PhD THESIS

The management of the soil resources from the Brad Depression

SUMMARY OF Ph.D. THESIS

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CONTENTS

INTRODUCTION

Globally, the quality status of soils is not among the best, and the evolution trend is considered to be oriented even towards a worsening of the situation (McINNES-CLARKE AND COLAB., 2019).

Problems related to soil quality are created by a number of factors, but agricultural practices registered both at the level of large farms and at the level of those who own in operation medium and small areas of agricultural land (CUI AND COLAB 2018), are considered as of major importance in this context (LAI, 2008).

1. The present stage of knowledge concerning the management of the soil resources

The concept of soil management is related to the farming systems practiced worldwide. Conventional approaches to sustainable agriculture are largely based on the efficient use of external nutrient sources. Research has shown that, even in the presence of a sufficient intake of macronutrients, agricultural production and soil fertility can be deficient, thus necessitating an understanding of the ecological dynamics that operate at ground level. In addition to the beneficial effects of elucidating all the mechanisms underlying the understanding of soil dynamics, it can make a substantial contribution to the intensification of organic farming practices.

2. The sustainable management of the soil resources

In order to ensure high soil productivity, it is necessary to promote the practice of sustainable management of this important resource. This practice makes an important contribution to ensuring the world's food needs. In order to ensure sustainable management, certain measures are required to reduce the processes of physical and chemical degradation of the soil (FAO REVISED WORLD SOIL CHARTER, 2015).

3. Research objectives

The doctoral thesis considers specific objectives developed to monitor soil resources in the Brad Depression and highlight their characteristics, as well as objectives related to the dynamics of developments and use of soil resources worldwide and in our country, as follows: study the dynamics of developments soil resources worldwide and in Romania; study of the dynamics of land resources use worldwide, in the EU and in Romania; the study of the interrelation between the use of soil resources in Romania and the one identified in the European Union and the study of the soils from the Brad Depression.

4. Environmental peculiarities of the experimental site

The natural environment in which the experimental part of the doctoral thesis took place targeted the Brad Depression located in Hunedoara County. The geographical features specific to the area are highlighted graphically in the physical map. The experimental area was located on an area of 98,000 m2, in the ranges 46 ° 5'0'' - 46°15'0''N, for longitude and 22°35'0'' - 23°0'0''E, for latitude (**www.google.com**).

5. Material and method

The monitoring of the soil resources from the Brad Depression was carried out in the period 2018 - 2019, on the territory of the 11 localities located on its territory, respectively: Baia de Criș, Blăjeni, Brad, Buceș, Bucureșci, Bulzeștii de Sud, Crișcior, Luncoiu de Jos, Ribița, Tomești and Vața de Jos (www.google.com). In order to study the dynamics of the evolution of soil resources and their use, use is made of official databases (http://www.fao.org/faostat/en/#data/RL).

The chemical materials used to carry out the experimental part of the doctoral thesis are represented by the chemical reagents used in the laboratory analyzes. The experimental part of the doctoral thesis was performed with the help of physical materials necessary for soil sampling, namely the GeoSampler probe and laboratory equipment for specific analyzes.

The observations refer to the morphological description of the soil profiles taken from the experimental site, in accordance with "SRTS 2012". The determinations refer to the laboratory analyzes performed for the physico-chemical characterization of the soil samples. Physical characterization refers to determinations performed in order to determine the soil texture (particle size analysis by sieving method), bulk density (cylinder method), porosity and hygroscopicity (by calculation). The chemical characterization concerns determinations of: pH (potentiometric), humus (volumetric), total nitrogen (Kjeldahl method), mobile phosphorus (spectrophotometric), mobile potassium (flamphotometric) and carbonates (wet oxidation method). Statistical methods were used to calculate the arithmetic means and dispersion parameters of the indicators of the dynamics of the evolution of soil resources and their use, as well as the correlations between them. STATISTICA v.8.0 for Windows was used.

6. Results and discussions

According to official statistics, which include data available for a period of 58 years, 1961 - 2018 (http://www.fao.org/faostat/en/#data/RL), the soil resources used show a low dynamics both at the level of monial, as well as in the case of most continents, fact highlighted by the low values of variability (Table 6.1).

Table 6.1

The soil resources used worldwide, by continents and in EU, 1961 – 2018 (thousands ha)

Issue	N	X	Minimum	Maximum	s	CV (%)
1	57	13021416	12994900	13041790	22323.74	0.17
2	57	2964856	2964823	2964921	42.70	0.00
3	57	3864929	3863585	3870460	1853.50	0.05
4	57	2880744	2693908	3108877	205662.37	7.14
5	57	2462199	2213085	2670483	229404.39	9.32
6	57	848689	848655	849627	180.44	0.02
7	57	403928.72	387364.60	424256.20	18194.76	4.50

1 –World; 2 – Africa; 3 – America; 4 – Asia; 5 – Europa/Europe, 6 – Oceania; 7 – Uniunea Europeană/ European Union.

In the European Union, there is an average of soil resources used, calculated for the period 2009 - 2018 equal to 423,843.73 thousand ha, which is a slightly downward trend (Fig. 6.5).

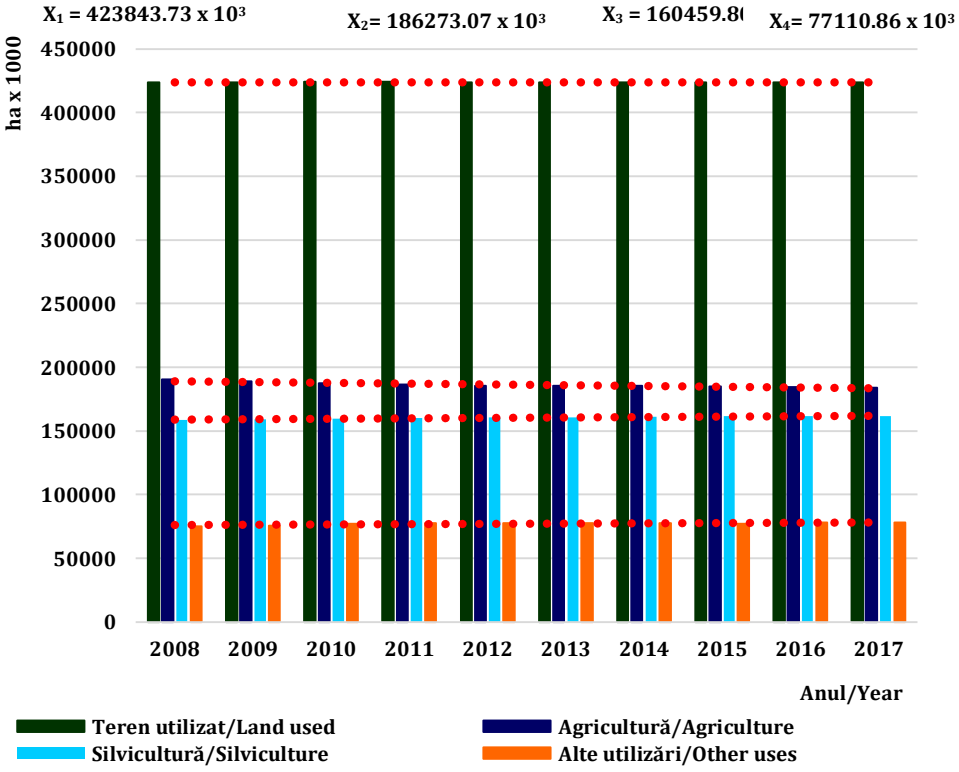


Fig. 6.5. The yearly and mean evolution of the soil resources used in European Union, 2009 – 2018

Regarding Romania, the use of soil resources shows specific evolutions. Thus, the total soil resources destined for various lucrative purposes register for the period 2009 - 2018, an average equal to 23,005.50 thousand ha, calculated on the basis of the average of the official data available for each year of the studied period. Their evolution registers a slightly upward trend, with an increase from 22,990 thousand ha in 2009, to 23,008 thousand ha in 2018, noting that this value is a constant in the last three years of the analyzed period.

According to official data and statistics, soil resources have uses that are considered to belong to specific categories. These various uses are highlighted by land use indicators.

Table 6.5

The means and dispersion parameters for the shares of the arable, cultivated, and organic cultivated areas, %

Issue	N	Period	X	M	Min	Max	s	CV%
Arable land	58	1961 - 2018	28.28	28.38	27.79	29,05	0.36	1.27
Cropland	58	1961 - 2018	30.63	30.41	30.10	32.64	0.57	1.85
Cultură organică	15	2004 - 2017	0.82	0.76	0.45	1.43	0.26	31.57

N –number of cases; X –mean; M –median; s –standard deviation; CV –coefficient of variation.

Table 6.6

The means and dispersion parameters for the shares of the areas covered with primary forest from total land, and planted and regenerated forest, from total forest area worldwide, 1990 – 2018, %

Issue	N	X	Min	Max	s	CV%
Primary forest	28	31.97	31.23	39. 46	0.15	0.47
Planted forest	28	6.00	3,99	7.29	0.93	15.43
Regenerated forest	28	94.19	92,67	95,97	5,32	5,64

N –number of cases; X –mean; M –median; s –standard deviation; CV –coefficient of variation.

The analysuis of the use of the soil resources in Romania, in context of European Union (EU-28) emphasizes their specific.

Table 6.17

The means and dispersion parameters for the shares of the arable, cultivated, field equipped for irrigations, and organic cultivated areas, of total areas in EU, %

Issue	N	Period	X	M	Min	Max	s	CV%
Arable land	58	1961 - 2018	57.4	57.4	56.14	58.47	0.7	1.3
Cropland	58	1961 - 2018	63.9	64.0	62.9	65.1	0.6	0.9
Area equipped for irrigation	58	1961 - 2018	8,13	8,94	4,34	10,41	1,82	22,44
Cultură organică	15	2004 - 2018	5.0	5.1	2,91	7,44	1.2	23.9

N –number of cases; X –mean; M –median; s –standard deviation; CV –coefficient of variation.

Table 6.18

The means and dispersion parameters for the shares of the areas covered with primary forest from total land, and planted and regenerated forest, from total forest area in UE, 1990 – 2018, %

Issue	N	X	Min	Max	s	CV%
Primary forest	29	37.16	35.54	38.57	0.88	2.36
Planted forest	29	32.17	30.05	34.31	1.43	4.44
Regenerated forest	29	68.06	65.67	70.50	1.62	2.38

N –number of cases; X –mean; M –median; s –standard deviation; CV –coefficient of variation.

Table 6.18

The means and dispersion parameters for the shares of the arable, cultivated, equipped for irrigations, and organic cultivated areas in Romania, %

Issue	N	Period	X	M	Min	Max	s	CV%
Arable land	58	1961 - 2018	64.72	64.61	62.90	67.55	1.37	2,11
Cropland	58	1961 - 2018	68.76	68.12	66.08	71.43	1.85	2,69
Area equipped for irrigation	18	2001 - 2018	1.64	1.30	0.32	3.84	0.96	58,58
Cultură organică	14	2005 - 2018	1.48	1.64	0.65	2.43	0.53	35,56

N –number of cases; X –mean; M –median; s –standard deviation; CV –coefficient of variation.

Table 6.19

The means and dispersion parameters for the shares of the areas covered with primary forest from total land, and planted and regenerated forest, from total forest area in Romania, 1990 – 2018, %

Issue	N	X	Min	Max	s	CV%
Primary forest	29	28,37	27,71	30,12	0,85	3,01
Planted forest	29	9,35	8,29	13,86	1.90	20,32
Regenerated forest	29	90,64	86,14	94,71	1.91	2.09

As Romania is one of the member states of the European Union, it is important to highlight the degree of concordance between the proportion of soil resources allocated to various lucrative purposes by the two entities.

According to SRTS - 2012 (Romanian Soil Taxonomy System - 2012), the constituent soils of the Brad Depression are the representatives of five classes, nine types and thirteen subtypes (Fig. 6.21), with a spatial distribution highlighted by the soil map, drawn up at scale 1 : 25,000 (Fig. 6.22).

Soil classes, types and subtypes have a different distribution on the territory of the 10 localities located in the study area (Fig. 6.23).

From the point of view of the occupied areas from the total of 98,000 ha, the soil classes identified in the studied area, represented by the Brad Depression, include different areas and proportions (Fig. 6.24).

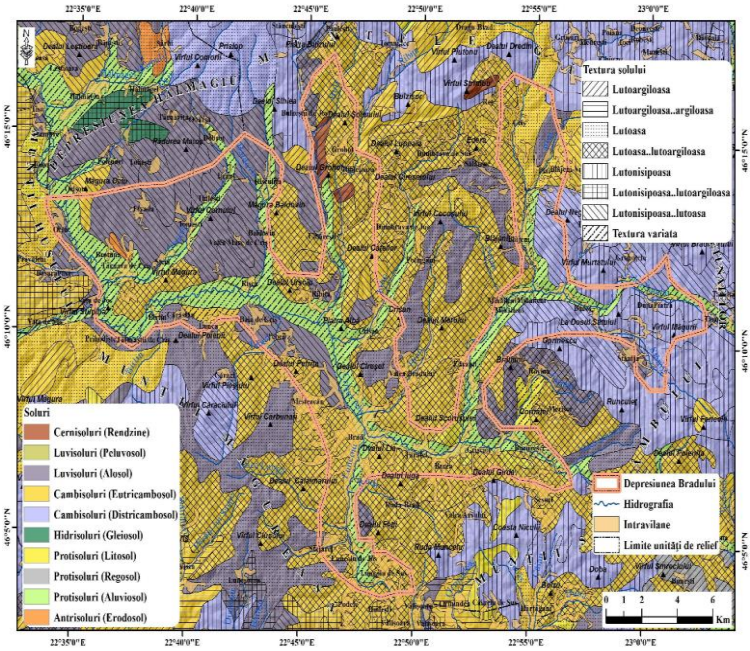
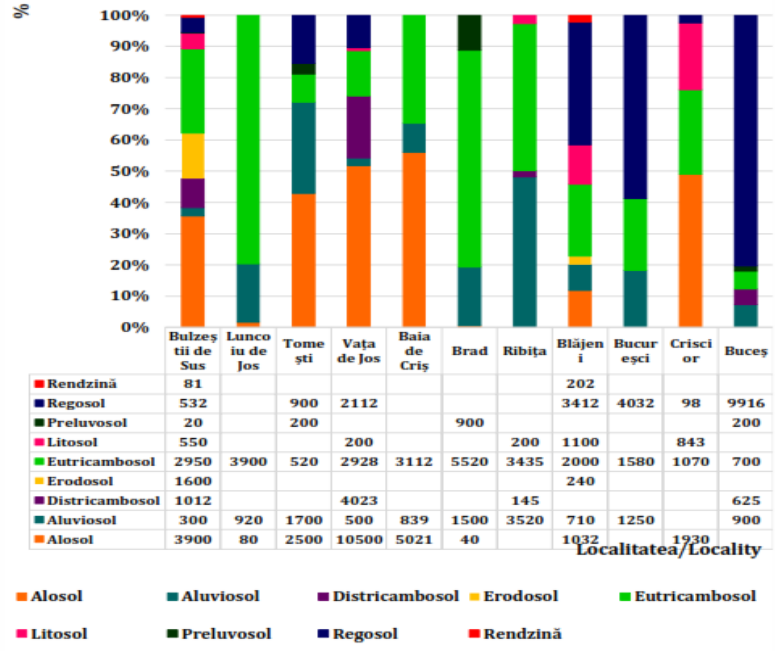


Fig. 6.22. The correlation between the mean shares of area occupied with regenerated forest from total forest land in Romania and the share reported in EU, 1990 – 2018



	Bulzeștii de Sus	Lunco iu de Jos	Tomești	Vața de Jos	Baia de Criș	Brad	Ribița	Blăjeni	Bucureșci	Crisci or	Buceș
Rendzină	81							202			
Regosol	532		900	2112				3412	4032	98	9916
Preluvosol	20		200			900					200
Litosol	550			200			200	1100		843	
Eutricambosol	2950	3900	520	2928	3112	5520	3435	2000	1580	1070	700
Erodosol	1600							240			
Districambosol	1012			4023			145				625
Aluviosol	300	920	1700	500	839	1500	3520	710	1250		900
Alosol	3900	80	2500	10500	5021	40		1032		1930	

Fig. 6.23. The areas and shares occupied by the soil types identified in localities from Brad Depression

7. CONCLUSIONS AND RECOMMENDATIONS

Worldwide, between 1961 and 2018, the average soil resources used in agriculture is equal to 4,817,663 thousand ha. In the European Union, there is an average of used soil resources equal to 423,843.73 thousand ha, calculated for the period 2009 - 2018, this registering a slightly downward trend in the analyzed period. In Romania, the evolution of soil resources used in agriculture for the same period (2009 - 2018) is characterized by a slightly downward trend, with an average of 13,761.80 thousand ha, of those intended for various lucrative purposes and forestry has averages equal to 23,005.50 thousand ha and 36,680.56 thousand ha, respectively, both showing a slightly upward trend.

Worldwide, over the whole period analyzed (1961 - 2018), the proportion of arable land used in total agricultural land is equal to an average of 28.28%, the proportion of cultivated land in total agricultural land shows an average of 30.63%, the proportion of land on which organic agriculture is practiced, from the total cultivated land registers a high variability, exceeding the threshold of 30% (CV = 31.57%), registering a median equal to 0.76%. The proportion of land resources occupied by primary forest in the total land resources allocated to forested land worldwide, presents an average of 31.97%, the proportion of forest planted from total forested land is equal to 6%, and the average proportion of land resources allocated to regenerated forest from total forested land, is equal to 94.19%.

The study of soils located in the Brad Depression carried out between 2018 and 2019, led to the characterization of 9 soil profiles, highlighting their membership in five classes (Antrisols, Cambisols, Cernisols, Luvisols and Protisols) which correspond to nine types and thirteen subtypes. From the point of view of their location, it is noted that Bulzeştii de Sus is the locality that includes all soil types identified in the Brad Depression, but in proportions that differ greatly from one soil type to another, but allosol and eutricambosol are predominant. The localities that include the fewest soil classes are those on whose territory three classes and four soil types have been identified. The localities where three soil classes have been identified are: Luncoiu de Jos, where allosol and eutricambosol predominate, Bucureşci where regosol predominates and Baia de Criş where eutricambosol predominates. The localities where four types of soil have been identified are: Brad town, where eutricambosol is predominant, Ribiţa commune, where alluvial and eutricambosol predominate and Criscior commune, where allosol predominates.

Taking into account the aspects revealed by the morphological and analytical characterization of the studied soil types and subtypes, it is considered appropriate to develop a standardized methodology for periodic monitoring of soil quality in the region, in order to identify early areas that could present risks to soil phenomena, degradation (decreased fertility, compaction, erosion, arid tendencies, excessive humidity, etc.). Early access to this type of information can be very important in order to take the necessary measures to avoid the occurrence of these phenomena.

The implementation of precision agriculture tools, which make use of IoT technologies, in order to monitor soil quality, both morphologically and analytically, is also recommended. This can be done by using drones and tools as GIS, GPS, etc..

It is recommended to analyze the appropriateness and adequacy of the land use categories identified in the Brad Depression, as well as the application of measures to correct the acidic reaction of the soil and/or the basic one, by applying appropriate amendments (based on calcium carbonate, gypsum, etc.). It is also recommended to practice amelioration fertilization, along with performing soil work designed to ensure an optimal aeration regime, to combat excess moisture and/or the tendency of aridization and destructuring.

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