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DEGRADED LANDS IN THE ABANDONED RICE FIELDS FROM BANAT REGION. CASE STUDY: DEGRADED SOILS IMPROVEMENT OF BEREGSĂU SETTLEMENT - COMTIM

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Abstract

In the Low Plaine from rivers Mureș - Timiș - Bârzava interfluve, during the 18th and 19th centuries has been existed about 14-15 rice - fields, for example at Banloc, Valcani, Sânnicolau Mare, Beregsău, Uivar, Otelec, Denta, Partoș, and other settlements. In the present time only the rice – field of Banloc functions, during of 124th years. The majority of rice - fields have been abandoned because of a wrong management, which has caused the water table to rise and the soils became gleyic - salic and/or sodic. We consider that the majority great areas with Gleysols and Solonetz, and also gleyic - salic - sodic soil types like Chernozems, Vertisols and Fluvisols which cover the Low Plaine, belongs to the abandoned rice - fields. There are present also, some aspects of the geological, geomorphological and the variation of the depth of ground water layer. Analytical data of the soil types dominantly for the rice - fields have been permited to establish the methods for improvement the former areas of rice - fields. The case study relates to the complex improvement measures for a plot of 53 ha which has been radically transformed really in a new soil type Anthrosols, much more productive.

***Key words**: rice field, degraded lands, analyse improvement, fertility.*

INTRODUCTION

Beginning with the year 1718th ample hydrotechnics and land improvement works have been effectuated, with a maximum intensity in the years of 20th century, respectively during decades 70th.

The transformation in arable territory from the vast expanse swamps, has been development an advanced agricultural system with a great number of crops.

The process of intensification of land use can be observed by the area with rice fields, starting with the rice - field Banloc, in the year 1786, from the Italian cultivators (Beutura D., 2002).

The rice is a pretentious plant, with certain environmental conditions, especially for clime and soil. The minimum germination temperature is 11-12ºC, optimum for growth 28-30ºC, with a transpiration coefficient of 750-1000, rise can growth only under a layer of 10-15 cm water, good oxygenated (Hagan R., 1968). Rise growing in Banat Plain have been realized in a surface irrigation system (Rogobete, 2006; Sandu, 1986).

Because soil and water contain soluble salts, such an irrigation system needs a permanently control in order to prevent degradation processes, like gleization - salinization - sodication (Oanea, 1977; Rogobete, 1993).

Must be also mentioned the scientific research of Oprea C. (1956; 1962; 1971) and Sandu Gh. (1984).

In the absence of a good management all the rice - fields (with one exception – Banloc) were abandoned because the level of rice production became non profitable. During of about 50 years of scientific research we have identified 11 abandoned rice-fields where the soils are strong degraded.

In the irrigation plot time of 125 years of Banloc a lot of properties are modified: the texture species become clayey, the bulk density is high even in the topsoil (1.33/1.68 g.cm^{-3}), infiltration rate is diminished from 38 mm.h^{-1} to 5 mm.h^{-1} at 50 cm depth, the level of calcium carbonate lowers from 40 cm to 150 cm depth.

MATERIALS AND METHODS

This scientific paper is the result of a prolonged researches in Banat territory, in the course of about 50th years. The pedological researches have been made personal or most frequently within the Pedological and Agrochemical Studies Office Timişoara (OSPA) and in the Soil Science Laboratory of Politehnica University Timişoara. It has been identified in the Low Plaine between the rivers Mures – Timiș – Bârzava, 11 territories of abandoned rice – fields, but only one of them is in function, respectively Banloc.

In the case of the plot (53 ha) which has been reclaimed in the year 1988, we have recently analyzed some soil samples from a soil profile, determined as Anthrosols.

RESULTS AND DISCUSIONS

Humans began to affect the land in many of the ancient countries and the process knows a gradual intensification parallel with the population increasing. Our research has been focused of the Low Plaine situated between the rivers Mureş - Aranca - Timiș - Bega - Bârzava, in the western part of Romania.

The Low Plaine is covered with the Quaternary deposits which are formed by clay, loess, sands or gravels. Another characteristic is the high level of the groundwater and the dominance of values of 1.0-2.0 m isophreatic. The qualitative analyse of the water present in the water bearing horizons indicate a variable total soluble salts content of 0.9 g/l in sandy zones, 1.0-1.5 m in loamy zones and 3.0-5.0 g/l in clayey zones. The oscillations of the groundwater level in these zones are 2.0-2.5 m. Because the feeding aquifer is in a volcanic tuff or andesite zone, the content of groundwater in cations of Ca^{2+}, Mg^{2+} and Na^{+} is great.

In the condition, predominantly, in the Low Plaine of an exudative moisture regime of 4-5 months, the saline and sodic soils occupies a great area.

Because the phreatic water - bearing stratum is near by soil surface, the hydrostatic level is free and the feeding zone coincides with the extension of the stratum. The presence at surface of a rich parent material with soluble salts, like $CaHCO_3^-$, $MgHCO_3^-$ and Na_2HCO_3 is the main reason for the existence of the insular soil area with sodication phenomena.

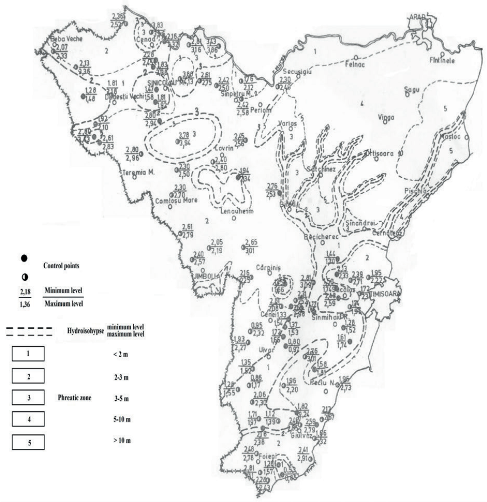

Figure 1. Hydrogeologic map

The recession of Pannonian Lake left behind an immense boggy area (Griselini, 1779) which is maintained pending to the 18th century on an area of about 877.000 ha (Historical Banat).

The land improvement arrangement initiated in the years 1716 have been radically modificated the aspect of Low Plaine (Rogobete, 1985). In fact, the land improvement works has been continued until the years 1970-2000 included in the seventh land improvement systems (Figure 2).

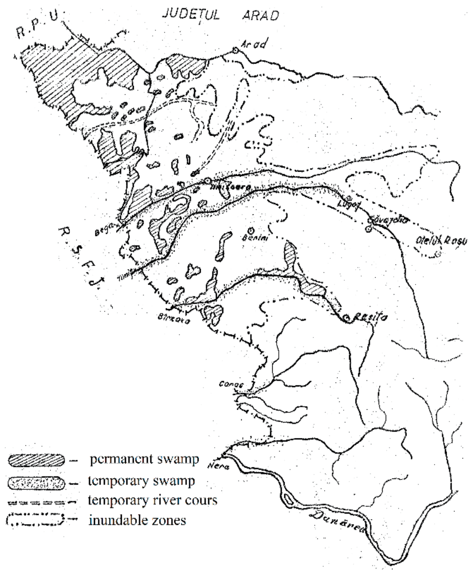

Figure 2. Map of Banat region, 17th century (after Grisselini)

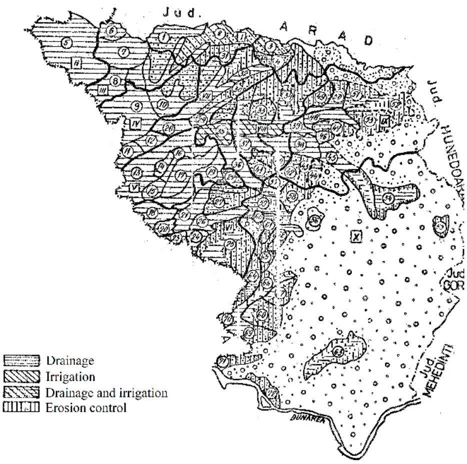

Figure 3. Land improvement map

Since the climatic conditions are favorable for rice cultivation in Banat region have been appeared a lot of rice fields arrangements.

Because of a bad management they have abandoned after a few years, with one exception Banloc (Figures 4, 5)

It will be presented the main rice fields from Banat:

1. Valcani

Hydrographical basin Aranca, cadastral territory 6198 ha

Table 1. Valcani Soil types, ha

AS	CZ	EC	VS	GS	SN	AT	Assoc
1044	912	87	1975	68	17	6	1661

Phreatic water excess - strong 4120 ha

Salinization - sodication - strong 719 ha

Soil profile from abandoned rice fields

Table 2. Vertosol salsodic (SRTS) - Pellic salic - sodic Vertisols (WRB), Analytical data Valcani

Depth, cm	11-27	27-58	58-78	78-108
Clay, %	66.5	63.4	62.5	42.0
Silt, %	14.3	17.4	16.8	23.8
BD, g/cm^3	1.51	1.49	1.49	1.40
pH_{H2O}	6.95	6.60	7.10	8.05
Humus, %	3.94	2.76		
CECs, me	45.43	49.28	48.70	40.0
Soluble salts, %			0.254	0.240
ESP			8.3	8.5

2. Sânpetru Mare

Feeding the two rice fields from river Aranca Cadastral territory 10.159 ha. There are two rice fields.

Table 3. Sânpetru Mare Soil types, ha

AS	CZ	VS	GS	SN	Association
1155	3678	2099	46	338	1860

Phreatic water, strong excess 339 ha

Salinization - sodication, strong excess 966 ha.

Table 4. Soloneț vertic - salic (SRTS) -Vertic -salic - Solonetz (WRB), Analytical data Sânpetru Mare

Depth, cm	3-16	16-30	30-50	75-95
Clay, %	36.7	41.1	40.3	38.0
Silt, %	27.2	27.2	26.4	30.5
BD, g/cm^3	1.43	1.46	1.42	1.44
pH_{H2O}	9.14	9.35	9.71	10.09
Humus, %	3.04	2.82	2.10	
CECs, me	27.85	36.58		
ESP	62.04	63.09		

Table 5. Vertosol gleyic - salic (SRTS) -Pellic - gleyic-salic (WRB), Analytical data Sânpetru Mare

Depth, cm	0-25	25-57	57-70	70-85
Clay, %	37.8	45.9	47.6	49.3
Silt, %	31.8	28.1	27.6	25.9
pH_{H2O}	6.50	7.57	8.33	8.94
Humus	3.53	3.42	2.53	
CECs, me	26.39	43.51	44.20	33.94
ESP			4.29	9.10
Soluble salt			86.9	147.0

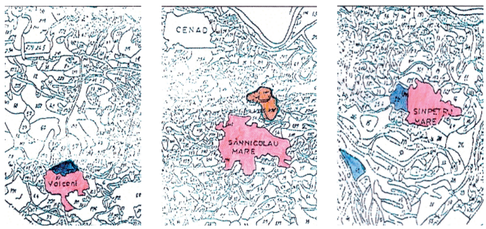

Figure 4. Rice fields Aranca hydrographical basin

3. Sânnicolau Mare

Hydrographical basin Mures-Aranca-Galatca Territory 13903 ha.

Table 6. Sânnicolau Mare Soil types, ha

AS	CZ	EC	VS	GS	SN	Association
1015	5329	2030	1016	634	127	2538

Strong phreatic excess 2470 ha

Salinization - sodication, strong 738 ha.

Table 7. Cernoziom gleic-sodic (SRTS) Gleyic-hyposodic Chernozems (WRB), Analytical data Sânnicolau Mare

Depth, cm	12-24	24-41	41-59	90-137	137-180
Clay, %	25.5	28.0	24.0	27.6	12.8
Silt, %	17.3	15.4	14.8	34.3	5.3
BD, g/cm^3	1.61	1.54	1.50		
pH_{H2O}	6.95	7.20	7.25	8.55	8.55
Humus, %	2.53	2.42			
CECs, me	15.87	17.23			
ESP				8.2	8.2

4. Otelec

Cadastral territory 8315 ha, the rice field was located on the left side of the Bega canal.

Table 8. Otelec Soil types, ha

AS	CZ	FZ	EC	VS	PE	GS	SN	Assoc
396	2432	2432	1038	1792	603	299	115	407

Strong phreatic water excess 1294 ha.
Salinization - sodication, strong 115 ha.

Table 9. Pelosol gleic salsodic (SRTS)-Gleyic-hyposalic-hyposodic Vertisols (WRB), Analytical data Otelec

Depth, cm	30-50	50-80	80-105	105-138
Clay, %	43.5	40.6	34.8	31.1
Silt, %	24.0	28.0	32.0	30.2
pH_{H2O}	8.30	8.30	8.90	8.80
Humus, %	3.28			
CECs, me	33.2	31.6	20.6	16.0
ESP	5.50	6.72	11.81	13.0
Soluble salts	56	56	116	130

5. Uivar

With the village Pustinis and Răuti, three rice-fields. The cadastral territory 11217 ha is traversed of the Bega channel with its affluents Beregsau and Timișat.

Table 10. Soil types, ha

AS	CZ	FZ	EC	VS	PE	GS	SN	Assoc
516	3162	864	1350	2147	785	389	131	895

Strong phreatic water excess 1474 ha.
Salinization - sodication, strong 135 ha.

Table 11. Cernoziom gleic-salinic (SRTS) Gleyic-hyposodic Chernozems (WRB), Analytical data Uivar

Depth, cm	20-35	35-50	50-65	65-100	100-130
Clay, %	31.4	32.2	32.3	32.1	29.0
Silt, %	23.9	24.8	22.8	19.8	20.9
BD, g/cm^3	1.51	1.47	1.62	1.60	
pH_{H2O}	8.33	8.45	8.49	8.53	8.68
Humus, %	2.73	1.79	0.94	0.58	
CECs, me	38.22	53.7	29.75	23.16	15.28
ESP, %		2.14	0.71	1.64	5.56
Soluble salts		140.5	186.1	186.1	180.1

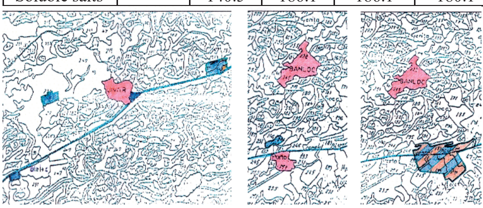

Figure 5. Rice fields Timiș-Bega-Bârzava hydrographical basin

6. Livezile

The cadastral territory is in Bârzava hydrographical basin, with an area of 5599 ha and traversed by the river Lanca and Birda, which are regularized and damming in.

Table 12. Soil types, ha

AS	CZ	FZ	EC	VS	PE	GS	SN
27	1133	821	2070	334	154	175	517

Strong phreatic water excess 1780 ha
Strong salinization - sodication 536 ha.

Table 13. Eutricambosol aluvic-gleic (SRTS)-Fluvi-gleyic eutric Cambisols (WRB), Analytical data Livezile

Depth, cm	15-38	38-55	55-85	85-125	125-180
Clay, %	39.8	37.7	38.4	39.4	42.6
Silt, %	31.5	30.7	30.9	32.6	24.4
pH_{H2O}	5.60	6.20	6.40	6.55	6.75
Humus, %	2.88	1.92			
CECs, me	31.00	30.24	30.46	32.58	32.39

7. Banloc

With the villages Partos, Ofsenita and Soca. The cadastral territory 11781 ha, placed in the Low Plaine Timiș-Bârzava, has the lowest altitude (75-85 m) from the Banat Plaine. The presence of ground water near the soil surface, with slow runoff determined the building three drainage systems in the zone, and two rice fields and a piscicultural arrangement with water from river Bârzava. The rice field from village Partos has been abandoned but the rice field from Banloc founded in the year 1786 is still in function.

Table 14. Banloc Soil types, ha

AS	CZ	EC	VS	PE	GS	SN	Assoc
437	720	2979	2850	358	274	28	2606

Strong phreatic water excess 2740 ha.
Strong salinization - sodication 65 ha.

Table 15. Eutricambosol gleic-sodic (SRTS)-Gleyic-sodic-eutric Cambisols (WRB), Analytical data Banloc

Depth, cm	0-28	28-44	59-78	78-93	93-112	112-125
Clay,<2μ	36.5	41.2	41.4	27.6	29.5	45.0
Silt, %	27.3	24.4	31.1	31.8	23.6	31.9
BD	1.50	1.56	1.54			
pH_{H2O}	6.80	6.70	7.10	8.10	8.10	8.25
Humus	2.73	2.42	1.63	1.43	0.86	0.53
CECs, me	31.24	30.19	31.75	29.13	29.8	38.40
ESP				22.6	18.1	28.3

8. Partos

Table 16. Pelosol gleic-sodic (SRTS) - Gleyic-sodic Vertisols (WRB), Analytical data Partos

Depth, cm	13-30	30-49	64-90	90-110
Clay, %	46.0	49.5	50.3	45.9
Silt, %	22.9	24.2	25.7	31.5
pH_{H2O}	6.95	7.25	7.90	8.30
Humus, %	3.16	3.06	2.66	
CECs, me	33.40	34.66	36.42	35.15
ESP		13.3	15.4	29.3

At these analyzed rice fields, can be added the rice fields from Timișoara, Beregsău, Gătaia and Denta which are also abandoned because due to the degradation processes become not profitable.

All the soil profiles, which have been used as rice fields and were abandoned, reveal strong degraded phenomena, especially phreatic water excess and gleization and also strong sodication processes.

All these phenomena are the result of two causes:

- a first cause is that the rice -fields are located on the soil with a low fertility because of a clayey texture or of a great ESP (15-30), for example on Solonetz;
- the second cause is a bad management in the time of rice field exploitation, which start up the degradation phenomena.

We consider that the bad management of the rice fields has a great contribution of the large spread in the Low Plain from Banat region of the soil type as Solonetz or sodic soils. For example, all the soil types like Chernozems, Cambisols, Fluvisols, Vertisols, are sodic. The degradation like sodication, take place not only in the rice field perimeter, but also in the limitrophe zones, and for that is imperative necessary as the drainage system to be in function, in order to control and maintain the level ground water at an optimum depth.

This supposes to realize maintenance works for the sustainable drainage systems.

Case study: Degraded soils improvement at the pig farm Beregsau - COMTIM.

Abandoned rice-field

The village Beregsau Mare and Mic is part of a great village Sacalaz, which has a territory of 11949 ha with 9432 ha arable.

Situated in the Low Plaine Timiș, 83-90m altitude, the territory is traversed by two rivers - Beregsau and Bega Veche. The level of ground water is oscillating between 0.5-3.0 m depth and with a medium mineralization-$Ca(HCO_3)_2$, $NaHCO_3$, $Mg(HCO_3)_2$.

In the 18th century, during the years 1765-1789, the village was colonized with german peoples - swabi. After the ample hydrotechnical and land improvement in the territory Sacalaz has been realized a piscicultural arrangement and a rice field. Because of wrong management, the rice field has been abandoned and the location remains with degraded soils which have salt and sodium in a high concentration.

Table 17. Soil cover of the arable territory (9438 ha)

Soil type	AS	CZ	FZ	EC	VS	PE	GS	SN
Area, ha	985	3719	617	2951	478	1320	249	302

All of the soil types are affected by degradation phenomena:

-water excess: at surface: moderate 254 ha, strong 930 ha;

-ground water: moderate 2223 ha, strong 1247 ha;

-salinization and sodication: moderate 2679 ha, strong 837 ha;

-compaction: 2073 ha;

The soil association, originated from the abandoned rice field which cover the plot of 53 ha was compound of the next soil types, in the year 1988:

1. Solonet gleic (SRTS) or Gleyic Solonetz (WRB) 45%.
2. Vertosol salinic (SRTS) or Pellic Hyposalic Vertisols (WRB) 30%.
3. Cernoziom salinic-sodic (SRTS) or Hyposalic - Hyposodic Chernozems (WRB) 25%.

Table 18. Solonet gleic (SRTS) – Gleyic Solonetz (WRB) Analytical data Beregsau 1988

Depth, cm	10-33	33-53	53-70	90-115
Clay, <2μ,%	46.2	50.70	51.8	36.9
Silt, %	21.6	16.1	22.0	25.8
Humus	2.88	1.88	1.66	1.87
pH_{H2O}	8.60	9.40	9.95	10.00
CECs, me	43.16	35.01	33.20	19.84
ESP	43.09	69.69	71.38	40.83

Table 19. Vertosol salinic (SRTS)-Pellic-hyposalic Vertisos (WRB) Analytical data Beregsau 1988

Depth, cm	0-25	41-61	61-76	76-105
Clay, <2μ,%	58.3	55.9	55.2	53.1
Silt, %	19.5	21.4	20.6	17.1
Humus, %	6.48	1.50	1.00	-
pH_{H2O}	7.40	8.30	8.40	8.41
CECs, me	48.50	44.00	42.00	40.00
ESP	3.98	4.68	4.14	
Cl^-, me		0.115	0.125	0.134
SO_4^{2-}, me		0.417	0.452	1.000
CO_3H^-, me		0.433	0.459	0.443

Table 20. Cernoziom salinic-sodic (SRTS)-Hyposalic-sodic Chernozems (WRB) Analytical data Beregsau 1988

Depth, cm	0-20	20-34	34-61	61-72	72-120
Clay, <2μ,%	30.1	34.8	41.3	35.0	20.2
Silt, %	19.8	22.5	17.8	18.0	16.2
Humus, %	3.35	3.28	2.93	1.05	
pH_{H2O}	6.67	8.30	9.19	9.40	8.89
CECs, me	31.20	30.45	32.20	28.32	21.76
ESP	6.80	10.08	13.29	8.85	8.50
Soluble salts	99.4	102.3	180.2	247.4	-

In August, 1988 year we sign a Protocol for research in order to improve the plot of 53 ha originated from the rice field. The improvement project relies on a detailed soil survey made of the author. The soil samples have been analyzed in the Soil Science Laboratory of Politehnica University Timişoara. The plot was included in the Drainage system Timişoara (Figure 6).

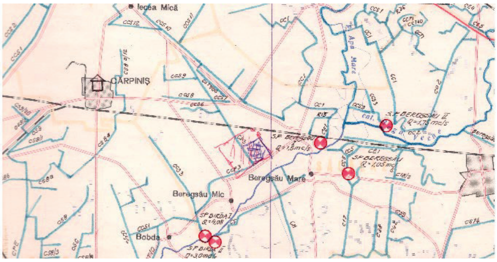

Figure 6. The improved plot of Beregsău

Soil improvement measures proposed and realized in about 6 months were:

1. leveling work for each plot with the slope orientated towards CA_3 or CCP_3 (supply or collector canals) corresponding the project;
2. tubular drainage at a medium depth of 1.00m with ballast filtering layer, which must be maintained at the surface of terrain after compaction; the distance between drains will be 10 m; the slope of the drains must be at least $1\ ^{0}/_{00}$; the rifled tube must be controlled, before laying the drain, the quality of the tubular drain.
3. it is necessary to retooling the existing collectors channels for a depth of 1.5 m;
4. mole drainage at 0.6 m depth, perpendicular on the tubular drainage chain, at 1.40m distance between the chain of mole drainages;
5. phosphogips amendment with 10 t/ha, incorporated by discing;
6. fertilization by natural organic manure obtained from the piggery, 80 t/ha incorporated by discing.
7. deep loosening at 0.5 m depth, with a simultaneous introduction of sand on the traces of the claws of the scarifier;
8. supply of earth material, fertile, in a layer of 20-30 cm depth, which must be maintained distinct towards the initial soil type, without mix and farming with a Cyzell or moldboardless plowing and seeded with perennial grass which has superficial roots.
9. leaching soluble salts by an over irrigation applied during autumn – beginning winter; the norm of leaching will be calculated after chemical analyses of the content of soluble salts from the soil and irrigation water and also of drained water.

The improvement measures have made by a specialized company IEELIF. Timişoara in the course of the year 1988.

In the following years, the reclaimed plot of 53 ha area became a new soil type and the level of production has known a significant rise.

Table 21. Antrosol aric-sodic (SRTS)-Aric-sodic Anthrosols (WRB) Analytical data Beregsau 2025

Depth, cm	20-30	40-60	60-80	80-100
Clay, <2μ,%	43.6	47.6	38.9	30.4
Silt, %	29.7	26.3	31.3	44.2
Humus, %	3.80	2.92	2.27	1.08
CECs, me	40.02	43.10	35.30	21.2
pH_{H2O}	8.18	8.27	8.46	8.52
ESP	5.73	11.65	36.20	22.54

Since the drainage system has been maintained only 10-15 years after the year 1989, the effect of improvement measures has been gradually mitigated. To make a parallel between the values of ESP from the Solonetz of the year 1988 with the ESP from the Anthrosols, respectively ESP=43.09-69.69 (1988) and 5.73-11.65 (2025), point out the radically reclamation the soil chemical conditions for plants cultivation.

CONCLUSIONS

Soil forming factors in the Banat Low Plaine are very favorable for the appearance of gleyzation, salinization and sodication processes.

The wide hydrotechnical works and land improvement measures have regularized the course of rivers Aranca, Timiș, Bega, Bârzava, and drying up the swamps. The agricultural land has strong increased to about 700000 ha in the region Banat and also the level of ground water has lowered in the Low Plaine at 3 – 5 m depth. The absence of the maintenance works in the drainage systems decreased the favorable effect regarding the soils fertility and the degraded phenomena turn up again.

The majority of soil types present a low salinization but the alkalization process is strong and the salsodic subtypes are dominantly. For example, there are Chernozems, Vertisols, Cambisols salsodic on about 30% from the total area.

The area in the Banat region with typically soil types with excessively clayey, gleysol and Solonetz is:

- Vertisols - 94883 ha (8.02%)
- Gleysols - 40764 ha (3.45%)
- Solonetz - 2106 ha (1.78%)

We consider that on this large area with gleyc and sodic soils has contributed, for certain, the wrong management practiced in the rice field.

Due to the negative soil profiles characteristics, were necessary a lot of kind meliorative measures, respectively hydro-pedo-agro-meliorative.

Between the eleven rice fields in which are dominantly soils as Vertisols, Gleysols, Solonetz and gleyic sodic, and salinic soils like Chernozems, Eutri-Cambisoils and Fluvisols, we have selected the abandoned rice field from COMTIM – Beregsău, because of the demand on research contract.

The improvement measures have been realized in a half year, but the cost was very high.

REFERNCES

Beutură, D. (2002). *Evoluția solurilor din amenajările orizicole și piscicole din Banat*. Phd thesis, Politehnica University Timișoara.

Cobzariu, I., Ungureanu, A. (1972). *Considerații asupra stratului freatic din Câmpia Timișului. Probleme de hidrometrie*, 2, București.

Coste, I., Țărău, D., Rogobete, Gh. (1997). Tendințe ale evoluției mediului înconjurător în SV României. Lucr. Simpoz. Național SNRSS.

Florea, N., and colab. (1974). Caracteristicile apelor freatice din Câmpia joasă Bega-Timiș. *Analele ICPA vol. XI.*

Grozav, A., Rogobete, Gh. (2020). *Interaction between irrigation and drainage Țeba Timișaț System, Timiș county*, Scient. Bulletin Politehnica University Timișoara, Hydrotech. vol 65, issue 1

Oanea ,N., Rogobete, Gh. (1977). *Pedologie generală și ameliorative*. Ed. Didactică și Pedagogică București.

Rogobete, Gh. (1993). Fenomene de subsidență a terenurilor. *Analele Univ. de Vest, Geografie vol. II, Timișoara.*

Rogobete, Gh., Constantinescu, L., Țărău, D. (1997). *Conductivitate hidraulică și variația nivelului freatic în sistemul Aranca*, Public. SNRSS, Timișoara.

Rogobete, Gh., Grozav, A. (2016). *Știința solului*. Ed. Politehnică Timișoara.

Rogobete, Gh. Țărău, D. (1997). *Solurile și ameliorarea lor. Harta solurilor Banatului*, Ed. Marineasa.

Rogobete, Gh., Țărău, D., coordonatori (2015), *Banatul istoric. Sol -Agricultura-Traditii*, Ed. Eurobit, 273 pg, Timișoara;

Rogobete, Gh. si co. (2021). *Solurile forestiere*, Ed. Eurobit, Timișoara.

Rogobete ,Gh., Beutură, D., Bertici, R, Grozav, A. (2006). *Land degradation phenomena in the oldest paddy in Romania-Banloc*, Proceedings 41st Croatian & 1 st International Symposium On Agriculture, Opatija-Croatia, pg. 275-276

Sandu, Gh. (1984). *Solurile saline și alcalice din România*, Ed. Ceres, București

Țărău, D., Rogobete, Gh., și colab., (2019). *Pământuri și locuri dintre Dunăre – Vf. Gugu - Crișul Negru*, Edit. Eurobit, Timișoara;

*** Arhivă O.S.P.A. Timișoara

***Harta geologică (1968) 1:200000, Timișoara Reșița Institutul geologic București

*** WRB (2014), FAO Roma