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COMPARISON OF SYSTEMS FOR TAXONOMY AND CLASSIFICATION OF SOILS FOR DESCRIPTION OF SOME DEGRADATION PROCESSES OCCURRING IN THEM

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Abstract

The aim of this work is based on data from large-scale soil survey, and on our own research to try to systematize and evaluate the main and economically significant factors for degradation of the complex of Cinnamon forest soils (Chromic luvisols) located near the town of Svilengrad, southeast Bulgaria. On the basis of data from large-scale soil survey, which is mainly based on genetic method for soil taxonomy is made generalization of soil map data, as are kept the requirements for conformity of soil types according to classification of FAO and the International soil database. Separate soil units are evaluated about: the degree of development of soil erosion, particle size distribution, degree of dehumification and soil acidity to a level harmful for the main agricultural crops. In the discussed in this study, complex of Cinnamon forest soils, was found that the differentiation of soil types on the basis of an improved system for taxonomy and classification, used in the FAO classification, better reflects the extent and direction of the degradation process. This is achieved without explicit mention of any of the degradation processes in the name of the soil units.

Key words: *Chromic luvisols, classification, degradation, taxonomy.*

INTRODUCTION

In modern interpretations of the problem soil and land degradation is a term which is interpreted very broadly according to the context of the study. The term 'degradation' generally means reducing of the effective soil fertility, which is associated simultaneously with alteration of the morphology and composition of the soil.

The main degradation processes of soil, including those in Bulgaria are the massive in recent years erosion of the lands, acidification, pollution with harmful to plants mineral and organic components, reduction of soil organic matter, loss of biodiversity, salinisation, compaction, mechanical excavation, and waterlogging. These processes are subject of extensive study both in specialized soil literature and in the broad researches examining the soil cover and its capacity as a link in the chain of agricultural production (Dregne, 1992; Eswaran and Dumanski 1994; Fahnestock et al., 1953).

During the continuing in recent years tendency for reducing of effectively used lands, first are eliminated soils with low natural productivity that simultaneously are located in problematic demographic areas. Most of them are genetically acid soils in low-forest zone mainly greyish brownish and light gray pseudopodzolic forest soils in the northern Bulgaria and cinnamon forest soil with differentiated to different degree profile - in the southern. The prospect of using these lands is different and is often dictated by the degradation processes in them.

This work aims, based both on data from large-scale soil survey, and on our own research to make an attempt to systematize and evaluate the main economically significant factors of degradation of the complex of cinnamon forest soils located in part of the territory of the town Svilengrad. This aim is discussed in genetics and meliorative-technological aspects, as the main task is the problem of land degradation.

MATERIALS AND METHODS

The object of present study is the complex of Cinnamon forest soils situated in southeastern part of the lands of the town Svilengrad. By itself this region is quite diverse in terms of its geology, geotectonics, relief, climate and soils. Erosion of cinnamon forest soils in this part of Bulgaria occurs to different degrees and in

various forms and very often dictates the characteristics of microrelief, mechanical composition, reserves of soil organic matter, pH and other economically significant characteristics of the soil.
On the basis of data from large-scale soil survey and following the requirements for conformity of soil differences with improvements in FAO soil classification – World Reference Base for Soil Resources(WRBSR) is made generalization of data from large-scale soil map.
Differentiated and unified on this principle soil units are evaluated about the degree of development of soil erosion, degree of dehumification – soil organic carbon, according to ISO 14235:1998, particle size distribution - by pipette method (Trendafilov and Popova, 2007) and soil acidity (pH_{H2O} – Arinushkina, 1970) to a level harmful to major crops.
The degree of erosion within the boundaries of united soil differences is implemented in accordance with the data from large-scale soil mapping in which these data are defined by scales for assessment of water erosion using a mathematical model in Executive Environment Agency of Bulgaria (ExEA), based on Universal Soil Loss Equation (Hudson, 1993).

The other parameters for characterizing the degree of degradation within the united soil differences are established by analysis of soil samples situated in a reticule within the contours of the observed area Figure 1.

Table 1. Scale for estimation of predicted and actual risk of sheet water erosion

Predicted water erosion risk of soil		
Classes of predicted water erosion risk of soil		Predicted soil loss, t/ha/y
1	Very low	0 - 5
2	Low	5 - 10
3	Low to moderate	10 - 20
4	Moderate	20 - 40
5	Moderate to high	40 - 60
6	High	100 - 200
7	Very high	> 200
Actual water erosion risk of soil		
Classes of actual water erosion risk of soil		Actual soil loss, t/ha/y
1	Very low	< T *
2	Low	T - 3
3	Low to moderate	3 - 5
4	Moderate	5 - 10
5	Moderate to high	10 - 20
6	High	20 - 40
7	Very high	> 40
* Soil loss tolerance		

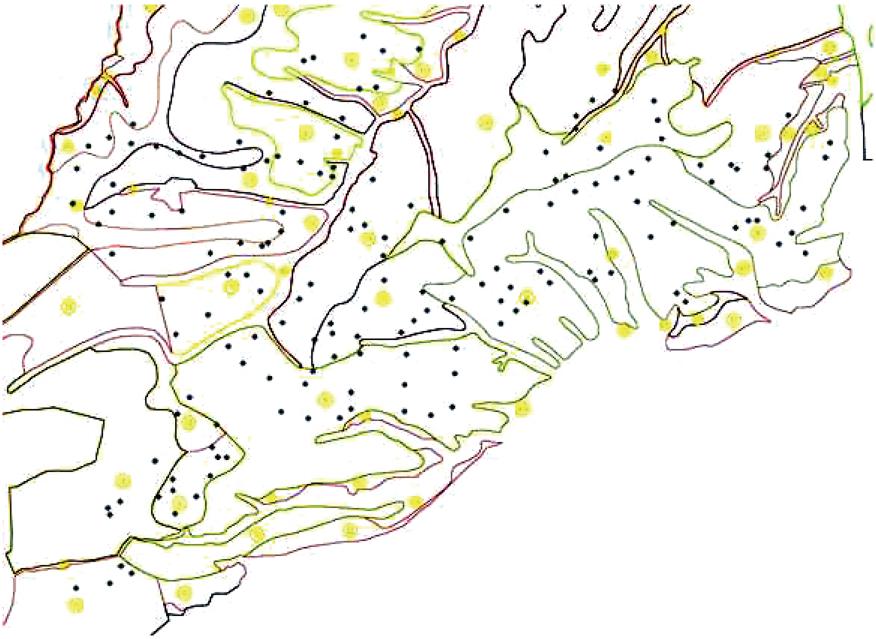

Figure 1. Situation of sampling points in the reticule

RESULTS AND DISCUSSIONS

Soil types

The officially accepted classification of soils in Bulgaria comprises soil differences, summarized in Table 2.

Classification of soils used in data from large-scale soil mapping is even more complicated and not always fully correspond to the taxonomy given in Table 2. The legend to the soil map (scale 1:25000 M) of studied area in Bulgaria, for example, is consist of 10 soil types, and its correlation with summarized taxonomic base (Table 2) is incomplete or is perceived default based on the genetic interpretation of the main taxa and sub-taxa. Because of these inconsistencies the classification systems do not gave an information about the presence of degradation processes and do not subordinated the factors and degradation processes, depending on their impact on the productivity and functionality of specific soil units.

Table 2. Part of the taxonomic list of soils in Bulgaria (Ninov, 2005)

Soil groups and sub-groups World reference base for soil resources (WRBSR)	Name according to "Improved classification system for soils in Bulgaria" 1992
Z O N A L S O I L S	
CHERNOZEMS	Chernozems
Calcic 35	*Calcareous and Typical*
Haplic 33	*Leached*
Luvic 34	*Degraded*
Gleyic 36	*Meadow*
PHAEOZEMS	Podzolized chernozems, Degraded chernozems, Dark-grey forest soils and Meadow chernozem-likes
Haplic 37	Podzolic chernozems
Calcic 38	*Meadow-chernozemics, calcareous*
Luvic 39	*Dark-grey forest*
Gleyic 40	*Meadow chernozem-likes*
VERTISOLS	Smolnitza Chernozem-smolnitza
	Leached
Eutric 18	*Calcareous*
Calcic 19	-
Gypsic 20	*Meadow*
Gleyic 21	
LUVISOLS	Gray forest, leached cinnamonic; cinnamon-likes
Haplic 41	*Brownish-gray (gray) forest*
Chromic 42	*Leached cinnamonic*
Calcic 43	*Gray forest, calcareous*
Vetric 44	*Cinnamonic-smolnitza-likes*
Albic 45	*Light-gray; highly leached to slightly podzolized*
Gleyic 47	*cinnamonic*
Rhodic 46	*Gray forest with gleyic B-horizon*
	Leached cinnamonic with red B-horizon
CAMBISOLS	
Chromic 25	Cinnamonic
Calcaric	*Typical*
	Calcareous
PLANOSOLS	
	Pseudopodzolic light-gray forest; Podzolic cinnamon
Eutric 48	forest; Cinnamon pseudopodzolic
Dystric 49	*Podzolic cinnamon or light-gray forest (pH > 5,2)*
	Light-gray forest, Cinnamon-podzolic, Podzolic-cinnamon
A Z O N A L S O I L S	*(pH < 5,2)*
LEPTOSOLS	
Lithic 13	
Umbric 14	Shallower than 50cm
	Lithosols
Rendzic 15	*Underdeveloped silicate soils (rankers); Shallow cinnamon*
	forest; Shallow gray forest
REGOSOLS	*Rendzinas (humic-calcareous)*
Eutric 10	
Dystric 11	Completely eroded soils
Calcaric 12	-
	-
	-

This requires the interpretation of factors and degradation processes to begin with a generalization of large-scale soil maps, based on accepted in our country table of correspondences of taxonomic units accepted in Bulgaria, with those adopted in FAO classification (WRBSR). The signs of degradation and the degree of development of the degradation process can be interpreted based on the already generalized map base that can be successfully used for monitoring of the degradation processes.

Soil units according to the large-scale soil survey, situated within the boundaries of studied region are:

- Moderately leached cinnamon forest soils, not eroded and slightly eroded, medium loam (5)[1]
- Moderately leached cinnamon forest soils, slightly eroded, medium loam (6);
- Highly leached to slightly podzolic cinnamon forest soils, not eroded and slightly eroded, medium loam (8);
- Highly leached to slightly podzolic cinnamon forest soils, slightly eroded, sandy loam, (9);
- Moderately leached cinnamon forest soils, moderately eroded, medium loam (11);
- Underdeveloped cinnamon forest soils, moderately eroded, sandy loam, slightly skeletal (14);
- Cinnamon forest soils, moderately and severely eroded, medium loam, slightly skeletal (17);
- Moderately leached cinnamon forest soils, moderately eroded, light clay (18);
- Moderately leached cinnamon forest soils, shallow, not eroded and slightly eroded, light loam, slightly skeletal (19);
- Moderately leached cinnamon forest soils, shallow, slightly eroded, light loam, slightly skeletal (20);

The situation of listed soil types on the area of the terrain is presented Figure 2.

On the basis of the morphological description, physico-chemical properties and brief characterization, and in view of the tasks of our investigation, the above described soil types, are summarized in accordance with the FAO international system for classification and taxonomy of soils - WRBSR (Table 2, first column).

As a result are separated four main soil differences, which situation on the terrain is presented in generalized soil map shown in Figure 3.

Degree of erosion

It is estimated the class of actual risk of sheet water erosion, regardless of the extent to which the erosion is already manifested within the boundaries of studied area.

Results are presented graphically in Figure 4. Between detached beforehand on the criteria of large scale soil survey data are established significant and statistically proven differences in the relation of soils into different erosion classes Table 1.

Erosion classes are coordinated well with the genetic origin of the soil to a certain part of the complex of cinnamon forest soils. With the highest grade of erosion and also homogeneous are undeveloped soil units, while the complex of shallow soils is relatively heterogeneous and generally less eroded.

In the generalized examination of the soil units according WRBSR (Figure 5), can be seen the following:

Relatively lowest degree of erosion is established for soils with a texture differentiated profile (Chromic luvisols). This coordinated with the concept of their formation. The difference between their degree of erosion with that of a well developed cinnamon soils with undifferentiated profile (Cambisols) is insignificant. The both groups have relatively degree of erosion in spite of soils with underdeveloped or shallow[3] profile.

Organic matter content

Differentiation of humus content in the surface horizons is proven influenced by soil type, both in soils, separated by genetic grounds, based on the classification in large-scale soil survey and in soil groups classified according to WRBSR.

From the genetically separated soils, the highest humus content is found in the deep moderate leached cinnamon forest soils. The original classification reflected in the legend of soil map the each soil detached in Figure 6 has different textural composition and different degree of erosion.

In a significant part of other genetically differentiated groups - for example between underdeveloped cinnamon forest soils and those with differentiated profile are not found differences in terms of humus content. A more detached humus distribution is observed in Figure 7, which shows the differentiation of humus in the cinnamon forest soil complex, where soils are divided into classes according to FAO.

Figure 2. Soil map of southeastern part of lands of Svilengrad (1:25000)

(5)[2] – Moderately leached cinnamon forest soils, not eroded and slightly eroded, medium loam; **(6)** – Moderately leached cinnamon forest soils, slightly eroded, medium loam; **(8)** – Highly leached to slightly podsolic cinnamon forest soils, not eroded and slightly eroded, medium loam; **(9)** – Highly leached to slightly podsolic cinnamon forest soils, slightly eroded, sandy loam; **(11)** – Moderately leached cinnamon forest soils, moderately eroded, medium loam; **(14)** – Underdeveloped cinnamon forest soils, moderately eroded, sandy loam, slightly skeletal; **(17)** – Cinnamon forest soils, moderately and severely eroded, medium loam, slightly skeletal; **(18)** – Moderately leached cinnamon forest soils, moderately eroded, light clay; **(19)** – Moderately leached cinnamon forest soils, shallow, not eroded and slightly eroded, light loam, slightly skeletal; **(20)** – Moderately leached cinnamon forest soils, shallow, slightly eroded, light loam, slightly skeletal.

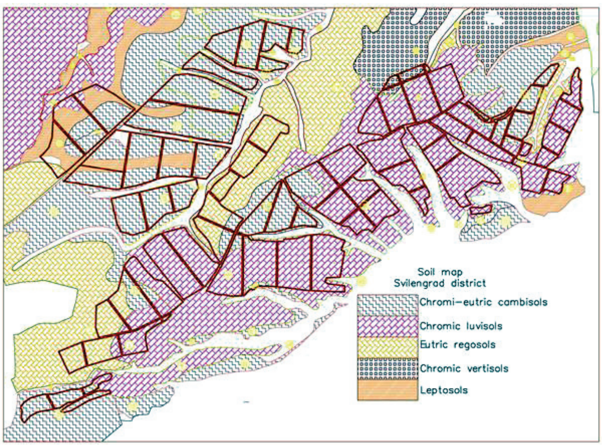

Figure 3. Generalized soil map of southeastern part of lands of Svilengrad

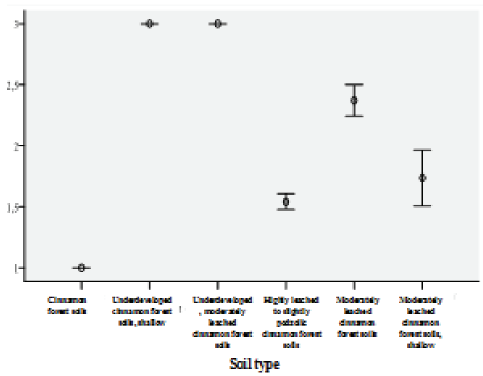

Figure 4. Class of actual risk of sheet water erosion of soil units detached according to the large-scale soil survey

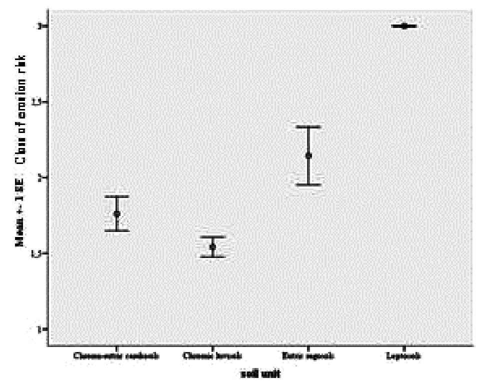

Figure 5. Class of actual risk of sheet water erosion of soil units detached according to FAO-WRBSR

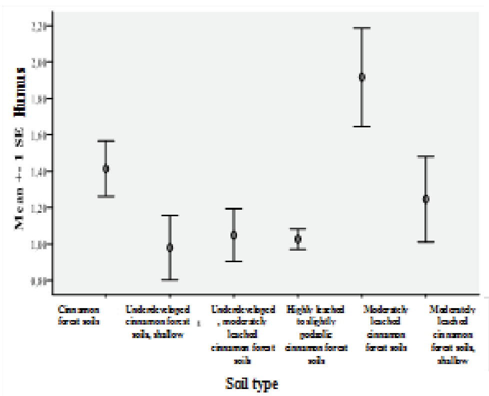

Figure 6. Humus content in surface horizon of soil units detached according to the large-scale soil survey

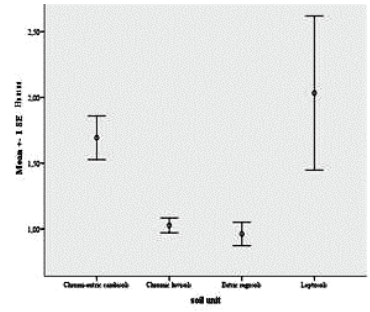

Figure 7. Humus content in surface horizon of soil units detached according to FAO-WRBSR

The change of the averages and the degree of variation very clear reflects the soil groups, differentiated according to FAO WRBSR. Figure 7 shows that relatively highest organic matter content, but in terms of highest degree of variation is established for the group of highly underdeveloped soils - Leptosols.

Obviously it comes to relatively young soils which in terms of their humus content are closest to their forest analogues. In the same interval changes the content organic matter in well developed cinnamon soils with undifferentiated profile - Chromi-eutric cambisols, while the humus content of texture differentiated Luvisols and Regosols is significantly and statistically proven lower.

Particle size distribution (soil texture)

Content of skeletal fraction

From genetically differentiated soils, the highest content of skeletal particles is determined for sub-taxa of underdeveloped soils, as the differences between them and other taxa are statistically proven (Figure 8). Certain gradation of skeleton content is established for soil classes detached according to FAO. In this classification system is determined very well expressed gradation from developed to underdeveloped soils in respect of the parameter 'skeletal content" (Figure 9).

Physical clay content

The content of clay is a key characteristic of textural composition of the soil. Changes in content of clay particles in the complex of cinnamon forest soils are shown in Figure 10 and Figure 11. The data show that soil affiliation to a particular taxon does not generate statistically proven differences in clay content.

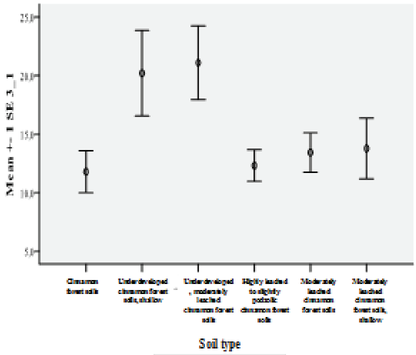

Figure 8. Content of skeletal fraction in soil units detached according to the large-scale soil survey

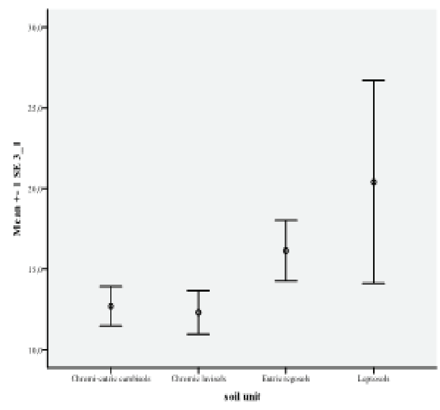

Figure 9. Content of skeletal fraction in soil units detached according to FAO-WRBSR

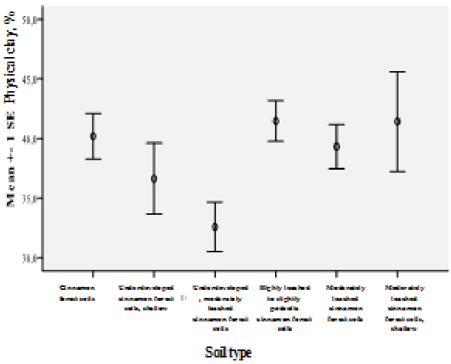

Figure 10. Content of physical clay in soil units detached according to the large-scale soil survey

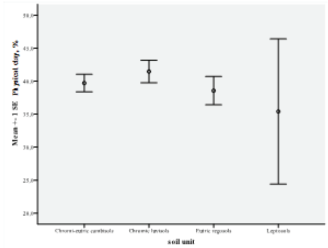

Figure 11. Content of physical clay in soil units detached according to FAO-WRBSR

Soil pH

The soil reaction (pH_{H2O}) is used as a criterion for soil acidity. The data are shown in Figure 12 and Figure 13.

The obtained results determine prevailing slightly acid reaction for most of the soil types. Between genetically detached soil units there are not determined significant differences in terms of soil pH.

For classes according to FAO significant differences are not determined only between underdeveloped and relatively young Leptisols and all other soil units. Probably this is due to relatively more preserved influence of the forest vegetation.

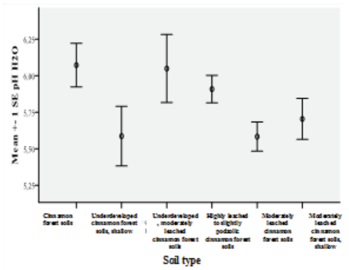

Figure 12. pH in soil units detached according to the large-scale soil survey

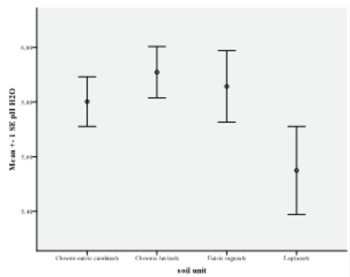

Figure 13. pH of soil units detached according to FAO-WRBSR

[1]Numbers in the legend of soil map scale M 1:25000
[2]Numbers in the legend of soil map M 1:25000
[3]Here can be understood also, secondary erosively shorten profiles.

CONCLUSIONS

The evaluation of parameters that characterize the degree of soil degradation, the trend of degradation processes and the degree of their development requires adequate differentiation of soil groups, with relatively uniform rate of development of the degradation process.

Differentiated with respect to degradation processes soil groups should be most relevant to the indications for differentiation of soil groups according to the accepted classification system.

At discussed in this study, complex of cinnamon forest soils, differentiation of soil units based on World reference base for soil resources of FAO better reflects the degree and the direction of the degradation processes.This is achieved without explicit reference to any of the degradation processes in the name of the soil units.

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