USING PEDOLOGIC INFORMATION IN DEFINING THE QUALITY AND SUSTAINABLE USE OF LAND IN WESTERN ROMANIA

L.NIȚĂ [1], D.ȚĂRĂU [1] , GH.ROGOBETE [2], GH DAVID [1]. D.DICU [1], Simona NIȚĂ [1]

[1] Banat`s University of Agricultural Sciences and Veterinary Medicine from Timişoara

[2] Polytechnics University of Timişoara

nitasimona70@yahoo.com

Abstract. *The sustainable soil/land management represents a modern form of ecosystem management, with the role to maintain and increase biodiversity and allow long term obtaining of high quality products. That is why the localizing and defining each land portion in the terrestrial space is of utmost importance in determining ecologic conditions, respectively the vocation of a certain land portion for certain agricultural or agro-forestry-pastoral uses. The purpose of the current research originates in the current scientific and practical preoccupations, more and more avid to accumulate knowledge regarding the physical, chemical and microbiologic characteristics of soils in relation with the local particularities of the natural frame for the land quality assessment, data which can be found in the pedologic studies carried out by territorial OSPA units. Through its geographic position and the relief terraced spacing with a general slope from east towards west, the studied territory determines a great diversity of ecologic conditions, generated by factor variability (cosmic-atmospheric and telluric-edaphic) which help establish an environment where plants can grow and deliver yields. The study refers to a 3693277 ha surface, of which 2430481 ha (65.81%), represent agricultural land, 16.61 % of Romania's total agricultural surface of* ***14635520 ha*** *(Order MADR 278/2011, Annex 1). The current paper's importance and novelty consists in the necessity to protect the edaphic layer and the environment through:*

- accumulation of scientific data needed in order to underlie working technologies which should help preserve the edaphic layer and sustainably manage soil and water resources,

- implementation of preserving work systems and sustainable management in the physical-geographic and climatic-edaphic conditions of the studied space.

Key words: *biodiversity, sustainability, monitoring, risk*

INTRODUCTION

Telluric-edaphic resources represented by relief, soil, water, vegetation and fauna present a series of properties defined and studied across time (ASVADUROV ET AL., 1983, BORCEAN ET AL., 1997, CANARACHE ET AL.,1980, COSTE ET AL., 1997, DUMITRU ET AL., 2000, NIȚĂ ET AL., 2010, RĂUȚĂ,1997, TEACI, 1980, 1983, ŢĂRĂU ET AL., 2015,) which have served and still serve to outline the entities for genetic and parametric clarification of soil units as well as to define agricultural practices with technological solutions estimated to orient the specialist through their application in various climatic conditions highlighting optimal vegetation conditions in order to increase the photosynthetic capacity to produce useful biomass necessary for human food and animal feed.

This interconditionality has been underlined in recent years by a series of international organisms (F.A.O., U.N.E.S.C.O., etc.) and unanimously accepted and integrated by all states (including Romania) participating in the United Nations Conference regarding the Environment and Development in Rio de Janeiro (1992), Johannesburg (2002).

Also, the *Agenda 2030 for sustainable development*, which has been adopted on the 25th of September 2015 by the *United Nations Organization*, establishes a global framework for the abolishment of poverty and achievement of sustainable development until 2030, based on the *Millennium Development Goals* (MDGs), adopted in 2000.

Taking all these into account, the paper presents, based on pedologic information found in the territorial OSPA archives (Timisoara, Arad, Bihor, Satu Mare), mostly on classic support, as well as based on the informational system $SPED_1$ and the BDUST-B system implemented in the territory by ICPA Bucharest, but also based on researched carried out across the years by the authors (at OSPA and BUASVMB in Timisoara), aspects referring to pedoclimatic characteristics as elements defining fertility and soil quality for land insurance and usage, expert support in elaborating sustainable management programs.

MATERIAL AND METHODS

The study refers to a surface of 3693277 ha (tab.1), of which 2430481 ha represent agricultural land (65.81%), situated in the western part of Romania, belonging from an administrative point of view to the counties: Satu Mare, Bihor, Timiş, Caraş-Severin constituting together the largest part of the historical realms: Banat, Crişana and Maramureș.

Table 1.

Surface structure (ha /%) for the main usage categories

Specification	Tillable	Pasture	Hay land	Vineyards	Orchards	Agricultural	Forests	Other	Total
Satu Mare (ha)	221609	57148	28193	3397	7144	317491*	80408	43901	441800
%	50.15	12.94	6.38	0.77	1.62	71.86	18.20	9.94	100
%	69.80	18.00	8.88	1.07	2.25	100	-	-	-
Bihor (ha)	309327	136201	47160	2057	4707	499452	197239	57736	754427
%	40.18	18.35	5.66	0.68	1.33	66.20	26.14	7.66	100
%	60.09	27.72	8.55	1.03	2.01	100.00	-	-	-
Arad (ha)	349240	127123	25976	3603	5578	511520	212037	51852	775409
%	44.92	16.52	3.28	0.49	0.77	65.97	27.35	6.68	100
%	68.09	25.04	4.95	0.75	1.17	100.00	-	-	-
Timiș (ha)	531593	125684	31418	4457	9246	702398	109057	58210	869665
%	60.97	14.86	3.38	0.49	1.07	80.77	12.54	6.69	100
%	75.49	18.40	4.17	0.61	1.33	100.00	-	-	-
Caraş Severin	127272	183411	76387	766	11784	399620	411276	41080	851976
%	14.96	21.46	8.93	0.13	1.43	46.91	48.27	4.82	100
%	31.81	45.75	19.01	0.28	3.05	100.00	-	-	-
TOTAL (ha)	1539041	629567	209134	14280	38458	2430481	1010017	252779	3693277
%	41.67	17.05	5.66	0.39	1.04	65.81	27.35	6.84	100
%	63.33	25.90	8.60	0.59	1.58	100	-	-	-

* (*Order MADR 278/2011, Annex 1*

The study of the ecopedologic conditions was carried out in accordance with the "Methodology of Pedologic Study Elaboration" (vol. I, II, III) developed by ICPA Bucharest in

1987, completed with specific elements from the Romanian Soil Taxonomy System, (SRTS-2012), as well as other normative documents re-updated by the M.A.A.P. Order 223/2002, respectively MADR Order 278/2011, based on the pedologic information accumulated in the archives of OSPA Timişoara, Arad, Bihor and Satu Mare (for over 65 years), studies completed with recent elements gathered in the field.

RESULTS AND DICUSSIONS

Because of its geographical position, the studied territory, situated at the middle of the northern hemisphere, presents a great ecologic condition diversity, determined by the broad variability of all factors (cosmic-atmospheric and telluric-edaphic) which help forming an environment where plants can grow and produce yields.

The overall Relief is characterised by a high complexity of morphological forms, from everglades and old deltas (with numerous relict courses and altitudes of ca 86 m), to semi-drained plains (overlapping the great spreading cones settled in a subsiding area with altitudes of 80-100 m), piedmont plains (with alluvial-proluvial or wind deposits), hillsides and piedmonts, high hills, sub and intra-mountainous depressions, as well as mountains with altitude of up to 2291 m (Vf. Gugu of M. Godeanu), with geologic structures and specific pedogeographic evolutions, related to the formation, in time and space, of the western part of the country.

On this sequence with an almost 2200 m difference, the relief of the western part of Romania, develops under the form of a grand an harmonious amphitheatre, open towards the north-west, undergoing permanent changes under the influence of natural factors as well as, especially, under the influence of man, who changed it in more significant way than other geographic regions of Romania.

Thus, tectonic elements lead to the fringing of the mountains along some fissures and grabens, phenomena more and more outlined by the permanent subsidence of areas from the central part of Pannonian Depression which is isolated from the Transylvanian Basin in the north-eastern part of the volcanic mountains Oaș-Igriș and crystal mountains Vârful Codrului, and then, to the east of marginal horsts of the M. Apuseni represented through: M. Plopiş, M. Pădurea Craiului, M. Codru Moma, M. Bihorului and M. Zarandului and to the south-east of M. Poiana Ruscă and Carpaţii Meridionali, the Pannonian region as being guarded to the south by the Mountain Banat, the mountain area linked to the plain by a chain of peripheral hills, which is penetrated by the plain relief, under the form of golfs, reaching the mountains.

The Western piedmont Hills extend under the shape of hilly porch under the Oașului, Apuseni and Banatului mountains, presenting a contiual, though unequal, development, almost disappearing on some portions and large in size on others (depressions, golfs).

They have a medium altitude of ca 300m, oscillating between 500 - 600m la contactul cu munţii şi între 250 - 150m la racordul cu zona de câmpie, fiind întrerupte de văile ce pătrund sub forma unor golfuri sau culoare până în zona înaltă.

Generally formed from Pliocene and Pleistocene rocks (slates, marl, argil, pebbles and sends), they present a calcareous fundament, sometimes at the surface (Lipovei Hills, Codrului HIlls), eruptive (D. Ciap of the Oașului Hills, Şanoviţa-Lucareţ of the Lipovei Hills, Măgura Copoci of the Tauţului Hills, etc) or crystal (Pogănişului Hills, etc.).

Situated on a crystal fundament sunk and fragmented in blocks, they developed form a littoral plain through erosive-accumulative activities generated by the rivers: Tur, Someş, Crişuri, Mureş, Bega, Timiş, Bârzava, Caraş, Nera and their affluents.

Representing the widest relief form of the studied space, *the Western Plain or the Banato-Crişana Plain,* stretches from north to south, under the shape of a strip between Romania's western border and the eastern hilly area it penetrates with golfs of various sizes, reaching inside the mountains.

The plain surface presents a reduced slope from east to west, a fact highlighted by the river direction, which cross it permanently.

The general altitude ranges from 200-l00m except for some lower portions, where it reaches 95 - 80m.

Its formation is closely linked to the basic level specific to the Pannonian Depression from the mid-Danube area, to the numerous flowing waters running down from the mountains, the eastern and western rising movements and the western subsidence movements, thus determining the evolution of two large groups stretching from east to west as follows: high planes (situated at the hill border) and low plains towards the Tisa axis.

Within thse formations, a high hill area can be delimited, with altitudes of 125-190m, represented by the following sectors: Carei,Tarna, Biharia, Miersig, Susag, Cermei, Minerău, Târnova, Vinga, Gătaia, Tormac, Oraviţa, Socol, etc. and a divagation area with altitudes of 90-100m, representing the less drained area from the sectors influenced by the rivers: Someş, Barcău, Crişul Repede, Crişul Negru, Crişul Alb, Aranca, Beregsău, Bega, Timiş, Bârzava, Moraviţa, Caraş, etc.

Present on the outer side of the piedmont plain, they represent the lowest step (80-l00m) and also the less drained. Their relief is largely characterised by a broad development of the main river everglades (Someş, Barcău, Crişuri, Aranca, Beregsău, Bega, Timiş, Bârzava, Moraviţa, Caraş), with numerous meanders, diffluents, unwindings and dried out courses or frequent overrises of their own riverbeds.

Low plains start from an altitude of ca 80 m and extend to the east towards the depression golfs to altitudes of 130 m. they are overlapping the subsiding area of the Pannonian Depression, formed of submersed dejection cones which were identified under the fluvial-lacustrine deposits occurring as marshes, covered ulterior with various materials: recent loess alluvial or wind deposits (where old settlements developed, which practiced a safer agriculture).

The low altitude and low depth of the underground water layer in recent alluvial deposits also explains the fact that they do not present a continual distribution, the relief being made up of a succession of grinds and fluvial-lacustrine depressionary areas, characteristic to a continental delta (Mureşului Delta).

The other characteristic is generate by the retreat of the Pannonian lake, which left behind a wide area of insalubrious marshes (*Fr. Griselini*, 1779), which was preserved until the end of the 18th century. During this period (*Gh. Rogobete*, 1985), there were still 877600 ha of marshes, periodically fed by numerous branches of the rivers transiting the area.

The geographic position within the continent, and the presences of the Carpathian Mountains to the east determine the studied territory to interfere with central European, East-European and Balkan influences, leading to a great diversity of the physical-geographic conditions directly and indirectly involved in soil formation and development

Table 2

The main soil types and associations from the western part of Romania (Ha and % of the agricultural surface)

Ct. no.	**SRTS 2012**	BIHOR		ARAD		TIMIŞ		CARAŞ-SEVERIN		SATU MARE		TOTAL	
		ha	%	Ha	%	ha	%	ha	%	ha	%	ha	%
1	Lithosol (di, eu, pr, rz)	10188	2.04	6650	1.30	9834	1.40	27534	6.89	-	-	54206	2.23
2	Regosol (di, eu,mo,um,li)	13336	2.67	23581	4.61	22477	3.20	13987	3.50	2857	0.90	76238	3.14
3	Psamosol (eu,mo,gc,)	9939	1.99	2353	0.46	211	0.03	200	0.05	3492	1.10	16195	0.67
4	Alluviosol (en, eu, mo, gc, vs, scac)	53091	10.63	43684	8.54	29150	4.15	28573	7.15	16192	5.10	170690	7.02
	P r o t s o l	86554	17.33	76268	14.91	61672	8.78	70294	17.59	22541	7.10	317329	13.06
5	Chernozem (ti, gc, ka, vs, sc, ac)	87804	17.58	121844	23.82	187189	26.65	3517	0.88	48894	15.40	449248	18.48
6	Phaeozem (ti, pa, vs, gc, st, cl)	27320	5.47	33914	6.63	24724	3.52	22379	5.60	635	0.20	108972	4.48
7	Rendzină (li, cb, ka)	1099	0.22	409	0.08	141	0.02	6754	1.69	-	-	8403	0.35
	C h e r n o s o l s	116223	23.27	156167	30.53	212054	30.19	32650	8.07	49529	15.60	566623	23.31
8	Nigrosol (ti, cb, li,)	1898	0.38	1637	0.32	-	-	799	0.20	-	-	4334	0.18
9	Humus soil (ti, cb, li)	1249	0.25	205	0.04	-	-	26055	6.52	-	-	27509	1.13
	U m b r i c s o i l s	3147	0.63	1842	0.36	-	-	26854	6.72	-	-	31843	1.31
10	Eutricambosol (ti, mo, vs, ro)	4195	0.84	27213	5.32	88994	12.67	48194	12.06	34924	11.00	203520	8.37
11	Districambosol (ti, um, ep, an, li)	6195	1.24	7570	1.48	-	-	40122	10.04	6350	2.00	60237	2.48
	C a m b i s o l s	10390	2.08	34783	6.80	88994	12.67	88316	22.10	41274	13.00	263757	10.85
12	Preluvosol (ti, mo, rs, vs, ca, st)	32863	6.58	53607	10.48	85131	12.12	41840	10.47	36512	11.50	249953	10.28
13	Lluvosol (ti, rs, ab, vs, pe, st)	144241	28.88	68440	13.38	76561	10.90	91033	22.78	97470	30.70	477745	19.66
14	Planosol (ti, ab, vs, st)	20477	4.10	6394	1.25	4214	0.60	559	0.14	-	-	31644	1.30
	L l u v o s o l s	197581	39.56	28441	25.11	165906	23.62	133432	33.39	175256	42.20	759342	31.24
15	Prepodosol (ti, um, tb, li)	1399	0.28	153	0.03	-	-	320	0.08	-	-	1872	0.08
16	Podosol (ti, um, fe, tb, li)	3995	0.80	205	0.04	-	-	799	0.20	-	-	4999	0.21
	S p o d o s o l s	5394	1.08	358	0.07	-	-	1119	0.28	-	-	6871	0.29
17	Vertosol+Pelosol (ti, gc, st, ss)	22625	4.53	60462	11.82	71223	10.14	9551	2.39	5715	1.80	169576	6.98
	Vertosols	22625	4.53	60462	11.82	71223	10.14	9551	2.39	5715	1.80	169576	6.96
18	Gleysol(eu, di, ka, mo, ce, ca, pe)	7442	1.49	12328	2.41	43127	6.14	2917	0.73	21589	6.80	87403	3.60
19	Stagnosol (ti, lv, ab, vs, pl)	3847	0.77	4041	0.79	7375	1.05	4396	1.10	32702	10.30	52361	2.15
	H y d r o s o l s	11289	2.26	16369	3.20	50502	7.19	7313	1.83	54291	17.10	139764	5.75
20	White alkali +Solonchak (ti, mo, ab)	20128	4.03	23428	4.58	42495	6.05	-	-	3492	1.10	89543	3.68
	S a l s o d i c s o i l s	20128	4.03	23428	4.58	42495	6.05	-	-	3492	1.10	89543	3.68
21	Histosol (di)	549	0.11	205	0.04	-	-	240	0.06	-	-	994	0.04
	H i s t o s o l s	549	0.11	205	0.04	-	-	240	0.06	-	-	994	0.04
22	Anthrosol (ad, er, dc)	25322	5.07	11588	2.27	7619	1.09	27834	6.96	6667	2.10	79030	3.25
23	Technosol (mi, ct, ek)	250	0.05	1609	0.31	1933	0.27	2017	0.51	-	-	5809	0.24
	A n t h r o s o l s	25572	5.12	13197	2.58	9552	1.36	29851	7.47	6667	2.10	84839	3.49
	T O T A L	499452	100	511520	100	702398	100	399620	100	317 491	100	243048 1	100

The relief, distributed in steps, determines a vertical and horizontal distribution of all environment elements, reflected in the vegetation distribution and step arrangement: in low plain areas, a steppe and forest steppe vegetation is identified, with quercus forests in plains and hills, and, on mountain peaks, subalpine and alpine pastures.

Due to the pedo-hydro-climatic and floristic conditions, as well as due to human intervention, starting with raising the first earth mounds or embankments and continuing with hydrate-ameliorative works executed ca 250 years ago, the soils from the researched space present a wide diversity. Thus, according to the Romanian Soil Taxonomy System (SRTS-2012), we identified 23 soil types (tab.2) and associations, including 11 of the 12 soil classes (Protosols, Chernosols, Umbric soils, Cambisols, Luvosols, Spodosols, Vertisols, Hydrosols, Salsodic soils, Histosols, Anthrosols).

According to the data presented above, agricultural land quality, as the result of the physical-geographic condition diversity and their intrinsic characteristics, as well as of anthropic interventions across time, differs a lot in space. That is why the Romanian land assessment methodology, which encompasses the synthesis of knowledge in the field as well as the local experience (D. Teaci 1980, I.C.P.A. Bucharest 1987), defines the land from an ecologic point of view in relation with the cosmic-atmospheric and technic-edaphic factors.

The basic principle of the assessment methodology developed in our country is that each ecologically homogenous land unit (TEO), of an administrative territorial unit (UAT), defined according to the current Methodology of Pedologic Study Elaboration. Using the 23 assessment indicators, which represent the more important, more significant, more precise and easier to assess, which can usually be found in pedologic mapping works, elaborated after 1987 by territorial OSPA units under the methodologic guidance of ICPA Bucharest, an assessment grade value between 1 and 100 is established.

With land assessment, for natural conditions, each of the above mentioned indicators contributes to the assessment grade establishment through an assessment coefficient which varies between 0 and 1 depending on whether the respective characteristic is totally unfavourable or optimal for the usage requirements or the plant taken into consideration (Annexes 3-1 to 3-18, MESP-1987, vol. II).

Thus, based on the pedologic information processed in accordance with the Methodology of Pedologic Study Elaboration (I.C.P.A. Bucharest 1987) and other normative documents, re-updated through the M.A.D.R. Order 278/2011, the agricultural land included in the researched space can be grouped (for every 20 points) in V usage classes depending on their vocation for tillable usage (fig.1) or their favourability for certain cultivated plants (fig.2-6).

	I	II	III	IV	V
Arad	19.2	21.5	34.6	19.1	5.6
Bihor	5.5	29.2	29.9	28.9	6.5
Caraș-Severin	4.9	21.1	21.7	38.8	13.5
Satu Mare	8.1	17.7	26.2	31.1	16.5
Timiș	19.1	23.2	26.9	27.8	3.0

Figure 1. Agricultural land distribution on usage classes for the TILLABLE usage category

	I	II	III	IV	V
Arad	19.6	21.5	34.2	19.8	4.9
Bihor	8.9	23.8	30.8	28.9	7.6
Caraș-Severin	8.2	18.6	29.9	32.9	10.4
Satu Mare	9.1	23.9	30.7	25.8	10.5
Timiș	21.8	25.6	29.9	18.4	4.3

Figure 2 Tillable land distribution in favourability classes for WHEAT

	I	II	III	IV	V
Arad	16.2	27.9	30.5	19.9	5.5
Bihor	9.9	26.8	31.8	22.9	8.6
Caraș-Severin	5.8	19.9	30.9	24.9	18.5
Satu Mare	9.5	16.1	25.8	28.9	19.7
Timiș	18.6	29.6	30.2	19.4	2.2

Figure 3 Tillable land distribution in favourability classes for CORN

	I	II	III	IV	V
Arad	18.2	29.9	10.5	22.9	18.5
Bihor	7.5	29.2	11.8	19.9	31.6
Caraș-Severin	5.8	19.9	30.9	24.9	18.5
Satu Mare	6.8	14.5	18.1	29.7	30.9
Timiș	18.8	29.7	30.1	19.6	1.8

Figure 4 Tillable land distribution in favourability classes for SUNFLOWER

	I	II	III	IV	V
Arad	18.6	20.9	16.5	27.5	16.5
Bihor	3.5	21.3	20.8	30.8	23.6
Caraș-Severin	3.8	17.9	15.8	29.9	32.6
Satu Mare	10.5	19.8	24.7	28.2	16.8
Timiș	17.6	26.8	28.1	25.4	2.1

Figure 5 Tillable land distribution in favourability classes for SOY BEANS

	I	II	III	IV	V
Arad	7.6	29.9	34.5	24.5	3.5
Bihor	9.9	28.3	29.1	30.1	2.6
Caraș-Severin	9.8	32.9	29.8	22.9	4.6
Satu Mare	7.5	21.2	34.4	23.8	13.1
Timiș	8.6	30.7	32.2	23.4	5.1

Figure 6. Tillable land distribution in favourability classes for CLOVER

From the enumeration of the main physical-geographic and edaphic characteristics of land from the western part of Romania, and the analysis of limitative factors resulting from their classification in quality classes, a necessity arises to intervene with some pedo-hydro-ameliorative or cultural measures, specific to each case:

- Measures to correct the acid reaction through periodical calcic amelioration or the alkali one through gypsation;
- Improving plant nutrition conditions through ameliorative fertilisation;
- Insuring an optimal aero-hydrologic regime through works to prevent and control humidity excess (canals, gutters, ditches, drainages, etc.) or, as need be, to prevent aridization tendencies (irrigations, protection curtains, adequate crops);
- Soil erosion and land slide prevention (embankments, coast channels, furrows, anti-

erosional curtains);

- Applying soil work technologies which should avoid its de-structuring and the formation of hardpan,
- Increasing the protection level of protected areas by organising buffer zones around them, and especially by organising ameliorative perimeters, revising and modernizing existing ones;
- Protecting biodiversity by introducing agro-ambiental schematas experienced in pilot farms regarding the application of an agricultural management adequate for the ecopedologic conditions specific for a certain place, at a certain moment, etc.;

CONCLUSIONS

Knowledge about natural conditions and especially the ecologic land potential (defined according to M.E.S.P.-ICPA Bucharest, 1987) for the main usage categories ad crops presents a special importance in accomplishing qualitative land assessment works, a fact that also justifies the necessity and topicality of the periodical pedologic and agro-chemical mapping activity.

Systematic pedologic and agro-chemical soil mappings carried out by the Offices for Pedologic and Agro-chemical Studies in our country offer precious data regarding the evolution of the soil quality state, the establishment and differential crop technology application, land assessment and favourability establishment for various crops, the foundation of land improvement works and ameliorative technologies, land organization and systematization. Also, the topicality of land mapping, assessment and evaluation activities results from the fact that the land, aside from its characteristics as a historic-natural body, is the most important production means in agriculture and a good subjected to ownership and, implicitly, exchange good on the market, with a certain usage value.

The data presented above show that under the conditions of an apparently good natural ecologic potential, the general situation of natural resources and those induced anthropically is completely unsatisfactory, since most of these resources are affected by one or more limitative and restrictive factors. These are sufficient motivations to justify the necessity to elaborate short and medium term strategies for the protection and preservation of the telluric-edaphic factors, as well as the necessity to respect field and laboratory investigation periodicity in all points of the 8x8 Km grid of the National sol-land monitoring system (organized by ICPA) and its completion with pedologic and agro-chemical studies.

BIBLIOGRAPHY

1. ASVADUROV H., BOIERIU I., 1983, Solurile judeţului Satu Mare [The Soils of the Satu Mare County], 1983 Centrul de mat. didactic şi de pro. Agricolă, Redacţia de propagandă tehnică agricolă Bucureşti,

2. BORCEAN I.,DAVID GH., BORCEAN EUGENIA, ŢĂRĂU D., GAVRILĂ RODICA,1997, Studiu privind zonarea porumbului de boabe în Banat [Study Regarding Grain Maize Zonation in Banat], Lcr. şt. U.S.A.M.V.B. Timişoara, secţia Cultura plantelor de câmp,

3. CANARACHE A., TEACI D., 1980, Caracterizarea tehnologică a terenurilor agricole ca bază a lucrărilor de raionare ameliorativă [Technological Characterisation of Agricultural Land as Basis for Ameliorative Zoning Works], Buletin Info. ASAS Bucureşti nr. 10,

4. COSTE I., ŢĂRĂU D., ROGOBETE GH., 1997, Tendinţe ale evoluţiei mediului înconjurător în Sud-Vestul României [Tendencies of Environment Evolution in the South-West of Romania], Lcr. Şt. Simp. Naţional de Pedologie Timişoara,
5. ANIȘOARA DUMA – COPCEA, CRISTINA STANCIU, CASIANA MIHUŢ, L. NIŢĂ, USING PEDOLOGIC INFORMATION IN ESTABLISHING FAVOURABILITY OF MAIN CROPS IN THE GIARMATA AREA, Research Journal of Agricultural Science, 48 (2), 2016, pp29-36,
6. DUMITRU M. ET AL., 2000, Monitoringul stării de calitate a solurilor din România [The Monitoring of Soil Quality State in Romania], Ed. GNP Bucureşti,
7. GRISELINI F., 1984, Încercare de istorie politică şi naturală a Banatului – Timişoara [An Attempt of the Political and Natural History of Banat] (Traducere şi note de Feneşan), Ed. Facla Timişoara,
8. NIȚĂ L.,MIRCOV V.D., CASIANA MIHUȚ, SIMONA NIȚĂ, DANCEA L., 2010 - The soil cover Aranca Plain in relation with the environmental and anthropic factors - Research Journal of Agricultural Science vol. 42 (3) Agroprint Editorial Timişoara
9. A.OKROS, L. NIȚĂ, SIMONA NIȚĂ, D. DICU, D. BEUTURĂ, ASTRID SIMONE GROSZLER, SOIL RESOURCES OF THE DOMAȘNEA COMMUNE, CARAȘ – SEVERIN COUNTY, Research Journal of Agricultural Science, 49 (1), 2017 pp 169-173
10. RĂUȚĂ C.,1997, Agricultura durabilă în România [Sustainable Agriculture in Romania], Ştiinţa Solului Seria a III-a,vol.XXXI, nr. 1,
11. Rogobete Gh., Man T.E., 1985, Îmbunătăţirile funciare din Banat - Ameliorarea solurilor grele şi tasate afectate de exces de umiditate [Land Improvement in Banat – The Amelioration of Heavy and Compacted Soils Affected by Humidity], Lcr. şt. S.N.R.S.S. Bucureşti, nr. 22,
12. TEACI D., 1980, Bonitarea terenurilor agricole [Agricultural Land Assessment], Ed. Ceres, Bucureşti,
13. TEACI D., 1983, Transformarea peisajului natural al României [Transforming Romania's Natural Landscape], Ed. Şt. şi Encicl. Bucureşti,
14. ŢĂRĂU D.,ROGOBETE GH., DAVID GH.,DICU D., 2015 – Ecopedological Resources from Banat and their suitability for the main agricultural crops and tree species, Research Journal of Agricultural Science,Facultatea de Agricultură, Vol. 47 (3),Ed. Agroprint Timişoara,
15. *** ARHIVA O.S.P.A. Timișoara , Arad, Bihor – *Studii pedologice şi agrochimice [Pedologic and Agro-chemical Studies]*
16. *** 1987, Metodologia elaborării studiilor pedologice [Methodology of Pedologic Study Elaboration], vol. I,II,III, Bucureşti,
17. *** SRTS-2012.