METHOD OF CORRELATION OF THE CURRENT ROMANIAN SOIL CLASSIFICATION SYSTEM SRTS-2012 WITH THE PREVIOUS SYSTEMS SRCS-1980 AND SRTS-2003. THE SRTS-2012+ SYSTEM

V. VLAD[1], N. FLOREA[1], M. TOTI[1], Victoria MOCANU[1]

[1] National Research and Development Institute for Soil Science, Agrochemistry and Environment Protection – ICPA Bucharest
virgil.vlad@icpa.ro

Abstract. *The soil classification system SRTS-2012, in use in Romania since 2013, was made correlated with the previous most recent two systems – SRCS-1980 (used in the period 1980-2002) and SRTS-2003 (used in the period 2003-2012). For that correlation, related to the diagnostic and taxonomic elements (terms) existing in SRTS-2012, some new terms and some modified terms were defined. In order to obtain accurate translation of the terms of the previous systems, three ways were used: (i) previous systems' terms having corresponding current system terms with negligible definition differences are directly translated into these corresponding standard SRTS-2012 terms, (ii) previous systems' terms having corresponding current system terms with non-negligible definition differences are translated into "modified" SRTS-2012 terms (variants of the corresponding terms) and (iii) previous systems' terms without appropriate corresponding current system terms are translated into new-defined terms. The previous systems' terms may be translated into one corresponding term or into a combination of terms, respectively a soil described in a previous system may be translated into a soil association. The opportunity of that correlation was used to introduce new terms for other needs: description of the "land conditions" (relief, hydrology and climate) and "association modes" (frequency, weighting) of soils, description of the "non-soil" areas to be represented on soil maps and other soil characterisations. A notation (specialised language) for mnemonic formalised description of soils is used to provide clear and unambiguous term translation and soil association definition. For that, mnemonic symbols (suggestive abbreviations easy to remember) are defined for each term. The SRTS-2012 soil classification system supplemented with the modified terms and the new terms defined as above (of which the main are given in the paper) is referred as the "SRTS-2012+" soil classification system, which totally has the following structure of diagnostic and taxonomic elements: 65 diagnostic horizons, 24 diagnostic properties, 11 diagnostic parent materials, 12 soil classes, one class of non-soils, 38 soil types, five non-soil types, 117 soil qualifiers, 13 non-soil qualifiers, 14 specifiers for soil characteristics, 61 soil particular characteristics and 306 other low level qualifiers (for defining the varieties, species, families, variants, land conditions and association modes of soils and non-soils).*

Key words: *soil classification, soil taxonomy, soil classification systems, soil classification system correlation, Romania*

INTRODUCTION

In the recent time, many countries have developed/modernised their national soil classification systems, such as the US (USDA SSS, 1999, 2014), Russia (SHISHOV et al., 2001), China (CRGCST, 2001), France (Baize & GIRARD, 2008), Hungary (MICHELI et al., 2014) and others. At the same time, the need of using unitary concepts, respectively a common language of international communication, a need increased by the present globalisation, has led to the development of international projects for unitary soil characterisation, description and classification: WRB system (World Reference Base for Soil Resources; IUSS WG-WRB, 2014; IUSS, 2010a) and USC system (Universal Soil Classification; GOLDEN et al., 2010; KRASILNIKOV et al., 2010; IUSS, 2010b). Development and evolution of the soil classification systems were determined on the one hand by the necessity to include scientific innovations

occurring in Soil Science and, on the other hand, by the needs for more diverse, more detailed, more specific and more quantitative soil/land information requested by the users.

Soil Science in Romania was within this evolving road, keeping pace with the international progress, through their own research, participating in international projects and developing and modernising the national soil classification system. Thus, in the last period, the Romanian System of Soil Classification SRCS-1980 (CONEA et al., 1980; FLOREA, 1982), the Romanian System of Soil Taxonomy SRTS-2003 (FLOREA & MUNTEANU, 2003; MUNTEANU & FLOREA, 2002; KRASILNIKOV & ARNOLD, 2009), the Field Guidelines for Soil Description (MUNTEANU & FLOREA, 2009) and the Romanian System of Soil Taxonomy SRTS-2012 (FLOREA & MUNTEANU, 2012; FLOREA, 2012) have been successively developed.

Need for correlation

1. During the application periods of the soil classification systems SRCS-1980 (1980 – 2002) and SRTS-2003 (2002 – 2012), the Romanian soil survey community elaborated a lot of soil descriptions for large territories in Romania. The documentations and databases resulted from these soil surveyes contain perennial information, which forms the main part of the "soil data bank" of Romania. Tens of thousands of soil profiles have been described and almost half of the country's agricultural area has been mapped and described at large scales. For example, in the most important work on the Romanian soils for the whole area of the country – the Soil Map of Romania at the scale 1:200,000 (FLOREA et al., 1963-1993, 1994) – the soil is described by using the SRCS-1980 system. The information contained in these works is fundamental to making decisions on various uses of soils/land in Romania a long future time, the works being remade with great difficulties because of the relatively high costs involved.

Due to that situation, the use/exploitation of these data implies to use in the same time – and sometimes in the same work – descriptions made in different soil classification systems, having rather different terminology, the differences between systems being determined by their evolving development/modernisation. These circumstances create difficulties in understanding and use of these soil descriptions, while the current soil classification system in force in Romania is the latest and most developed version – the SRTS-2012 system.

The publications defining the SRTS-2003 and SRTS-2012 systems contain some equivalences of their main taxonomic elements to those of the previous system SRCS-1980. These equivalences are general and they are not necessarily also vice-versa (from SRCS-1980 or SRTS-2003 to SRTS-2012).

Consequently, *there was imposed the necessity of developing a method and a tool to help efficiently the accurate translation (correlation) of the soil descriptions made in terms of the previous systems SRCS-1980 and SRTS-2003 into the descriptions using the terms of the current system SRTS-2012.*

2. This correlation was also needed *in order to translate* the new and old *soil descriptions into the WRB international soil classification system terminology*, required by international communication needs and by the INSPIRE Directive of the European Union (INSPIRE WG-Soil, 2011). Such a correlation/translation requests to use an unitary Romanian terminology, which can only be that of the SRTS-2012 system, currently in force.

3. *The soil as a system is defined by its intrinsic characteristics and its internal processes, as well as by its interrelations with "its external environment", consisting on the one hand of other land elements (relief, lithology, hydrology and climate) and, on the other hand, of other co-existing soils in landscape* (FLOREA et al., 1987). That imposes the need to ***complementarily*** *include in the classification*, in addition to the soil intrinsic characteristics, olso *the land conditions of the soil and the kind of its association with other soils in landscape.*

Indeed, all these aspects are required to be taken into account because in practice soil users also operate with these elements: with land-specific characteristics (other than those strictly of soil), as well as with characteristics of technological plots, which are of suitable size and often non-homogeneous as soil characteristics. Also, the need of soil mapping at smaller scales requires almost always grouping the different soils into soil unitary associations in order to be visibly plotted on maps.

The correlation of the SRCS and SRTS systems offered the opportunity to introduce and specify *complementary extensions of the soil classification systems* for defining and specifying the information on "*land conditions*" and "*association mode*" of soils.

4. In the Romanian classification systems, ***the soil*** as object of classification is "*a natural body resulting from the combined action of an assembly of pedogenetic factors on the upper part of the terrestrial crust, having its own organisation and features as reflected in their sequence of horizons named soil profile*" (FLOREA & MUNTEANU, 2012).

Given that in the soil maps of a territory also other areas that do not meet the definition of soil need to be represented, the notion of "***non-soil***" was introduced. It is defined as *any area of the terrestrial crust that does not meet the definition conditions of soil* (land under buildings, roads, water bodies, rock areas and so on). Introducing the notion of non-soil is in line with the approach of the WRB international soil classification system, where the soil has a broader definition than in the SRTS, namely "*any material within 2 m of the Earth's surface that is in contact with atmosphere, excluding living organisms, areas with continuous ice not covered by other material, and water bodies deeper than 2 m*" (IUSS WG-WRB, 2014).

The correlation of the soil classification systems SRCS and SRTS provided an opportunity to conventionally introduce and specify *the non-soils as complementary extensions of the soil classification systems.*

5. This opportunity of soil classification systems correlation also offered the possibility to complete the set of soil qualifiers with *other soil characteristics, not-specified in SRTS-2012 system*, that proved to be useful in various soil surveys, especially in soil mapping of large territories, such as the Soil Map of Romania at the scale 1:200,000.

6. Last but not least, the SRCS – SRTS correlation provided the opportunity to systematically synthesize knowledge on soil characterisation and to reclaim some possible ambiguities/inconsistencies in the notions and terms used by the Romanian soil classification systems.

***

In order to achieve the above set out objectives of correlation-extension, there was necessary to define new terms and modified terms (related to those existing in SRTS-2012), which were added to the SRTS-2012 system, *yielding a covering system named* "***SRTS-2012+***". The results of the correlation-extension work were included in a dictionary of correlated terms of the four systems (including SRTS-2012+), structured on categories of diagnostic and taxonomic elements as well as on categories of soils / non-soils defined at the type-subtype level (VLAD et al., 2014).

This paper presents the method of correlation of the soil classification system currently in force in Romania, SRTS-2012, with the previous systems SRCS-1980 and SRTS-2003. Also, the main new/modified terms introduced in SRTS-2012+ for the need of correlation, for describing the land conditions and association modes of soils, for describing the non-soil areas to be represented on soil maps and for other extensions are briefly presented.

THE METHOD OF CORRELATION

The analysis of the characteristics, structural elements and stepwise development of the soil classification systems SRCS-1980, SRTS-2003 and SRTS-2012 leads to a set of conclusions regarding the possibilities of correlating them:

There are differences – some very small (negligible) and some others that also can be considered negligible – between the definitions of diagnostic elements (horizons, properties, parent materials) in SRCS-1980, respectively in SRTS-2003, comparatively with the corresponding definitions in the SRTS-2012 system. At the same time, there are some diagnostic elements in the previous systems that do not exist in the SRTS-2012 system.

There are differences – some negligible and some others non-negligible (small, large and very large) – between different corresponding definitions of soil types in the three classification systems. Some soil types in a system were divided or, on the contrary, merged in other soil types in other systems. Some soil types were removed and other new soil types were defined when evolving from one system to another. Some soil types were moved to the next lower taxonomic level (of soil subtype), or even to the level of soil variety, while other soil types were scaled up from the level of soil subtype.

There are differences – some negligible (more or less), some other non-negligible – between different corresponding definitions of high or low level soil qualifiers in the three classification systems. Some high or low level soil qualifiers were removed when evolving from a classification system to another, many new ones were introduced, while others were transferred from a taxonomic level to another (higher or lower).

Summarizing, the diagnostic elements (horizons, properties, parent materials) and the taxonomic elements (soil types, soil qualifiers, soil characteristic specifiers, soil particular characteristics and other low taxonomic level qualifiers) of the soil classification systems SRCS-1980 and SRTS-2003, from the point of view of correlation with the SRTS-2012 system, can be grouped into three categories:

(I) elements (terms) that have a direct correspondence with one element of one type or another, respectively of one taxonomic level or another, of the SRTS-2012 system, having identical definitions or negligible definition differences;

(II) elements (terms) that have a "similarity correspondence" with one element of one type or another, respectively of one taxonomic level or another, of the SRTS-2012 system, with relatively small differences in definitions, but these differences can not be neglected that the equivalence accuracy to be acceptable;

(III) elements (terms) that do not have a similarity correspondence with any element defined in the SRTS-2012 system.

The highlighted differences between the three soil classification systems determine their terms not to be directly translated from one system to another with an acceptable approximation/accuracy, except the terms of the "I" category. For translating the terms of the "II" and "III" categories, some new information is needed (not acquired during the originating soil survey). In fact, it is necessary a re-classification based also on additional information, that can only be obtained through some additional soil surveys, which are usually relatively costly from point of view of financial, human and time resources involved – not always available.

To gain full and accurate use of existing older soil descriptions (made in terms of the soil classification systems SRCS-1980 and SRTS-2003) in a unified and coherent way with the current classification system, SRTS-2012, it was adopted the solution of extending this system by defining variants of its standard terms, named "***modified terms***", which directly correspond with the SRCS-1980/SRTS-2003 terms of the "II" category, and by defining "***new terms***"

according to the SRTS-2012 terminology, which directly correspond with the SRCS-1980/SRTS-2003 terms of the "III" category.

In this way, all the three categories of terms of the soil classification systems SRCS-1980 and SRTS-2003 can be translated accurately directly into terms or combinations of terms:

- the terms of the "I" category (with direct correspondence) are directly translated into standard terms of SRTS-2012 system;
- the terms of the "II" category (with similarity correspondence) are directly translated into modified SRTS-2012 terms;
- the terms of the "III" category (without appropriate correspondence) are directly translated into new terms (related to the SRTS-2012 system).

Using the standard terms, modified terms and new terms, a ***Dictionary of correlation*** of the diagnostic and taxonomic elements of the soil classification systems SRCS-1980 and SRTS-2003 with the SRTS-2012/2012+ system elements was built up (VLAD et al., 2014).

In order to provide clear and unambiguous translation definitions of the soil classification system terms and of the soils (soil typological units), especially of the soil associations (knowing that some SRCS-1980/SRTS-2003 soils are translated into soil associations), in the Dictionary of correlation the ***Notation for mnemonic formalised description of soils*** (VLAD, 2016) is used. It is a development and a generalisation of the method used for a formalised definition of the Legend of the Soil Map of Romania at the scale 1:200,000 (VLAD et al., 2012).

The Notation allows descriptions by formulas using strict rules, mnemonic symbols for taxonomic elements (suggestive abbreviations easy to remember) and specific "operators", ensuring in this way correct interpretation and easy "reading" of soil descriptions by users, with the added advantage that such formalised descriptions can be interpreted (processed) by computer software. Also, the Notation introduces a formalised coherent methodology for describing soil associations, extendable for the diversity of soils and of scales of their mapping. The formula of soil unit defined by the SRTS-2012 system, of course, can be further used whenever appropriate, being more compact (but at the same time more "hermetic").

THE SRTS-2012+ SOIL CLASSIFICATION SYSTEM

*The SRTS-2012 soil classification system supplemented with the modified terms and the new terms defined to directly translate all the terms of the SRCS-1980 and SRTS-2003 systems, to describe the complementary characteristics regarding land, soil association and others, as well as to describe areas of non-soils is referred to hereinafter as the "**SRTS-2012+**" soil classification system.*

The modified SRTS-2012 terms introduced in SRTS-2012+ as direct equivalents of SRCS-1980/SRTS-2003 terms are intended to be applied ***only for*** using the soil surveys developed in the past by applying the SRCS-1980 or SRTS-2003 systems and ***only when*** those soil surveys do not provide enough information for applying (translating into) standard SRTS-2012 terms.

Many soil qualifiers of high and low taxonomic level newly introduced in SRTS-2012+ referring to different specific soil characteristics may be used as needed in different soil surveys together with the standard SRTS-2012 qualifiers.

The new/modified terms of the SRTS-2012+ were defined in order to be direct equivalents of the SRCS-1980/SRTS-2003 terms that have no such equivalents in SRTS-2012 or the differences are non-negligible. Where the differences were considered negligible new/modified terms were not defined, but these differences were specified in the Dictionary. Two cases of neglecting were taken into consideration: (a) the differences between definitions

are minor and (b) the areas of concerned soils in Romania are negligible. These neglects were specified in the Dictionary.

The modified terms of the SRTS-2012+ system are identified by the names, respectively by the symbols (codes), of the corresponding standard SRTS-2012 terms that were modified, which are added at the end with an apostrophe character <'> ("*first*"), or a quote character <"> ("*second*"), or the character <^> (read here "*third*"). For example, <*vertic'*> is a modified version of the standard SRTS-2012 qualifier <*vertic*>. The end character <^> identifies the modified terms that are specific to SRTS-2003 system (with one exception: <*batigleic*^> = <*gleizat*> in SRCS-1980).

In the case of simplified translations *(which supports weaker accuracy)* ***the end characters*** *"first", "second" and "third" from the modified terms nomenclature* ***may be neglected*** *(removed) and in this way* ***direct translations are obtained, which use only standard SRTS-2012 terms*** *(and possibly new ones).*

In order to translate the SRCS-1980/SRTS-2003 soil descriptions, it was aimed at finding simple descriptions, respectively simple formulas, as equivalents. Consequently, in the cases of translation where using existing standard terms would result in complicated names and formulas, some modified terms or/and, if necessary, new terms were defined, as for example: *hiperdistric* (*oligobasic* in SRCS-1980), *hiperfolic* (*Foliosol* soil type in SRTS-2003), *hiperscheletic/hiperprundic* (*scheletic/prundic* in SRTS-2003), *mezoscheletic*, *geoerodic* and others.

Some of the modified and new terms defined for SRTS-2012+ are not disjunctive from all related standard SRTS-2012 terms (they are partly overlapped). They are disjunctive and they fully cover the Romanian soil domain only if they are used as a subset equivalent to all related SRCS-1980 terms, respectively SRTS-2003 terms. For example, the qualifiers *rendzinic', rendzinic" şi rendzinic^* are not disjunctive from the qualifier *rendzinic*, while the qualifiers *nodulocalcaric*, *cernoziomoid*, *argilic* (clayic), *lutic* (loamic), *siltic*, *psamic* (arenic), *spodic* and *mlastinos* (marshy) are disjunctive to the other SRTS-2012 qualifiers.

The information on the land conditions of soil (characteristics of relief, hydrology and climate) and on the mode of associating the soil in soil associations (frequency, weighting, typology etc.) is conventionally regarded as forming two "***complementary*** ***low taxonomic levels/categories*** added in extension of the existing taxonomic hierarchy of the SRTS systems. These categories are named "***land conditions***", respectively "***association mode***" of soil. Adding the land conditions transforms *soil unit* into *land unit*, occasionally named "*soil-land unit*". The land conditions and the association mode are defined each of them by a set of ***low level qualifiers***, named "***complementary***", which in their turn are defined using attributes (value classes) of specific indicators.

In the SRTS-2012+ system ***new soil types*** *(related to SRTS-2012)* ***were not defined****, only modified soil types were defined.*

However, ***five types of non-soils*** were added in SRTS-2012+. They are conventionally considered as forming ***the 13-th class*** in the highest level category of the classification system hierarchy. A set of ***new complementary qualifiers*** for defining ***subtypes of non-soils*** were introduced. The non-soil types are identified by codes formed by two characters, of which first is the character <#> and the second an uppercase letter. The qualifiers for defining non-soil subtypes are identified by codes of two lowercase letters. For characterising the non-soils also some appropriate soil qualifiers (high/low level) may be used, as for example for specifying rocks or anthropogenic deposits.

Some supplementary characteristics of soils and of non-soils that cannot be specified by system's defined terms may be specified in the form of free synthetic "***comments***" that are enclosed between two characters tilde "~" and placed in the end of soil descriptions.

In the ***names/descriptions of soils*** (soil units) the term names consisting of several words (usually the case of low level qualifiers) are separated between them by a comma (",") followed by a space (" "). For that reason the names of such terms do not contain commas, which was replaced with explicit linking words (e.g. and, or, or/and). If necessary, the compound names may use a dash ("-") without adjacent spaces between the linked words (e.g. <lutos-nisipos> = <loam-sand> = <sandy loam>).

Certain terms, usually secondary qualifiers and/or the main low level qualifiers may be enclosed between parentheses in the soil names/description ["("...")"].

The ***low taxonomic level qualifiers*** are formed by soil particular characteristics and by qualifiers obtained by assigning certain value classes to indicators characterising the soil/land. Unlike the symbols (codes) of soil types and high level qualifiers, which are well-established in the SRCS/SRTS systems as formed by two letters (uppercase, respectively lowercase), ***mnemonic symbols*** *(codes)* formed by three or more lowercase letters were established for the low level qualifiers in the SRTS-2012+ system.

The mnemonic symbols of the most soil particular characteristics are simple symbols. In the case of the low level qualifiers consisting of value classes of soil attribute indicators, ***compound mnemonic symbols*** are established. They are formed by concatenating two parts – indicator subcode and value class subcode – separated by the colon concatenation operator (":") without adjacent spaces, for example: <adafr:mi> = <apa freatica la mica adancime> = <**ad**ancime **a**pa **fr**eatica: **mi**ca> = <groundwater depth: small>).

In the case of soil indicators whose values could be numbers, instead of value class subcode the average value specific to the soil may be given (the default measurement unit being assumed), as in the following examples: <ka:35> = <content of 35% calcium carbonate>; <p:80> = <weighting of 80% of the soil in each areal of the soil association>.

In the case of soil indicators that may have more than one value classes for a soil unit, compound codes/subcodes may be formed by concatenating the simple subcodes of the respective classes, as for example: <sa:slmo> = <**sa**linizat **sl**ab si/sau **mo**derat> = <salinisation: low and/or moderate>. Also, the compound subcodes for rocks and parent materials may specify different particular cases by additionally concatenating specific subcodes, such as: k = carbonatic, nk = non-carbonatic, r = recent, nr = non-recent, cmp = compact, scns = <non-consolidated and/or low consolidated>, etc.

When more complex definition for some low level qualifiers are needed, compound mnemonic symbols may be formed by concatenating some other simple mnemonic symbols using as concatenation operators some association or alternative operators, without adjacent spaces, as defined by the *Notation for mnemonic formalised description of soils* (VLAD, 2016). In these cases, in order not to interfere with the association/alternative operators possibly used for describing soil associations, the compound symbols are "encapsulated" by enclosing them between two semicolon encapsulation operators (";"), as for example: <;tx:nslu@pfns@pf;> = <**te**x**x**tura **n**i**s**ipoasa-**lu**toasa si/sau **p**ra**f**oasa-**n**i**s**ipoasa si/sau **p**ra**f**oasa> (= <soil texture: loamy sand and/or sandy silt and/or silt>), where the "@" ("or-exclusive", and/or) operator is used .

The main new and modified SRTS-2012+ terms are:

1. <u>*Diagnostic elements*</u>*:*
   a) *Diagnostic horizons:* one modified horizon (vertic') and three new horizons (A ocric-molic, A ocric-umbric, R rendzinic).

b) Diagnostic properties: two modified terms (scheletic^, subscheletic^) and two new terms (alic and rendzinic' properties).

c) Diagnostic parent materials: one modified term (scheletic-calcarifer^ material).

2. Soil types / non-soil types:

- 11 modified terms (Cernoziom', Cernoziom'', Cernoziom^, Faeoziom', Faeoziom'', Faeoziom^, Rendzina', Rendzina^, Pelosol^, Gleiosol', Solonet');
- four new non-soil types (Rocks, Anthropogenic Deposits, Waters, Buildings) and a new special category of land (Urban Land), conventionally considered as non-soil type, to be used in soil maps for identifying the not-surveyed territories inside of localities (urban or rural, soils and non-soils).

3. Soil qualifiers and specifiers of soil characteristics:

a) Qualifiers (high taxonomic level) of soil / non-soil:

- 24 modified qualifiers (baticalcaric', baticalcaric'', hiperdistric, folic', hiperfolic, gleic', batigleic', batigleic'', batigleic^, amfigleic', amfigleic'', hiperprundic, rendzinic', rendzinic'', rendzinic^, pararendzinic', pararendzinic'', salinic', salsodic', hiperscheletic, mezoscheletic, sodic', vertic', vertic^);
- nine new qualifiers (cernoziomoid, mlastinos, geoerodic, argilic, lutic, siltic, psamic, nodulocalcaric, spodic);
- 13 complementary qualifiers of non-soil (compact rocks, limestones/dolomites, stones/boulders, gravels, sands, unconsolidated rocks, rivers, natural lakes, artificial lakes, domestic buildings, industrial buildings, roads, railways).

The qualifier <cernoziomoid> was introduced to distinguish the former Cernoziomoid Soils of SRCS-1980 (Phaeozems in SRTS) from other Phaeozems that do not meet the definition criteria of the Cernoziomoid Soils.

The qualifier <mlastinos> (marshy) was introduced for marshy Gleysols (marsh/swamp, submerged/semi-submerged soils, surface water most of the year, completly gleyied: Gr horizon from surface and reducing colours > 90%) in order to be distinguished from typical Gleysols (rarely submerged a small part of the year, reducing colour of 50 – 90%).

The qualifier "geoerodic" identifies the former Erodisols (SRCS-1980) originating from natural erosion (without significant human interventions).

Given the practice's needs of soil characterisation and given the development of the WRB international soil classification system, four high level qualifiers regarding soil texture were introduced/re-introduced: <*argilic*> (clayic, equivalent to the former SRTS-2003 <pelic>, with changed name in order not to create confusion with respect to the soil type Pelosol), <*psamic*> (arenic, existing in SRTS-2003), <*lutic*> (loamic) and <*siltic*>.

The qualifiers *nodulocalcaric* and *spodic* were re-introduced to offer the possibility of translating the respective characteristics from SRTS-2003 and also of specifying them in current descriptions.

b) Specifiers of soil characteristics: three new specifiers: <*ne..*> (not ..., non-..., without ..., excepting ...), <*orto..*> (soil meets all definition criteria of the respective qualifier throughout entire soil profile section of definition) and <*para..*> (similar to ...).

4. Low level qualifiers:

a) Soil particular characteristics (for defining soil varieties): three modified terms (hipohistic^, subrendzinic^, moder') and seven new terms (cloruric, sulfatic, sulfuratic, proxihipoteric, branciog, mor', acid mull).

b) Other low level qualifiers for defining soil varieties: eight modified terms (gleyisation: puternic' / strong', moderat', slab' / low'; stagno-gleyisation: moderat', slab' / low', in adancime' / in depth; sodicisation: foarte puternic' / very strong', puternic') and six new terms (B natric at great and/or very great depth; non-calcaric; emers / emerged; gleyisation: moderat puternic, moderat' puternic'; deep and/or very deep soil).

c) Low level qualifiers for defining soil species: five new terms as soil texture categories: textura siltica (siltic), sol prafos-nisipos (sandy silt), textura lutica (loamic), sol lutos-nisipos-slabprafos (low-silty sandy loam) and sol lutos-nisipos-extrafin (very-fine-sandy loam).

Texture subclass "lut nisipos prafos" (silty sandy loam) of SRTS-2012 was sub-divided into two subclasses – "praf nisipos" (sandy silt) and "lut nisipos extrafin" (very-fine-sandy loam) – the first belonging to the class of siltic soil, and the second to lutic (loamic) soil. The subclass "lut nisipos slabprafos" includes the subclasses of coarse/medium/fine-sandy loams of SRTS-2012.

d) Low level qualifiers for defining soil families: 28 new terms: 20 parent *materials*, one class of parent material *granulometry* (skeletic organic deposit), five *parent/underlying rocks* and two new low level qualifiers for characterisation of the sand deposits (continental, marine).

e) Low level qualifiers for defining soil variants: 20 new terms: three land-uses, eight human-induced modifications of soil, nine degrees of soil pollution (including excavation and covering).

The indicator "Soil pollution degree" of SRTS-2012 was redefined by rafining into 10 classes (low level qualifiers) based on two criteria:

- *cumulative quantitative and/or qualitative decreasing of yield* of the most sensitive crop/land-use (of those current in Romania) caused by *all* pollutions/excavations/coverings that affect the soil (related to the yield obtained in not-affected soil conditions);
- intensity of soil pollution/excavation/covering - related to the reference values of the most sensitive crop/land-use (of those current in Romania).

The soil pollution/excavation/covering degree is defined as the highest class resulted from the application of the two criteria. The soil pollution/excavation/covering intensity is defined using the reference values for the content of pollutants in soil or for the soil degradation, in the layer of 0-25 cm from soil surface (normal value and alert and intervention thresholds for different land-uses), as well as using the cumulative pollution/excavation/covering index, defined as the sum of specific indices referring to the existing soil pollutions/excavations/coverings, related to the intervention thresholds.

f) Complementary low level qualifiers for defining land conditions of soil: 98 new terms: six main landforms, five vegetation zones, 30 meso-/micro-relief forms, three landslides classes, five gully erosion classes, seven slope gradient classes, four classes of land exposition to sun, 10 classes of soil natural covering (with stone fragments, boulders, reeds etc.), seven grounwater table depth classes, three land flooding classes, 10 classes of average annual air temperature and eight classes of average annual cumulative precipitations.

g) Complementary low level qualifiers for defining soil association mode: five new terms: two classes of soil frequencies in the areals of the soil association (f:) (frequently, seldom) and three classes of soil weightings/percents in an association areal (p:) (dominant, codominant, especially).

The qualifiers regarding the two indicators may be missing in the soil association definition and in these cases standard default values are assumed: f: = 90 – 100% and p: has different standard default values depending on the number of soils in association and on the order place of respective soil in association definition: 60 – 40%, 50 – 30 – 20%, 40 – 30 – 20 – 10%, 30 – 25 – 20 – 15 – 10%.

h) Low level qualifiers for non-soils: Six soil qualifiers (garbic, mixic, reductic, rudic, spolic, urbic) are reused for characterising the anthropogenic deposits and two new low level qualifiers for defining soil families are reused for characterising the sand deposits.

***

The above-presented developments determined the following total structure of diagnostic and taxonomic elements of the SRTS-2012+ system: 65 diagnostic horizons, 24 diagnostic properties, 11 diagnostic parent materials, 12 soil classes, one class of non-soils, 38 soil types, five non-soil types, 117 soil qualifiers, 13 non-soil qualifiers, 14 specifiers for soil characteristics, 61 soil particular characteristics and 306 other low level qualifiers (for defining the varieties, species, families, variants, land conditions and association modes of soils and non-soils).

CONCLUSIONS

1. At present, the use of the main part of the existing Romanian soil information implies to know the terminology of the current soil classification system, SRTS-2012, and also the terminologies of the previous two systems used in Romania, SRCS-1980 and SRTS-2003. Some differences exist between the terms of these systems, which resulted from their evolving development/modernisation. Consequently, the use in the same time of these different terminologies raises some difficulties to users.

2. The use of the existing large volume of documentations and of the existing large databases that are described by applying the previous two soil classification systems imposed the necessity of accurate translation of these soil descriptions into terms of the current system, because the alternative is to remade the respective soil surveys with some difficulties caused by the relatively high costs involved.

3. In order to obtain accurate translation of the terms of the previous systems, three ways were used: (i) previous systems' terms having corresponding current system terms with negligible definition differences are directly translated into these corresponding standard SRTS-2012 terms, (ii) previous systems' terms having corresponding current system terms with non-negligible definition differences are translated into "modified" SRTS-2012 terms (variants of the corresponding terms) and (iii) previous systems' terms without appropriate corresponding current system terms are translated into new-defined terms. The previous systems' terms may be translated into one corresponding term or into a combination of terms, respectively a soil described in a previous system may be translated into a soil association.

4. The correlation was a good opportunity to make some developments to the current soil classification system aiming at other needs: some term adaptation to the WRB international soil classification system, introduction of two new complementary low taxonomic level categories characterising "land conditions" (relief, hydrology and climate) and "association modes" (frequency, weighting) of soils, description of the "non-soil" areas to be represented on soil maps and other soil characterisations.

5. In order to provide clear and unambiguous term translation and soil association definition, the use of a notation (specialised language) for mnemonic formalised description of soils proved to be an efficient method. For that, mnemonic symbols (suggestive abbreviations

easy to remember) are defined for each term, including compound mnemonic symbols, which use special characters to concatenate their subcode components.

6. The SRTS-2012 soil classification system supplemented with the modified terms and the new terms defined for system correlation and development forms the SRTS-2012+ soil classification system.

BIBLIOGRAPHY

BAIZE, D., GIRARD., M.C., (coord.), (2008). *Référentiel pédologique 2008*. l'Association Française pour l'Etude du Sol, Ed. Quae, 2009, Paris-Versailles, 405 p.

CONEA, A., FLOREA, N., PUIU, S., (coord.), (1980). *Sistemul Român de Clasificare a Solurilor*. ICPA Bucureşti, 174 p.

CRGCST, (2001). *Chinese soil taxonomy*. Cooperative Research Group on Chinese Soil Taxonomy, Beijing and New York, USA, Science Press.

FLOREA, N., (1982). *Romanian system of soil classification*. Revue Roumaine de Géographie, tom 26, Ed. Academiei României, Bucureşti, p. 71-79.

FLOREA, N., BĂLĂCEANU, V., RĂUŢĂ, C., CANARACHE, A., (coord.), (1987). *Metodologia elaborării studiilor pedologice - Partea I, II, III*. ICPA, Ministerul Agriculturii, Metode Rapoarte Îndrumări, nr.20, Bucureşti, 191+349+226 p.

FLOREA, N., BĂLĂCEANU, V., MUNTEANU, I., ASVADUROV, H., CONEA, A., OANCEA, C., CERNESCU, N., POPOVĂŢ, M., (coord.), (1963-1993). *Harta Solurilor României, scara 1:200.000.* Institutul Geologic / IGFCOT, 1963 – 1993, Bucureşti, 50 sheets.

FLOREA, N., BĂLĂCEANU, V., MUNTEANU, I., ASVADUROV, H., CONEA, A., OANCEA, C., (coord.), (1994). *Harta Solurilor României, scara 1:200.000. Legenda Generală. (Soil Map of Romania, scale 1:200,000. General Legend).* Ed. IGFCOT, Bucureşti, one sheet.

FLOREA, N., MUNTEANU, I., (2003). *Sistemul Român de Taxonomie a Solurilor – SRTS, Ediţia 2003.* Ed. Estfalia, Bucureşti, 182 p.

FLOREA, N., MUNTEANU, I., (2012). *Sistemul Român de Taxonomie a Solurilor – SRTS, Ediţia 2012.* Ed. Sitech, Craiova, 206 p.

FLOREA, N., (2012). *Soil Taxonomy in Romania*. Soil Horizons, doi 10.2136/sh12-01-0006, 7 p.

GOLDEN, M., MICHELI, E., DITZLER, C., ESWARAN, H., OWENS, P., ZHANG, G., MCBRATNEY, A., HEMPEL, J., MONTANARELLA, L., SCHAD, P., (2010). *Time for a Universal Soil Classification*. Proceedings of the 19th World Congress of Soil Science, Symposium 1.4.1. Classification and information demand, p.48-51, Brisbane, Australia, Published on DVD.

INSPIRE WG-Soil, (2011). *INSPIRE Data Specification on SOIL – Guidelines. D2.8.III.3_v2.0.* INSPIRE Thematic Working Group SOIL, 10+186 p.

IUSS WG-WRB, (2014). *World Reference Base for Soil Resources 2014. International soil classification system for naming soils and creating legends for soil maps.* IUSS/FAO, IUSS Working Group WRB, World Soil Resources Reports no.106, FAO, Roma, 189 p.

IUSS, (2010a). *Commission 1.4. Soil Classification, Working Group 1.1. World Reference Base*. International Union of Soil Sciences, http://www.iuss.org/.

IUSS, (2010b). *Commission 1.4. Soil Classification, Working Group 1.6. Universal Soil Classification.* International Union of Soil Sciences, http://www.iuss.org/.

KRASILNIKOV, P., ARNOLD, R., (2009). *Soil classification of Romania*. In: Krasilnikov, P., Ibanez, J.J., Arnold, R., Shoba, S. (eds.). *A Handbook of Soil Terminology, Correlation and Classification*. *Earthscan*, London, Sterling, Chapter 17, p.176-181.

KRASILNIKOV, P., ARNOLD, R. W., IBANEZ, J-J., (2010). *Soil classifications: their origin, the state-of-the-art and perspectives*. Proceedings of the 19th World Congress of Soil Science, Symposium 1.4.2. Soil classification - benefits and constraints to pedology, p.19-22, Brisbane, Australia, Published on DVD.

MICHELI, E., FUCHS, M., LANG, V., SZEGI, T., DOBOS, E., (2014). *The Method of development and structure of the Modernized Hungarian Soil Classification System*. The 20th World Congress of Soil Science (June 2014, Jeju, Korea), C1.4-2, O90-3.

MUNTEANU, I., FLOREA, N., (2002). *Present-day status of Soil Classification in Romania*. In: Micheli, E., Nachtergaele, F.O., Jones, R.J.A., Montanarella, L. (eds.), Soil Classification 2001, EC, JRC, European Soil Bureau, Research Report No. 7, EUR 20398 EN, p. 55-62.

MUNTEANU, I., FLOREA, N., (2009). *Ghid pentru descrierea în teren a profilului de sol şi a condiţiilor de mediu specifice.* ICPA Bucureşti, MAPDR, Ed. Sitech, Craiova, 230 p.

SHISHOV, L.L., TONKONOGOV, V.D., LEBEDEVA, I.I., GERASIMOVA, M.I., (eds.), (2001). *Russian soil classification system*. Moscow, V.V. Dokuchaev Soil Science Institute.

USDA SSS, (1999). *Soil Taxonomy: A basic system of soil classification for making and interpreting soil surveys, Second edition.* Soil Survey Staff, USDA-NRCS, Agr. Handbook 436, Washington DC, 869 p.

USDA SSS, (2014), *Keys to Soil Taxonomy, 12th edition.* Soil Survey Staff, USDA, Natural Resources Conservation Services, Washington DC, 360 p.

VLAD, V., FLOREA, N., MUNTEANU, I., SECELEANU, I., (2012). *Method for a formalised definition of the Legend of the Soil Map of Romania at the scale 1:200,000.* Ştiinţa Solului / Soil Science, 3-rd Series, Journal of the Romanian National Society of Soil Science, ISSN 0585-3052, vol. XLVI, nr. 1, p. 15-31.

VLAD, V., FLOREA, N., TOTI, M., MOCANU, V., (2014). *Corelarea sistemelor de clasificare a solurilor SRCS şi SRTS. Sistemul SRTS+*. Ed. Sitech, Craiova, 191 p.

VLAD, V., (2016). *Notation for mnemonic formalised description of soils* (in preparation for Geoderma).