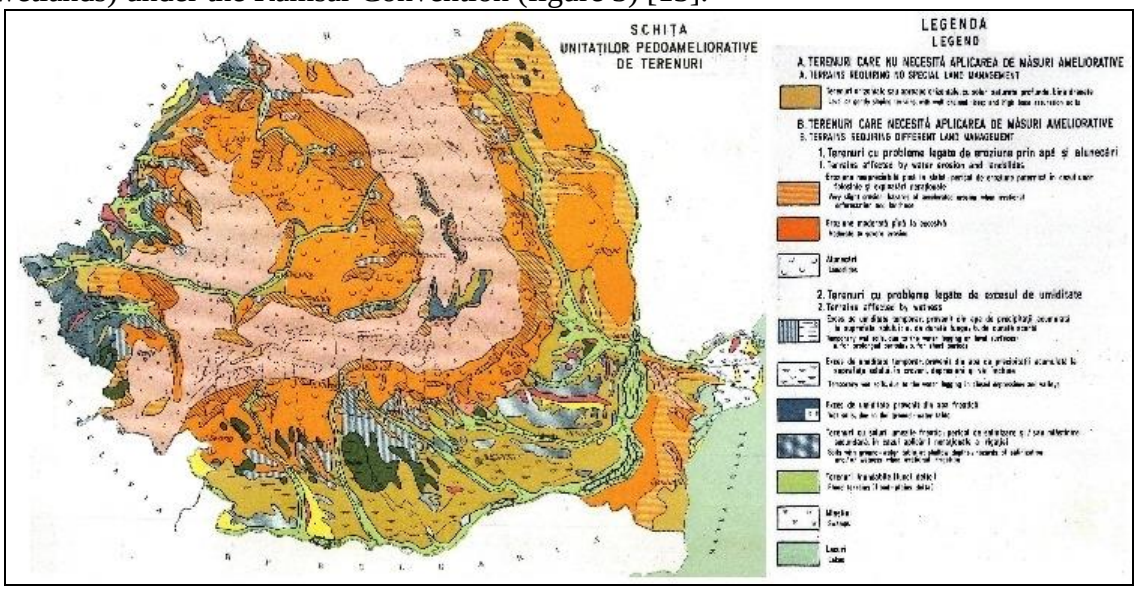

Figure 1 Map of areas with excess moisture in Romania (1: 3,000,000, ICPA) [14].

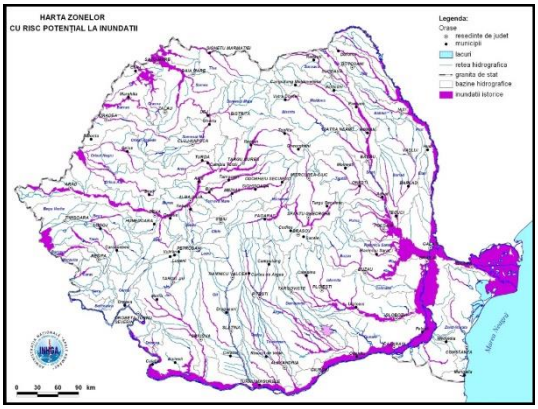

Figure 2 Map of flood risk areas

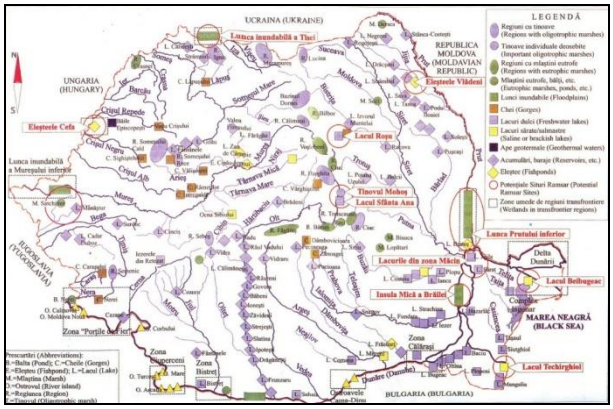

Figure 3 Map of wetlands in Romania [14]

Banat is the name for the historical province divided today between Romania, Serbia and Hungary. The Plain of Banat was a large marsh, about 200 years ago, that has been converted into agricultural land through works of damming, river control and drainage. The same area, which in the past could not be used for a socio-economic benefit, arrived today at a point that requires irrigation to produce a sure agricultural crop.

Hydroameliorations are defined as the totality of land reclamation works that aim to maintain in soil a favorable ratio between ground water and other factors of soil fertility, on land with excess or shortage of water [4].

Since the mid-nineteenth century, land-improvement works have targeted solving local problems by independent facilities of embankments, drainage, irrigations, combating soil erosion. In 1965, on the territory of Timiș-Bega complex, thirteen distinct drainage systems were in operation, serving an area of 153,000 ha of land. The irrigated area was 23,000 ha.

In the European context in which we find ourselves today, we cannot address hydrological issues form an isolated perspective, but things must be taken together, as mentioned in the very European Water Policy - it has to address the increasing awareness of citizens and other involved parties for their water; at the same time water policy and water management are to address problems in a coherent way [5].

MATERIALS AND METHODS

Romanian legislation - land improvement works [1]:

- Land improvements Lax no. 138/2004, republished, modified and later completed, published in the Official Monitor no. 88 from 13 February 2009.
- G.E.O. no. 82/2011 regarding some measures that involve land improvement activity organization, published in the Official Monitor no. 694 from 30 September 2011.
- G.D. no. 1223/2011 for approving the Rules of organization and functioning of the National Agency for Land Development, published in the Official Monitor no. 904 from 20 December 2011.
- G.D. no. 1872/2005 for approving the Methodological norms for implementing the Law of land improvements no. 138/2004, modified and later completed published in the Official Monitor no. 109 from 6 February 2006.

European legislation - land improvement works [1]:

- Regulation (EC) no. 1080/2006 of the European Parliament and of the Council of 5 July 2006 on the European Regional Development Fund and repealing Regulation (EC) no. 1783/1999.
- Regulation (EC) no. 1083/2006 of the Council of 11 July 2006 of laying down general provisions on the European Regional Development Fund,

European Social Fund and the Cohesion Fund and repealing Regulation (EC) no. 1260/1999.

- Commission Regulation (EC) no. 1828/2006 of December 2006, setting out rules for the implementation of Council Regulation (EC) no. 1083/2006, which establishes general provisions on the European Regional Development Fund, European Social Fund and the Cohesion Fund and of Regulation (EC) no. 1080/2006 of the European Parliament and of the Council for European Regional Development Fund.
- Commission Regulation (EC) no. 885/2006 of 21 June 2006 laying down detailed rules for applying Community Council Regulation no. 1290/2005 regarding the accreditation of paying agencies and other bodies and EAGF and EAFRD clearance of accounts.

RESULTS AND DISCUSSIONS

Brief description of the evolution of hydroameliorations in Banat

Starting with the eighteenth century, in the region around the city of Timisoara and of lower Timiș, an area which was mostly marshy and muddy, large-scale hydraulic works were initiated for drainage, flood protection, for improving navigation, for supplying the city with drinking water and for industrial purposes. Engineer Maximilian Emmanuel de Fremaut was noted in these hydrotechnical works, important for that period.

In the eighteenth century, the Plain of Banat was a marsh, and this was why the land could not be used for agriculture, therefore the area is abandoned. The Austrians were those who started large-scale hydraulic works in the eighteenth century in Western Romania. Between 1717 and 1800 extensive floodable and marshy areas from the Plain of Banat were claimed for agriculture through land-improvement works. In the nineteenth century, the total area of 1.9 million hectares of Romanian Banat, waterlogging affected about 25% of the area. The 1970-1989 period is the time when hydroameliorative works had the greatest growth. Since 1970, a complex program of arranging the Banat space was adopted, and through it the most important systems of drainage have been achieved: Vinga-Biled-Beregsău (25,530 ha), Checea-Jimbolia-Aranca (over 55,000 ha), Timişul Mort (approximately 20,000 ha). The evolution in time of surfaces with drainage works between 1950 and 1985 is presented below, and it is a period in which, as it can be seen from the graph, arranged areas have increased exponentially, the period after the Second World War being noticeable, a period of time during which land reclamation policy took a different dimension in Romania.

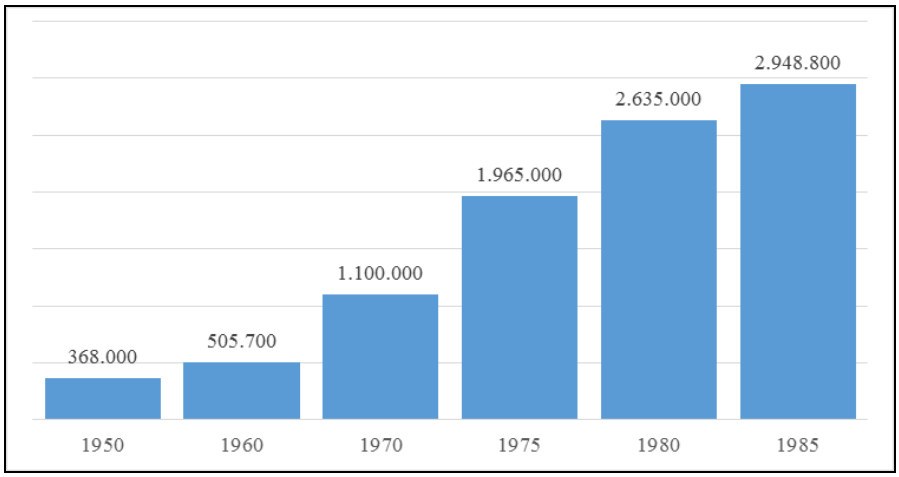

Figure 4 The evolution in time of surfaces arranged with drainage works in Romania, 1950-1985 [7]

Timiș County

In 1728, under the supervision of Count Florimund de Mercy (1666-1734), the military governor of Banat, regularization works of the Bega river and drainage of marshes around Timisoara are initiated, and by 1756 Bega river is regularized, the course of the river is moved laterally south to the old riverbed and the surrounding marshes are drained. Before the regularization, Bega river fed the wetlands in west, areas that were drained for strategic, economic and sanitation reasons [18].

The figures below show the areas with excess water (figure 5) and the hydroameliorative arrangements in Timiș County (figure 6).

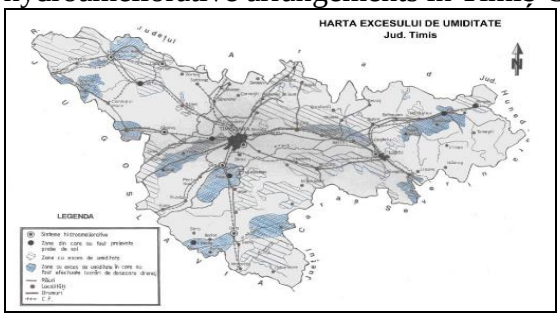

Figure 5 Map of moisture excess in Timiș County [7]

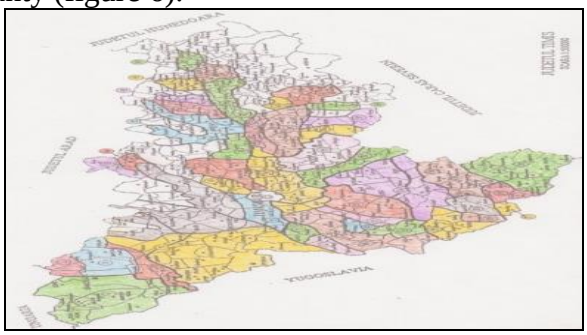

Figure 6 Hydroameliorative arrangements in Timiș [3, 7, 11]

In the mid nineteenth century, Constantin Rădulescu, chief engineer of the city of Timișoara, had an important role in regulating the Timiș river, through the dam at Coșteiu and downstream up to Bega channel.

An important role in draining the marshes around Timisoara and in its defense against floods it is attributed to the double connection Coştei-Topolovăţ, the work of the Dutch engineer Maximilian Fremaunt.

Between 1717-1800 drainage canals were built around the city of Timișoara and in the hydrographic basins of Timiș and Bârzava and preparations were made for Bega canal in navigation purposes.

In the early twentieth century, the engineer Emil Szilard, called the city's chief engineer in 1902, took over the municipal technical office and initiated the regularization of the Bega channel.

Between the years 1910-1912 significant floods took place, events that demonstrated again the need for land-improvement works execution, because until 1944 the hydroameliorative situation was not improved at all. Embankment works included 622,000 hectares, and part of this surface was installed with drainage works too (approx. 57%). Between 1900 and 1920 were constructed the drainage systems of Răuţi, Utvin, Rudna-Giulvăz and Gad.

After the First World War, between 1944 and 1970, several major land-improvement works are built, especially dams and drainage systems.

Due to restrictions on crossing waters over the border, in the mid twentieth century, drainage systems located near the border undergo an upgrading and completion process, systems such as: Aranca, Checea-Jimbolia, Timişaţ-Teba and Banloc-Tolvădia.

Caraș-Severin County

The contemporary situation, namely areas with excess water (figure 7) and hydroameliorative arrangements (figure 8) in Caraș-Severin County are shown in the following figures.

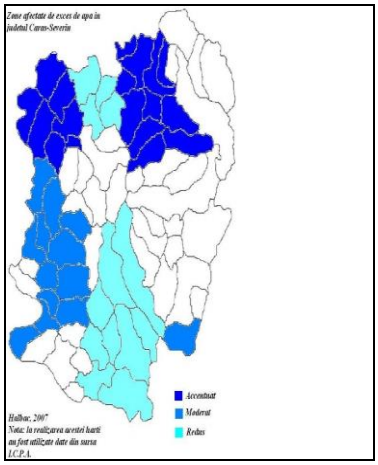

Figure 7 Map of areas affected by water excess (ICPA)

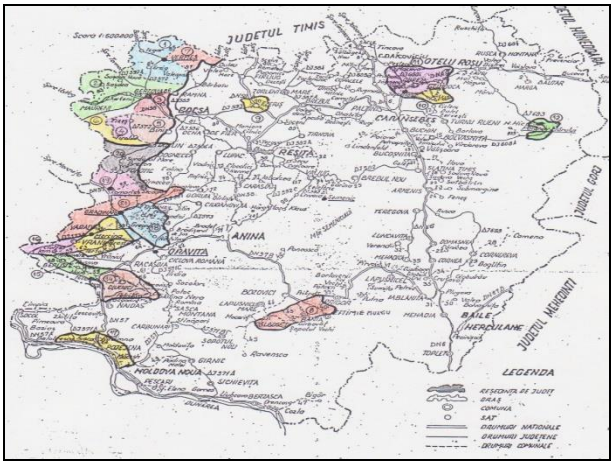

Figure 8 Hydroameliorations in Caraș-Severin County [3, 7, 11]

Arad County

The figures below show the areas with excess moisture in Arad county and the contemporary situation of surfaces with land improvement works, with the following framings: areas designed for irrigation, irrigation and drainage with pumping, irrigation and gravitational drainage, irrigation and drainage, irrigation and soil erosion control (SEC), for to SEC, for drainage with pumping, for gravitational drainage, drainage, embanked surfaces, channels of supply and distribution of water and reversible channels, for both irrigation and drainage, embankments (figure 9, 10).

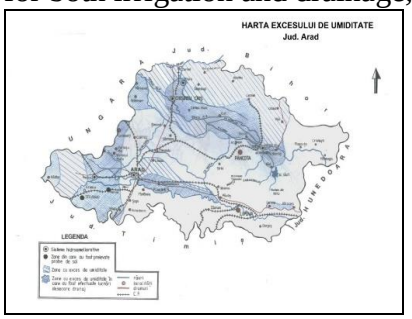

Figure 9 Map of moisture excess in Arad County [7]

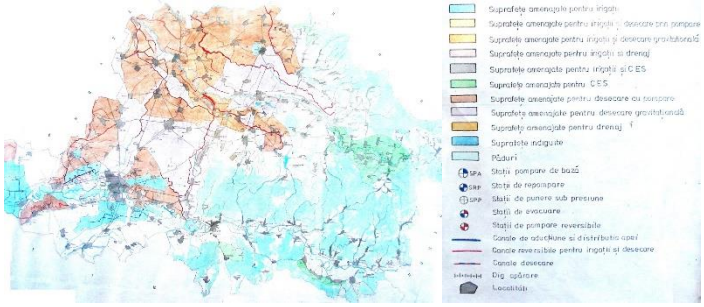

Figure 10 Surfaces of land improvements - ANIF Arad [3]

The current situation

Currently, in dry years in Banat, it is mandatory to irrigate the land in order to ensure the required quantity of water in soil for the normal development of agricultural crops.

The representative systems of drainage in Timiș Branch of the National Land Improvement Agency (ANIF) Bucharest, are in number of 42 existing drainage systems, plus the Lugoj standard perimeter.

On the Timiș county area, drainage arrangements have an area of 438,788 ha, and on Caraș-Severin county territory they are comprising 28,627 ha. Of the total of 467,415 ha of this area, 332,042 ha is the area that has pumped drainage (71%) of which 75.67% in the county of Timiș.

Below are presented the drainage surfaces for Timiș, Arad and Caraș-Severin counties.

Table 1

Drainage surfaces for Timiș, Arad and Caraș-Severin counties [3, 7, 11]

No.	Arrangement	Surface (ha)	
		Surface drainage	Drainage
A	**TIMIŞ COUNTY**	**438788**	**11225**
1	Șag - Topolovăț	27653	4260
2	Vinga - Biled - Beregsău	25530	665
3	Behela	1662	
4	Fibiş - Alioş	1588	
5	Ghiroda - Recaş	8879	
6	Recaş Chizătău	3500	
7	Miniş - Chizdia	5076	
8	Râu Glaviţa	8486	
9	Hitiaş - Coştei	384	
10	Nord Lanca Birda	31615	617
11	Pogoniş	11069	
12	Șurgani	7760	
13	Cernabora Timişina	8310	
14	Banloc	10196	944
15	Moraviţa	12700	
16	Bârzava Mijlocie	13469	338
17	Roiga	6855	
18	Beregsău Amonte	1513	
19	Bethausen - Ohaba	630	
20	Tr. Vuia - Dumbrava	838	
21	Timişul Superior	3099	
22	Cincă	248	
23	Bega Superioara	364	
24	Șergani - Cernabora	182	
25	Mănăştur - Bunea Mare	94	
26	Aranca	55582	25
27	Mureşan	6040	448
28	Sânnicolau - Saravale	19998	1208
29	Galatca	8280	
30	Checea - Jimbolia	54451	684
31	Uivar - Pustiniş	5403	300
32	Răuţi - Sânmihaiu German	5128	321
33	Begheiu Vechi Vest Timişoara	10500	10
34	Țeba - Timișați	28063	285
35	Bociar	4126	
36	Caraci	5503	240
37	Rudna - Giulvăz	5643	252
38	Sud Lanca Birda	9984	
39	Timişul Mort	19692	539
40	Livezile	5462	89
41	Partoş - Glogoni	2876	
42	Cherestău - Dicşani	357	
B	**CARAŞ-SEVERIN COUNTY**	**28627**	**831**
1	Amenajare zona Cadar-Remetea	1782	
2	Amenajare zona Bocşa-Şoşdea	4400	
3	ISCIP Berzovia	552	552
4	CES+Desec. în bh Bârzava Mijlocie	251	
5	CES+Desec. în bh Bocşa - Biniş - Doclin	1657	
6	Amenajare Nera mal stâng Dalboşeţ - Prilipet	970	
7	CES în bh Pogoniş zona Tău - Ezeriş	30	
8	CES+Desec. în bh Timişul Superior	177	177
9	CES+Desec. în bh Bistra zona Bistra-Oţelu Roşu	2885	
10	Amenajare Caraş mal stâng Vrani-Mercina	5102	102

No.	Arrangement	Surface (ha)	
		Surface drainage	Drainage
11	Amenajare Caraş mal stâng Greoni - Ticvani	3234	
12	CES+Desec. în bh Caraş sub bazinul Ciornovăţ	1085	
13	CES + elim. exces umidit. zona Forotic-Surduc	281	
14	Amenajare Caraş versant drept zona Vărădia-Secăşeni	2100	
15	Desec. în bh Caraş sub bazinul Vecinic zona Iam-Rusova	1817	
16	Amenajare Caraş mal stâng zona Iam-Ciortea	2304	
C	**ARAD COUNTY**	**259043**	
1	Semlac Pereg	8622	
2	Fântânele Şagu	7144	
3	Păuliş Matcă	4193	
4	Mureşel Ier	3095	
5	Neudorf	962	
6	Cermei Şicula	242	
7	Chisindia Buteni	131	
8	Canalul Morilor	16992	
9	Ţiganca	64	
10	Vinga	163	
11	Nădlac Şeitin	1820	
12	Mureş Mal Drept	13610	
13	Ier Arad Frontiera	32918	
14	Crac Nădlac	12104	
15	Teuz	55780	
16	Aranca Secusigiu	5817	
17	Chiser Poganier	17008	
18	Cigher	9902	
19	Budier	20316	
20	Hanioş Vărşand	24374	
21	Pil Vărşand	3402	
22	Cermei Tăut	6021	
23	Colector Oradea	417	
24	Gut	3809	
25	Ineu Bocsig	950	
26	Chisindia	703	
27	Chizdia	324	
28	Bodeşti	900	
29	Almaş	121	
30	Crişul Alb	4420	
31	Mureş	1987	
32	Musteşti	732	

Currently, ANIF presents the following situation on land improvement arrangements under the management of the Agency [2]:

A. Irrigation
- 10,630 km - irrigation channel
- 26,700 km - buried pipeline
- 2,710 pc.- pumping stations
- 870 pc.- exploitation constructions

B. Surface drainage
- 56,600 km - surface channels
- 32,414 km - bridges
- 736 pc. - pumping stations
- 508 pc. - exploitation constructions

C. Drainage
- 40,660 km - collector and absorbent drain pipe

D. Fighting soil erosion
- 13,220 km - channels
- 6,861 km - outlets
- 55,664 pc.- falls, dams, threshold
- 29,835 pc.- bridges
- 7,183 km - ravines arrangements
- 28,050 km - exploitation roads
- 103 pc.- exploitation constructions

Irrigation arrangements

They have a small share in arable land, but the climatic evolution of the last 40 years require their ever increasing presence in the Plain of Banat as well as lowering the ground water level, due to an efficient drainage.

The irrigation arrangements that ANIF - Timiș Branch has in its administration are large systems of a total area of 9,929 ha - gross, or 9,745 ha - agricultural, distributed in Timiș County alone as follows:

Table 2

Irrigation arrangements - ANIF - Timiș Branch - Inferior Mureş (2008) [7, 11]

Hydrotechnic system	Surface (ha)		of which hydtroameliorative system (Timiș 2004):							
	total	agricultural	Periam		Cărpiniș		Timișoara		Lugoj	
			total	agricultural	total	agricultural	total	agricultural	total	agricultural
Șag - Topolovăţ	8747	8614	-	-	-	-	6927	6861	1820	1753
Beregsău	542	542	-	-	542	542	-	-	-	-
Periam	640	589	640	589	-	-	-	-	-	-
Total	9929	9745	640	589	542	542	6927	6861	1820	1753

On the Timiș County territory there are other local irrigation arrangements of a total area of 5,941 ha, so the total area with irrigation works in the county of Timiș to this date is 15,870 ha.

Timiș Branch ANIF supplied water using the irrigation pumping stations and the irrigation channels, made waterproof by concrete slabs, or by channels that have a mixed role (irrigation and drainage), for the total area of 11,996 ha, or 11,841 ha - agriculture.

The irrigable potential of Timiș County is higher, so if we analyze the surfaces circulated before 1989 and we compare them with today's results, it results that the surface that needs irrigation has a total area of 43,526 ha, of which:

– in large systems 9,929 ha;
– in local arrangements 19,652 ha;
– directly from the source 13.945 ha.

The surface interested in irrigation works could be further extended by completing irrigation arrangements from large systems, active projects from before 1989 in Șag-Topolovăţ irrigation system and not continued, unfinished due to a lack of financial resources.

Private arrangements in Banat [12]

Recently, new irrigation arrangements appeared also, private, as follows:

– Local irrigation arrangement in Aranca System, Compartment IV, Timiș County (gross surface for irrigations of 6,711 ha).

– Irrigation arrangement with central pivot in Mureșan drainage arrangement, Sânnicolau Mare, Timiş County (irrigated surface of 994.17 ha).

– Irrigation arrangement in Nord Lanca Birda unit, Birda locality, Timiş County (terrain surface proposed for irrigation arrangements: 1031.00 ha, and 195.50 ha for expansion).

– Irrigation arrangement in Răuţi – Sânmihaiul German drainage arrangement, Cenei, Timiş County (area for irrigation arrangements of 290.00 ha).

– Irrigation arrangement in Ţeba – Timişaţ drainage arrangement, Otelec locality, Timiş County (the surface of land taken into study for the irrigation arrangement is 872.74 ha).

– Irrigation arrangement in Rudna – Giulvăz and Ţeba – Timişaţ arrangements, Foeni and Giulvăz localities, Timiş County (irrigated surface: 471.60 ha).

– Irrigation arrangement in Ţeba – Timişaţ drainage system, Otelec and Giulvăz localities, Timiş County (stage I - sprinkler irrigation arrangements 800 ha, from which irrigated surface is about 400 ha, and in the second stage, another section of 400 ha).

– Irrigation arrangement in Răuţi – Sânmihaiul German drainage system, Uivar, Timiş County (a surface taken into study for irrigation arrangements of 923.84 ha, and in the second phase, a network of underground pipes will be constructed for section II - 400 ha).

CASE STUDY - ŢEBA – TIMIŞAT ARRANGEMENT [7]

Țeba-Timișaț arrangement is located between Timiș and Bega rivers, downstream of Timișoara, in the hydrographic basin of the rivers Timiș and Bega; is limited to the north by Bega Navigable channel, to the west by Serbia, south by Timiș River and by the drainage arrangements Rudna - Giulvăz and Caraci, and to the east by Șag-Topolovăț complex arrangement.

The arrangement includes the terrains that belong to the cadastral zones of Foeni, Giulvăz, Peciu Nou, Uivar, Sânmihaiu Român and Șag. Cruceni, Foieni, Ionel, Otelec, Ivanda, Sânmartinul Sârbesc, Sânmartinul Maghiar, Diniaş and partially Sânmihaiu Român are included in the perimeter of the system.

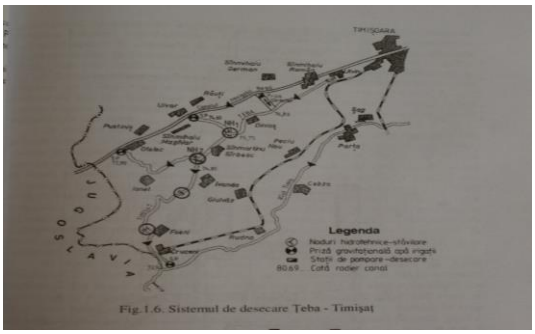

Figure 11 Ţeba-Timişaţ drainage arrangement – site plan [7]

The gross area is of 28,063 ha, respectively 26,531 ha net, of which 285 ha closed drainage. The arrangement was commissioned in 1962, subsequently completed between 1985 and 1987. The surface of the arrangement is divided into three compartments, corresponding to the hydropower scheme: Cruceni, Otelec and Diniaș, each compartment having its main collector. The excess water is evacuated by pumping into Bega river and mixed into Timiș river.

The Cruceni compartment (16,011 ha) comprises eight drainage units (Greşar, Mlaca, Bica, Şant în Cot, Otelec Sud, Temeşiţ, Ivanda Vest, Ivanda); Otelec compartment (7,144 ha) is divided into two drainage units (Otelec Vest and Est); and Diniaș compartment (9,034 ha) comprises two drainage units (Diniaş Aval and Diniaş Amonte).

Several factors influence the level of groundwater in the area, such as level variations in Bega channel and in Timiș River, rainfall on surfaces located upstream of the perimeter, and especially the rainfall in October - May period.

Figure 12 Cruceni pumping station (Photo: E.T. Man)

Figure 13 Pumps hall - Cruceni pumping station (Photo: E.T. Man)

In 2008, in collaboration with the Polytechnic University of Timisoara, Cruceni pumping station was rehabilitated and upgraded based on the recalculated drainage flows, using meteorological and hydrological data in the area.

The perimeter of the arrangement comprises the following main physical works:

– drainage channels: 818.5 km;

– pumping stations - PS - (flow):

3 base PS (Cruceni – 16.96 cbm/s, Otelec mal stâng – 7.76 cbm/s, Diniaş – 5.2 cbm/s) and 5 PS of pre-pumping (Mlaca – 3.75 cbm/s, Bica – 1.16 cbm/s, Şanţ în Cot – 1.16 cbm/s, Otelec Sud – 1.20 cbm/s, Temeşiţ – 1.2 cbm/s), from which 1 PS (Cruceni) discharges into Timiș river, 2 PS discharge into Bega Navigabil channel, and 5 discharge into CPE Otelec channel (Temeşiț); it is composed of 43 units with an installed flow of 40.17 cbm/s and an installed power of 4,449 kW.

– bridges: 701 pc.;

– hydrotechnical nodes: 8 pc.;

– absorbent drains: 27.3 km;

– interior river dams: 21.4 km;

– exploitation cantons: 4 pc.

In 2013, the network of drainage canals with a length of 818,489 m was functional, but partially covered with aquatic vegetation, herbaceous and woody.

The main works that were executed in the last 25 years have been maintenance operations of the network channels. In 2005, due to flooding, Timiș river right bank dam was broken, channels had to be unclogged and some hydrotechnic structures required repairs.

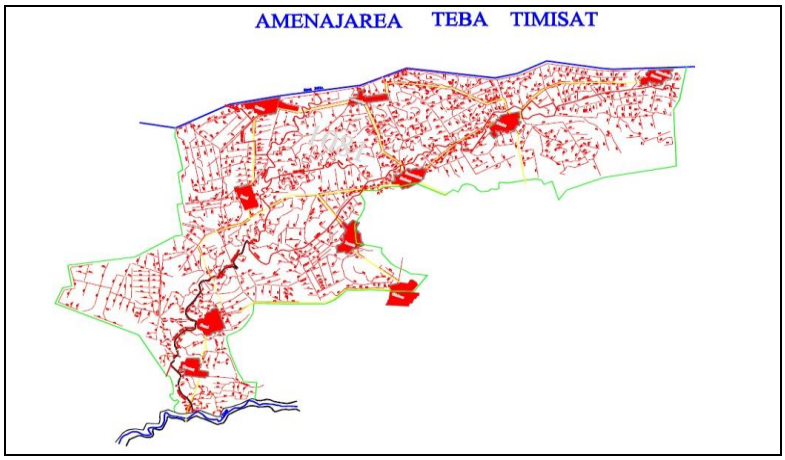

Figure 14 Ţeba-Timişat drainage system [3, 7, 11]

CONCLUSIONS

This paper briefly presents the time evolution of land-improvement arrangements (embankments, surface drainage, drainage, irrigation, fighting soil erosion etc.) in Banat, an evolution influenced by the historical development of this marsh area which was recovered for agricultural usage and for more, through hydroameliorative works mentioned above.

The paper illustrates the areas with excess moisture, both at national level and local, in Timiș, Caraș-Severin and Arad counties, an area included in the presented zone, the Banat, maps with areas of potential flood risk, but also the national and European legislation, maps of hydroameliorative arrangements from the counties discussed, evolution over time of drainage arrangements surfaces, the current situation of land improvement under the administration of the National Agency for Land Improvements, and also a case study of Ţeba-Timișaț arrangement.

Since the main works that were executed in the last 25 years have been mainly maintenance works of the channel network and completion, it is important that existing arrangements of drainage to receive a greater attention, given that Banat, being transformed from a marsh to an agricultural terrain that we see today, has the potential to become again what once was.

Țeba-Timisaț arrangement is important and representative for the Banat region. Being operational since 1962 and being upgraded between 1985 and 1987, the arrangement serves an area of 28,063 ha, through a network of 818.5 km of drainage channels, eight pumping stations and eight hydrotechinal nodes.

Climate change (global warming) have led lately to the need to apply irrigation in order to be certain of an agricultural production, independent of the climatic evolution. Thus, in recent years, new local irrigations have been constructed, in order to ensure optimum conditions for crops, in terms of the amount of water in soil, arrangements summarized in this paper.

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