Conversion of Some Soil Types, Subtypes, and Varieties between the Taxonomic Classification System of Soils of the Czech Republic and the World Reference Base for Soil Resources

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Abstract: The article illustrates the compatibility of the Czech Republic Taxonomic Soil Classification System validated in the CR with the international World Reference Base for Soil Resources. It utilises the archive data on the soil types, subtypes, and varieties from the General survey of agricultural soils in the Czech Republic and soil profiles from new soil survey on the pilot area of Litoměřice district. It indicates the possibilities of the future refinement of both systems.

Keywords: refinement of soil classification systems; soil conversions; TKSP CR, WRB

The World Reference Base for Soil Resources (WRB) had already progressed under the auspices of the International Union of Soil Sciences (IUSS) since the eighties of the last century, and in 1998 it shaped up into a form of the concrete proposal (Deckers 2000; ISSS-ISRIC-FAO 1998; IUSS Working Group WRB 2006, 2007; Nachtergaele *et al.* 2000). In that year, WRB was adopted as the European Union system for soil correlation. The structure, concepts and definitions of WRB are strongly affected by the Legend of the Soil Map of the World on the scale of 1:5 000 000 (FAO-UNESCO 1974; FAO-UNESCO-ISRIC 1990), which borrowed an approach through the diagnostic horizons and features of Soil Taxonomy of the United States Department of Agriculture.

The Taxonomic Classification System of Soils of the Czech Republic (TKSP CR) connects with previous classification systems (mainly with Morphologic-genetic soil classification system of the CSFR – Hraško *et al.* 1991) and besides WRB is itcompatible with other international standards of soil classification (Soil Taxonomy, Référentiel pédologique, Systematik der Böden Deutschland). It includes not only agricultural and forest soils, but also soils of anthropogenic origin. It has arisen for the purpose of easier harmonisation of the Czech map and database background papers with the sources from other European countries. The system has been constantly applied and further improved during the current innovative soil survey of the CR (Němeček *et al.* 2001).

The article briefly introduces the basic principles of both systems used, compares them and facilitates the orientation in WRB. With the help of some soil types, subtypes, and varieties conversions between these systems, it refers to the possibilities of mutual refinement in the framework of ongoing convergence of both systems.

MATERIAL AND METHODS

At soil conversions from TKSP CR to WRB, as well as from WRB to TKSP CR, more possibilities arise at most of the soil profiles, e.g. in the dependence on the parent material. By reason of a limited extent of the article soil types, subtypes, and varieties, conversions from TKSP CR to WRB are elaborated for the soils occurring in the Litoměřice district (Table 1) and for those in the surroundings of the district (Table 2). The tables contain the selection of soils according to the background papers from the Research Institute for Soil and Water Conservation, Prague.

The archive data of the General survey of agricultural soils from the years 1960–1970 contained the basic material. On the pilot area, the data were also statistically verified and digitised. At the level of the soil types, subtypes, and varieties, the conversions from the original Genetic-agronomic soil classification into the valid TKSP CR (Sládková 2007) pointed out the need of several refinements of the valid soil classification system, which soil survey of Litoměřice district was also directed to in 2006. The examples of the soil profiles conversions between TKSP CR and WRB were completed by laboratory analyses of several soil pits, coming from this soil survey. In term of natural conditions in general, the Litoměřice district area is characterised by average annual air temperature 7.0–8.5°C, average annual sum of precipitation 489–617 mm (Němeček *et al.* 1965), and by volcanic activity in the geologic past.

In order to describe the methodical approach, the main principles are mentioned of the applied soil classification systems as presented further.

The taxonomic units of WRB are defined by means of the measurable and observable diagnostic horizons, basic soil classification identifiers which are defined by combination of characteristic soil properties, and (or) soil materials.

WRB is represented by:

– 32 referential soil groups
– prefixes and suffixes, which define different soil units (allowed qualifiers of the defining terms)

In the case of application, more than two qualifiers can be connected with brackets after the standard defining term (e.g. strongly humic properties and colour). In addition, the defining term of a soil unit can express the depth (from shallow to deep: Epi, Endo, Bathi) and intensity (from slight to strong: Proto, Para, Hypo, Ortho and Hyper) of the features, which are fundamental for the soil cultivation selection. In multi-sequential soil profiles, qualifying terms such as Cumuli or Thapto describe cumulation or burying.

The referential groups of WRB are sorted in the following order: Histosols (HS), Anthrosols (AT), Technosols (TC), Cryosols (CR), Leptosols (LP), Vertisols (VR), Fluvisols (FL), Solonetz (SN), Solonchaks (SC), Gleysols (GL), Andosols (AN), Podzols (PZ), Plinthosols (PT), Nitisols (NT), Ferralsols (FR), Planosols (PL), Stagnosols (ST), Chernozems (CH), Kastanozems (KS), Phaeozems (PH), Gypsisols (GY), Durisols (DU), Calcisols (CL), Albeluvisols (AB), Alisols (AL), Acrisols (AC), Luvisols (LV), Lixisols (LX), Umbrisols (UM), Arenosols (AR), Cambisols (CM), Regosols (RG).

The Taxonomic Classification System of Soils applied in the Czech Republic (Němeček *et al.* 2001 and further e.g. Němeček & Kozák 2001; Vokoun *et al.* 2003) is a hierarchical system, which, in the context with the world development of this area, differentiates the parent materials, diagnostic horizons, and soil properties.

The following taxonomic categories exist:

Referential classes (groups) **of soils** (15): the main units of the world classification systems.

Soil types (28): basic units of the Czech system, characterised by the presence of certain diagnostic horizon or horizons and/or marked diagnostic features. A name: a noun with ending-zem or other, no-sol.

Subtypes: distinctive modifications of the soil type, expressing the central conception of the type, transitions to other types, marked lithological-genetic features (arenic, pelic, etc.), marked debasification, salinisation, sodisation, distinctive hydromorphic and anthropic influences. The name: an adjective placed after the name of the soil type.

Varieties: less distinctive modifications of the soil type, features of forest soils up to 0.25 m. The name: specification of the adjective describing the subtype.

Main soil forms: determined by the type of the parent material and by its lower categories.

Local soil forms: distinguished according to the details of particle size distribution, skeleton content, slope (exposition, inclination, the form of slope).

Ecological phases: distinguished according to humus forms (forest soils)

Degradation phases: degree of the soil degradation (mainly errosive wash, accumulation, superimposition), contamination (exceeding the limits of the background values of contaminants), intoxication (surpassing of the critical values of contaminants contents and their mobility for certain transfer path).

RESULTS AND DISCUSSION

When presenting the main principles of both systems applied, the opportunity arises to describe the differences in a better way. The main difference is that

WRB is composed on a key approach, whereby the TKSP CR is based on the taxonomic system.

In the case a soil is classified according to WRB, it is necessary to describe the individual soil profiles, to inspect the whole key until it is possible to identify the referential soil groups by means of the parent material and soil profile properties, and to describe the profiles satisfactorily by the help of prefixes and suffixes. Rather an extensive selection of prefixes and suffixes is significant for accurate soil profile description and for the WRB structure being suitable for future data computer processing. At present, the stated procedure on diagnosing a large number of soil pits is rather time consuming for day by day work.

In TKSP CR, the definition of every referential class of soil and the set and description of lower classification categories are noted in the same place. To be classified in some subcategory under the appropriate referential class and to be described more accurately, the soil profile should firstly comply with the characteristics of the referential class. Finally, the possibility of the description is limited. The only data related to the referential class can prevent the application of suitable subcategories.

During the soil classification systems correlation and soil profiles conversions between these systems is it necessary to keep permanently in mind that WRB lays stress mainly on the properties of the individual soil profiles, whereby TKSP CR emphasises rather the properties of higher categories, especially the referential classes of soils. It is possible to deduce that extending WRB is simpler compared to TKSP CR. The referential soil group or prefixes and suffixes can be more easily added to a key than, for example, new referential class of soils to TKSP CR, which should be carefully integrated and complexly linked to other categories, because of the strict abiding by mutual exclusivity of individual categories.

Table 1 contains drafts for the soil types, subtypes, and varieties conversions between TKSP CR (Němeček *et al.* 2001) and WRB (ISSS-ISRIC-FAO 1998; IUSS Working Group WRB 2006, 2007) in the Litoměřice district. Table 2 shows the conversions of the soils in the closest surroundings of the district.

The soils, described in Tables 1 and 2, are classified into these referential soil groups of WRB (arranged according to their order in the key): Histosols, Anthrosols, Leptosols, Vertisols, Fluvisols, Gleysols, Podzols, Planosols, Stagnosols, Chernozems, Phaeozems, Albeluvisols, Luvisols, Arenosols, Cambisols, Regosols. Some soil types and subtypes in the Litoměřice district and in surroundings conform, even without any consideration of the parent materials, to the referential basics of the two WRB soil groups (Luvizem stagnic, Pseudoglej modal, Chernice gleyic, Regozems stagnic, and gleyic and mainly the former Rendzinas profiles, ordered according to TKSP CR into different soil types).

Strongly anthropogenically influenced soils of Litoměřice district and in the surroundings contain only small amounts of artifacts and keep the characteristics of the original referential groups of soils. Therefore, these soils are not classified into the referential group Technosols; only the qualifier Technic is used.

For some soil groups in the WRB system, the supplementation with the following prefixes and suffixes appears as useful:

Histosols – Mesotrophic (ms);

Leptosols – Melanic (me) – so far, there were only Mollic (mo) or Humic (hu) in WRB 1998 and 2007; Arenic/soil pit of Pararendzina cambic arenic in Sládková (2008a);

Fluvisols – Luvic (lv);

Podzols – Ferric (fr) – so far, there were only Ortsteinic (os) in WRB 2007, Humic (hu);

Planosols – Humic (hu) – in WRB 1998 and 2007 it offered from humic horizons only those anhydromorphic (molic and umbric), that do not come into question in the case of the Czech soil type ‘Stagnogley’, its some profiles could be included in the referential soil group Planosols;

Phaeozems – Fluvic (fv), Histic (hi), Natric (na) – so far, there were only Sodic (so) in WRB 1998 and 2007, Humic (hu);

Luvisols – Orthic (or);

Cambisols – Luvic (lv), Spodic (sd); Melanic (me) – so far, there were only Mollic (mo) in WRB 1998 or Humic (hu) in WRB 2007; Arenic /soil pit of Kambizem arenic – mentioned below/

Regosols – Melanic (me) – so far, there were only Humic (hu) in WRB 1998 and 2007, Chernic (ch).

The following conversions of the soil profiles on the basis of the data of the new soil survey in the Litoměřice district demonstrate the measure of detail by the monitored soil classification systems by means of soil horizons comparison. The examples come from four cadastres in the Litoměřice district. Soil pits of Chernozem carbonated come from cadastre Slatina, Chernozem modal from Řepnice, Regozem pelic from Úštěk, Kambizem arenic from

Table 1. Soil types, subtypes, and varieties conversions between TKSP CR (2001) and WRB (1998, 2007) in Litoměřice district

TKSP CR CULS Prague (2001)	Sign.	WRB ISSS-ISRIC-FAO (1998); IUSS Working Group WRB (2007)	Sign.
'Regozem' modal	RGm	Haplic Regosol (1998, 2007)	ha RG
'Fluvizem' modal	FLm	Haplic Fluvisol (1998, 2007) Eutric Fluvisol (1998), Haplic Fluvisol (Eutric) (2007)	ha FL eu FL, ha FL (eu)
Fluvizem gleyic	FLq	Gleyic Fluvisol (1998, 2007)	gl FL
Fluvizem carbonated	FLc	Calcaric Fluvisol (1998), Haplic Fluvisol (Calcaric) (2007)	ca FL, ha FL (ca)
Chernozem 'modal'	CEm	Calcic Chernozem (1998, 2007), Haplic Chernozem (1998, 2007)	cc CH, ha CH
Chernozem 'luvic'	CEl	Luvic Chernozem (1998, 2007)	lv CH
Chernozem 'carbonated'	CEc	Orthicalcic Chernozem (1998, 2007)	cco CH
Chernozem carbonated 'slightly (deep) stagnic'	CEcg'	Calcic Chernozem (1998), Hypoendostagni-calcic Chernozem (2007)	ca CH, wstn ca CH
Chernozem 'arenic' or 'pelic'	CEr, CEp	Chernic Regosol (1998, 2007); Areni-humic Regosol (1998), Haplic Regosol (Humic Arenic) (2007) Humic Regosol (1998), Haplic Regosol (Humic Clayic) (2007)	ch RG; ar hu RG, ha RG (hu ar) hu RG, ha RG (hu ce)
'Chernice' modal	CCm	Fluvi-gleyic Phaeozem, Haplic Phaeozem (1998, 2007)	fv gl PH, ha PH
Chernice modal carbonated	CCmc'	Calcaric Phaeozem (1998), Haplic Phaeozem (Calcaric) (2007)	ca PH, ha PH (ca)
Chernice modal slightly peated	CCmo'	Histo-humic Phaeozem (1998), Histic Phaeozem (Humic) (2007) Histo-humic Gleysol (1998), Histic Gleysol (Humic) (2007)	hi hu PH, hi PH (hu) hi hu GL, hi GL (hu)
'Sedozem' modal	SEm	Greyic Phaeozem (1998, 2007)	gz PH
Sedozem luvic	SEl	Luvi-greyic Phaeozem (1998, 2007)	lv gz PH
'Hnedozem' modal	HNm	Orthic Luvisol (1998, 2007), Haplic Luvisol (1998, 2007)	or LV, ha LV
Hnedozem modal slightly (deep) stagnic	HNmg'	Hypoendostagni-orthic Luvisol (1998, 2007), Hapli-hypoendostagnic Luvisol (1998, 2007)	wstn or LV, ha wstn LV
Hnedozem luvic	HNl	Albic Luvisol (1998, 2007)	ab LV
Hnedozem stagnic	HNg	Stagnic Luvisol (1998, 2007)	st LV
Hnedozem luvic stagnic	HNlg	Stagni-albic Luvisol (1998, 2007)	st ab LV
'Luvizem' stagnic	LUg	Stagnic Albeluvisol (1998, 2007), Stagni-albic Luvisol (1998, 2007)	st AB, st ab LV
'Kambizem' modal 'eubazic' or 'euthrophic'	KAme', KAmb'	Eutric Cambisol (1998), Haplic Cambisol (Eutric) (2007)	eu CM, ha CM (eu)

Table 1 to be continued

TKSP CR CULS Prague (2001)	Sign.	WRB ISSS-ISRIC-FAO (1998); IUSS Working Group WRB (2007)	Sign.
Kambizem modal slightly stagnic	KAmg’	Hypostagni-eutric Cambisol (1998), Hypostagnic Cambisol (Eutric) (2007)	wst eu CM, wst CM (eu)
Kambizem luvic	KAl	Luvic Cambisol (1998, 2007) Luvi-eutric Cambisol (1998), Luvic Cambisol (Eutric) (2007)	lv CM lv eu CM, lv CM (eu)
Kambizem melanic stagnic euthrophic	KAngb‘	Melani-stagni-eutric Cambisol (1998), Melani-stagnic Cambisol (Eutric) (2007) Humi-stagni-eutric Cambisol (1998), Stagnic Cambisol (Humic Eutric) (2007)	me st eu CM, me st CM (eu) hu st eu CM, st CM (hu eu)
Kambizem melanic slightly stagnic euthrophic	KAng’b’	Melani-hypostagni-eutric Cambisol (1998), Melani-hypostagnic Cambisol (Eutric) (2007) Humi-hypostagni-eutric Cambisol (1998), Hypostagnic Cambisol (Humic Eutric) (2007)	me wst eu CM, me wst CM (eu) hu wst eu CM, wst CM (hu eu)
Kambizem melanic euthrophic	KAnb’	Melani-eutric Cambisol (1998), Melanic Cambisol (Eutric) (2007) Humi-eutric Cambisol (1998), Haplic Cambisol (Humic Eutric) (2007)	me eu CM, me CM (eu) hu eu CM, ha CM (hu eu)
Kambizem stagnic	KAg	Stagnic Cambisol (1998, 2007)	st CM
‘Pseudogley’ modal	PGm	Dystric Planosol (1998), Haplic Planosol (Dystric) (2007) Haplic Stagnosol (2007)	dy PL, ha PL (dy) ha SG
‘Gley’ modal	GLm	Eutric Gleysol (1998), Haplic Gleysol (Eutric) (2007) Haplic Gleysol (1998, 2007)	eu GL, ha GL (eu) ha GL

Table 2. Soil types, subtypes, and varieties conversions between TKSP CR (2001) and WRB (1998, 2007) for soils in surroundings of Litoměřice district

TKSP CR CULS Prague (2001)	Sign.	WRB ISSS-ISRIC-FAO (1998); IUSS Working Group WRB (2007)	Sign.
'Ranker' modal	RNm	Hyperskeleti-dystric Leptosol (1998), Hyperskeletic Leptosol (Dystric) (2007)	hk dy LP, hk LP (dy)
Rendzina modal	RZm	Rendzic Leptosol (1998, 2007) Calcaric Regosol (1998), Haplic Regosol (Calcaric) (2007)	rz LP ca RG, ha RG (ca)
Rendzina melanic	RZn	Melani-rendzic Leptosol (1998, 2007) Melani-calcaric Regosol (1998), Melanic Regosol (Calcaric) (2007) Humi-rendzic Leptosol (1998), Rendzic Leptosol (Humic) (2007) Humi-calcaric Regosol (1998), Haplic Regosol (Calcaric Humic) (2007)	me rz LP me ca RG, me RG (ca) hu rz LP, rz LP (hu) hu ca RG, ha RG (ca hu)
Rendzina 'melanic leached'	RZnv	Melani-dystri-rendzic Leptosol (1998), Melani-rendzic Leptosol (Dystric) (2007) Melani-dystri-calcaric Regosol (1998), Melanic Regosol (Calcaric Dystric) (2007) Humi-dystri-rendzic Leptosol (1998), Rendzic Leptosol (Humic Dystric) (2007) Humi-dystri-calcaric Regosol (1998), Haplic Regosol (Calcaric Humic Dystric) (2007)	me dy rz LP, me rz LP (dy) me dy ca RG, me RG (ca dy) hu dy rz LP, rz LP (hu dy) hu dy ca RG, ha RG (ca hu dy)
Rendzina 'cambic'	RZk	Rhodi-rendzic Leptosol (1998, 2007) Rhodi-calcaric Regosol (1998), Rhodic Regosol (Calcaric) (2007)	ro rz LP ro ca RG, ro RG (ca)
Regozem modal slightly (deep) stagnic	RGmg'	Hypoendostagnic Regosol (1998, 2007), Hapli-hypoendostagnic Regosol (1998, 2007)	wstn RG, ha wstn RG
Regozem stagnic	RGg	Stagnic Regosol (1998, 2007), Endostagnic Arenosol (2007)	st RG, stn AR
Regozem gleyic	RGq	Gleyic Regosol (1998), Endogleyic Regosol (2007) Gleyic Arenosol (1998), Endogleyic Arenosol (2007)	gl RG, ng RG gl AR, ng AR
Fluvizem stagnic	FLg	Stagnic Fluvisol (1998, 2007)	st FL
'Smonice' modal	SMm	Pellic Vertisol (1998), Haplic Vertisol (Pellic) (2007) Calcaro-pellic Vertisol (1998), Haplic Vertisol (Calcaric Pellic) (2007)	pe VR, ha VR (pe) ca pe VR, ha VR (ca pe)
Chernozem 'chernic'	CEx	Chernic Chernozem (1998)	ch CH
Chernice modal 'peated'	CCmo'	Histic Phaeozem (1998, 2007)	hi PH
Chernice gleyic	CCq	Gleyic Phaeozem; Fluvi-mollic Gleysol (1998, 2007)	gl PH, fv mo GL
Hnedozem luvic slightly (deep) stagnic	HNlg'	Hypoendostagni-albic Luvisol (1998, 2007) Hapli-hypoendostagni-albic Luvisol (1998, 2007)	wstn ab LV ha wstn ab LV
Luvizem modal	LUm	Haplic Albeluvisol (1998, 2007)	ha AB
Luvizem modal slightly stagnic	LUmg'	Hypostagnic Albeluvisol (1998), Hapli-hypostagnic Albeluvisol (2007)	wst AB, ha wst AB

Table 2 to be continued

TKSP CR CULS Prague (2001)	Sign.	WRB ISSS-ISRIC-FAO (1998); IUSS Working Group WRB (2007)	Sign.
Kambizem modal 'mesobazic'	KAma'	Dystric Cambisol (1998), Haplic Cambisol (Dystric) (2007) Eutric Cambisol (1998), Haplic Cambisol (Eutric) (2007)	dy CM, ha CM (dy) eu CM, ha CM (eu)
Kambizem modal slightly (deep) gleyic	KAmq'	Bathihypogleyi-eutric Cambisol (1998), Bathihypogleyic Cambisol (Eutric) (2007)	dwgl eu CM, dwgl CM (eu)
Kambizem luvic stagnic	KAlg	Stagni-luvic Cambisol (1998, 2007)	st lv CM
Kambizem luvic slightly stagnic	KAlg'	Hypoendostagni-luvic Cambisol (1998, 2007)	wstn lv CM
Kambizem gleyic	KAq	Gleyic Cambisol (1998), Endogleyic Cambisol (2007)	gl CM, ng CM
Kambizem 'dystric podzoled'	KAdz'	Spodi-dystric Cambisol (1998), Spodic Cambisol (Dystric) (2007)	sd dy CM, sd CM (dy)
Kambizem dystric podzoled slightly stagnic	KAdz'g'	Hypostagni-spodi-dystric Cambisol (1998), Hypostagni-spodic Cambisol (Dystric) (2007)	wst sd dy CM, wst sd CM (dy)
Kambizem dystric stagnic	KAdg	Stagni-dystric Cambisol (1998), Stagnic Cambisol (Dystric) (2007)	st dy CM, st CM (dy)
Kambizem dystric slightly stagnic	KAdg'	Hypostagni-dystric Cambisol (1998), Hypostagnic Cambisol (Dystric) (2007)	wst dy CM, wst CM (dy)
Kambizem dystric gleyic	KAdq	Gleyi-dystric Cambisol (1998), Endogleyic Cambisol (Dystric) (2007)	gl dy CM, ng CM (dy)
Kambizem dystric slightly (deep) gleyic	KAdq'	Bathihypogleyi-dystric Cambisol (1998), Bathihypogleyic Cambisol (Dystric) (2007)	dwgl dy CM, dwgl CM (dy)
'Kryptopodzol' modal or arenic	KPm, KPr	Spodi-dystric Cambisol (1998), Spodic Cambisol (Dystric) (2007)	sd dy CM, sd CM (dy)
Kryptopodzol gleyic	KPq	Gleyi-spodic Cambisol (1998), Endogleyi-spodic Cambisol (2007)	gl sd CM, ng sd CM
Podzol modal 'ferric'	PZmz'	Hapli-ferric Podzol (1998, 2007), Haplic Podzol (1998), Hapli-ortsteinic Podzol (2007)	ha fr PZ, ha PZ, ha os PZ
Podzol modal ferric slightly (deep) stagnic	PZmz'g'	Hypoendostagnic Podzol (1998), Hapli-hypoendostagni-ortsteinic Podzol (2007)	wstn PZ, ha wstn os PZ
Podzol stagnic ferric or humic	PZgz', PZgh	Stagni-ferric Podzol (1998, 2007), Stagnic Podzol (1998), Stagni-ortsteinic Podzol (2007); Humi-stagnic Podzol (1998), Stagnic Podzol (Humic) (2007)	st fr PZ, st PZ, st os PZ; hu st PZ, st PZ (hu)
Podzol gleyic ferric or humic	PZqz', PZqh	Gleyi-ferric Podzol (1998, 2007), Gleyic Podzol (1998), Gleyi-ortsteinic Podzol (2007); Humi-gleyic Podzol (1998), Gleyic Podzol (Humic) (2007)	gl fr PZ, gl PZ, gl os PZ; hu gl PZ, gl PZ (hu)

Table 2 to be continued

TKSP CR CULS Prague (2001)	Sign.	WRB ISSS-ISRIC-FAO (1998); IUSS Working Group WRB (2007)	Sign.
Podzol ‘humic’	PZh	Humic Podzol (1998), Haplic Podzol (Humic) (2007), Ferri-humic Podzol (1998), Ferric Podzol (Humic) (2007)	hu PZ, ha PZ (hu), fr hu PZ, fr PZ (hu)
Podzol humic slightly (deep) stagnic	PZhg’	Humi-hypoendostagnic Podzol (1998), Hypoendostagnic Podzol (Humic) (2007)	hu wstn PZ, wstn PZ (hu)
‘Stagnogley histic’	SGo	Histic Stagnosol (2007); Histo-humic Planosol (1998), Histic Planosol (Humic) (2007)	hi ST; hi hu PL, hi PL (hu)
Gley modal slightly peated; Gley ‘aquic’	GLmo‘; GLq	Histo-humic Gleysol (1998), Histic Gleysol (Humic) (2007), Histic Gleysol (1998, 2007); Anthraquic Gleysol (1998, 2007)	hi hu GL, hi GL (hu), hi GL; aq GL
Gley histic	GLo	Histic Gleysol (1998, 2007)	hi GL
‘Organozem fibric’	ORf	Fibric Histosol (1998, 2007)	fi HS
Organozem ‘mesic’	ORm	Mesotrophic Histosol (1998, 2007)	ms HS
Organozem ‘sapric’	ORs	Sapric Histosol (1998, 2007)	sa HS
Organozem gleyic	ORq	Folic Histosol (Petrogleyic) (1998, 2007)	fo HS (py)
‘Antropozem’	AN	Anthrosol (1998, 2007); Technic Leptosol (2007); Technic Fluvisol (2007); Technic Cambisol (2007); Technic Regosol (2007)	AT; te LP; te FL; te CM; te RG

cadastre Levín (Sládková 2007, 2008a). Within the framework of an attempt at TKSP CR refinement, the survey has been focused predominantly on the Rendzina soil type and then on some properties of Chernozems and Kambizems.

TKSP CR
CEc – Chernozem carbonated
SN – calcareous marls
WRB
cc CH (gz ce) – Calcic Chernozem (Greyic Clayic)
calcareous marl

Soil profile stratigraphy:		TKSP CR	WRB
1	0–16 cm	Apk	Ak
2	16–42 cm	Ack	Ak
3	42–55 cm	ACk	ACk
4	> 55 cm	Ck	Ck

The results of laboratory analyses are described in Table 3.

TKSP CR
CEc – Chernozem carbonated
SN – calcareous marls
WRB
cc CH (gz ce) – Calcic Chernozem (Greyic Clayic)
calcareous marl

Soil profile stratigraphy:		TKSP CR	WRB
1	0–9 cm	Apk	Ak
2	9–39 cm	Ack	Ak
3	39–57 cm	ACk	ACk
4	> 57 cm	Ck	Ck

The results of laboratory analyses are described in Table 3.

TKSP CR
CEc – Chernozem carbonated
SN/SP – double parent material of calcareous marls and loesses
WRB
cc CH (gz) – Calcic Chernozem (Greyic)
calcareous marl and loess

Soil profile stratigraphy:		TKSP CR	WRB
1	0–14 cm	Apk	Ak
2	14–59 cm	Ack	Ak
3	59–75 cm	ACk	A/Ck
4	75–183 cm	Ck	Ck (calcareous clay)
5	> 183 cm	Dk	Dk (loess)

The results of laboratory analyses are described in Table 4.

TKSP CR
CEm – Chernozem modal
PSc/SC – double parent material of calcareous sandstones and carbonated slope desposits
WRB
ha CH – Haplic Chernozem
calcareous sandstone and carbonated slope desposits

Soil profile stratigraphy:		TKSP CR	WRB
1	0–31 cm	Ack	Ak
2	31–54 cm	ACk	ACk
3	54–87 cm	Ck	Ck (calcareous sand)
4	> 1 m	Dk	Dk (carbonated slope deposit)

The results of laboratory analyses are described in Table 4.

TKSP CR
RGp – 'Regozem pelic'
SC – marlites
WRB
ha RG (ca eu ce) – Haplic Regosol (Calcaric Eutric Clayic)
marlite

Soil profile stratigraphy:		TKSP CR	WRB
1	0–33 cm	Apk'	A
2	> 33 cm	Ck	Ck

The results of laboratory analyses are given as the pit No. 9 in Table 1 in Sládková (2010).

TKSP CR
KAr – Kambizem arenic
sŠR – psefitic silitic sediments
WRB
ha CM (eu sl) – Haplic Cambisol (Eutric Siltic)
psefitic silitic sediment

Soil profile stratigraphy:		TKSP CR	WRB
1	0–28 cm	Ad	A
2	28–35 cm	Bv	B
3	> 35 cm	C	C

WRB does not allow prefix/suffix Arenic by the referential soil group Cambisols.

The results of laboratory analyses are described in Table 5.

These soil horizons occur within the scope of the soil profiles mentioned above:

TKSP CR
A – humic horizon
Ack – anhydromorphic chernic humic horizon with the carbonate content of bivalent ($^{2+}$) cations – carbonated (over 1–3%), event. strongly carbonated (over 3%)
Ak – humic horizon with the carbonate content of cations $^{2+}$– carbonated (over 1–3%), event. strongly carbonated (over 3%)
Ap – plough layer (topsoil)
Apk – plough layer (topsoil) with the carbonate content of cations $^{2+}$– carbonated (over 1–3%), event. strongly carbonated (over 3%)

Table 3. Laboratory analysis concerning soil pits of Chernozems carbonated – CEc from the soil survey of Litoměřice district in 2006

	CEc 1				CEc 2			
	horizont (cm)				horizont (cm)			
	Apk (0–16)	Ack (16–42)	ACk (42–55)	Ck (> 55)	Apk (0–9)	Ack (9–39)	ACk (39–57)	Ck (> 57)
Soil properties and characteristics								
Clay < 0.001 mm (%)	33.70	34.60	28.50	28.40	37.60	39.30	33.60	24.20
Clay < 0.002 mm (%)	45.00	46.40	38.80	38.40	49.00	50.20	47.40	39.10
Part. size I < 0.01 mm (%)	68.40	68.20	64.00	64.60	70.60	72.40	73.50	69.20
< 0.02 mm (%)	77.20	77.70	72.90	71.80	81.50	82.60	83.50	77.10
< 0.05 mm (%)	92.30	91.30	90.80	91.10	94.20	94.30	95.60	88.80
Part. size II 0.01–0.05 mm (%)	23.90	23.00	26.90	26.50	23.60	22.00	22.10	19.60
Part. size III 0.05–0.25 mm (%)	6.00	7.40	8.60	8.50	4.70	4.70	4.20	10.70
Part. size IV 0.25–2 mm (%)	1.60	1.30	0.60	0.40	1.20	1.00	0.20	0.50
pH active (–)	7.55	7.71	7.87	8.04	7.95	7.86	8.05	8.22
pH potential exchangeable (–)	7.20	7.27	7.35	7.83	7.34	7.37	7.57	7.76
Carbonates (%)	34.00	35.00	56.00	52.00	19.00	22.00	38.00	48.00
Cox (%)	1.78	1.66	0.62	0.26	2.06	1.94	1.42	0.30
θ_{mom} (% mass)	24.73	–	–	–	19.71	–	–	–
θ_{mom} (% vol.)	30.24	–	–	–	32.33	–	–	–
θ_{MKK} (% vol.)	37.87	–	–	–	32.34	–	–	–
ρ_z (g/cm^3)	2.67	–	–	–	2.73	–	–	–
$\rho_{d\ red}$ (g/cm^3)	1.22	–	–	–	1.64	–	–	–
P (% vol.)	54.21	–	–	–	39.92	–	–	–
Vz (% vol.)	23.97	–	–	–	7.59	–	–	–
K_{MKKVZ} (% vol.)	16.34	–	–	–	7.58	–	–	–
θ_{ns} (% vol.)	43.47	–	–	–	36.65	–	–	–
θ_{BV} (% vol.)	19.40	–	–	–	12.90	–	–	–
Potential (cmol/kg)								
CEC	24.96	25.39	17.90	14.15	31.18	30.79	27.07	14.94
S	31.19	32.09	27.72	22.83	36.87	39.33	37.98	24.08
K	1.35	0.90	0.58	0.67	1.18	0.70	0.59	0.51
Na	0.51	0.54	0.58	0.57	0.50	0.52	0.51	0.51
Mg	1.51	1.95	2.84	3.36	1.45	1.46	1.38	1.00
Ca	27.73	28.62	23.59	18.12	33.65	36.54	35.41	21.92
Al	0.09	0.08	0.13	0.11	0.09	0.11	0.09	0.14
Efficient (cmol/kg)								
ECEC	26.62	26.17	18.43	14.07	33.13	32.92	31.12	15.42
S	31.13	33.15	25.18	19.91	36.92	40.49	36.20	20.44
K	1.46	1.01	0.69	0.73	1.24	0.76	0.64	0.60
Na	0.50	0.55	0.58	0.58	0.50	0.63	0.61	0.65
Mg	1.36	1.93	2.73	3.24	1.38	1.49	1.40	1.05
Ca	27.71	29.58	20.97	15.24	33.73	37.54	33.44	18.04
Al	0.10	0.08	0.21	0.12	0.07	0.07	0.11	0.10

Notes to Tables 3–5: potential: extract of 0.01M $BaCl_2$ buffered by TEA to pH 8.1; efficient: extract of not buffered 0.01M $BaCl_2$; soil samples were elaborated in the Central laboratories of the Research Institute for Soil and Water Conservation in Prague

Table 4. Laboratory analysis concerning soil pits of Chernozem carbonated – CEc and Chernozem modal – CEm from the soil survey in Litoměřice district in 2006

	CEc 3				CEm		
	horizont (cm)				horizont (cm)		
	Apk (0–14)	Ack (14–59)	ACk (59–75)	Ck (75–183)	Ack (0–31)	ACk (31–54)	Ck (54–87)
Soil properties and characteristics							
Clay < 0.001 mm (%)	43.60	33.50	34.70	29.30	19.30	20.30	8.40
Clay < 0.002 mm (%)	51.30	39.70	41.50	36.30	23.10	23.60	10.40
Part. size I < 0.01 mm (%)	73.20	54.90	63.70	56.30	30.60	30.30	14.70
< 0.02 mm (%)	84.30	64.00	79.30	71.90	36.70	36.20	19.10
< 0.05 mm (%)	97.50	74.30	96.90	96.60	45.30	47.30	27.00
Part. size II 0.01–0.05 mm (%)	24.30	19.40	33.20	40.40	14.70	17.10	12.30
Part. size III 0.05–0.25 mm (%)	1.40	24.20	2.50	3.20	22.80	27.00	28.20
Part. size IV 0.25–2 mm (%)	1.10	1.50	0.60	0.20	31.80	25.60	44.80
pH active (–)	7.95	8.02	8.16	8.30	7.50	8.07	8.45
pH potential exchangeable (–)	7.31	7.38	7.64	7.78	7.14	7.60	8.15
Carbonates (%)	11.00	9.00	19.50	26.00	< 0.10	7.20	6.40
Cox (%)	1.86	1.70	1.14	0.18	1.30	0.34	< 0.12
θ_{mom} (% mass)	20.91	–	–	–	26.42	–	–
θ_{mom} (% vol.)	32.13	–	–	–	39.48	–	–
θ_{MKK} (% vol.)	34.87	–	–	–	39.37	–	–
ρ_z (g/cm)	2.67	–	–	–	2.63	–	–
$\rho_{d\ red}$ (g/cm)	1.54	–	–	–	1.49	–	–
P (% vol.)	42.44	–	–	–	43.27	–	–
Vz (% vol.)	10.31	–	–	–	3.79	–	–
K_{MKKVZ} (% vol.)	7.57	–	–	–	3.90	–	–
θ_{ns} (% vol.)	40.43	–	–	–	43.51	–	–
θ_{BV} (% vol.)	22.40	–	–	–	22.00	–	–
Potential (cmol/kg)							
CEC	34.02	29.00	27.46	17.17	18.80	13.59	5.30
S	40.75	38.60	39.59	27.53	19.89	17.97	12.92
K	0.78	0.57	0.54	0.54	1.44	0.84	0.54
Na	0.49	0.46	0.53	0.63	0.58	0.59	0.67
Mg	2.05	2.41	3.32	2.48	1.18	1.26	0.99
Ca	37.32	35.03	35.09	23.80	16.56	15.23	10.65
Al	0.11	0.13	0.11	0.08	0.13	0.05	0.07
Efficient (cmol/kg)							
ECEC	38.64	34.79	29.86	18.74	17.05	14.71	5.84
S	40.95	41.24	36.18	25.79	20.31	18.83	10.08
K	0.82	0.63	0.57	0.68	1.52	0.93	0.53
Na	0.61	0.67	0.64	0.68	0.65	0.66	0.65
Mg	2.25	2.55	3.19	2.50	1.10	1.41	0.91
Ca	37.21	37.31	31.71	21.82	16.99	15.76	7.86
Al	0.06	0.08	0.07	0.11	0.05	0.07	0.13

Apk' – plough layer (topsoil) with the carbonate content of cations $^{2+}$ – slightly carbonated (carbonates in solum 0. 3–1%)
ACk – intermediate horizon between the humic horizon and the parent material with the carbonate content of cations $^{2+}$ – carbonated (over 1–3%), event. strongly carbonated (over 3%), with no distinct transition
A/Ck – intermediate horizon between the humic horizon and the parent material with the carbonate content of cations $^{2+}$ – carbonated (over 1–3%), event. strongly carbonated (over 3%), with distinct transition
Bv – weathered horizon, none, event. less distinct traces of illuviation; brown cambic (metamorphic) horizon
B/Ck – intermediate horizon between the weathered horizon and the parent material with the carbonate content of cations $^{2+}$ – carbonated (over 1–3%), event. strongly carbonated (over 3%), with distinct transition
C – parent material
Ck – parent material with a carbonate content of cations $^{2+}$ – carbonated (over 1–3%), event. strongly carbonated (over 3%)
Dk – seat rock (markedly distinct from the parent material) with the carbonate content of cations $^{2+}$ – carbonated (over 1–3%), event. strongly carbonated (over 3%)

WRB

A – surface horizon (not distinguished, if organic or organic-mineral)
Ak – surface horizon with the carbonate content of cations $^{2+}$
ACk – intermediate horizon between the surface horizon and the parent material with the carbonate content of cations $^{2+}$, with not distinct transition
A/C – intermediate horizon between the surface horizon and the parent material, with distinct transition
A/Ck – intermediate horizon between the surface horizon and the parent material with the carbonate content of cations $^{2+}$, with distinct transition
B – weathered horizon
B/C – intermediate horizon between the weathered horizon and the parent material, with distinct transition
C – parent material
Ck – parent material with the carbonate content of cations $^{2+}$
Dk – seat rock with the carbonate content of cations $^{2+}$

The conversion accuracy of the soil classification systems is important for digital mapping. The relatively low punctuality of the WRB system is given by its original use for correlation, not classification of soils. Taking into account the origin from the legend of the overview-scale map, WRB is very suitable to digital maps creation, especially if it is more detailed onwards. As other authors have already mentioned (e.g. Deckers *et al.* in Eswaran *et al.* 2003), regardless of the number of qualifiers used, it enables a hierarchical structure and would be an ideal tool for the classification of the soil profiles, characterising the SOTER unit (e.g. Nachtergaele in Eswaran *et al.* 2003). SOTER (Soil and Terrain Digital Database) is one of the three main EUSIS (European Union Soil Information System) databases.

Under the Czech conditions, WRB is too general for the maps creation on a detailed scale. The needed maintenance of correlation between TKSP CR and main world referential systems, especially WRB, obstructs in some cases the precise adjustment of TKSP CR to home conditions. This is markedly visible e.g. when studying the TKSP CR referential class Antrosols. The implementation of the referential soil group Technosols into WRB in 2006 helped partially the conversions of the TKSP CR referential class to WRB and also reacted on the long-term need for the enlargement of anthropogenic soils. The implementation of the referential soil group Stagnosols into WRB in the same year facilitated the conversions as well, even though it did not resolve all the present questions in hydromorphic soils classification, and mainly the undesirable overlapping of the referential groups (WRB) or classes (TKSP CR), where hydromorphic soils are classified. Under the Czech conditions, the correlation with WRB has a negative impact also on the accuracy of TKSP CR referential classes Leptosols and Kambisols (also e.g. Sládková 2007, 2008b, 2009). It would be suitable to consider carefully more extensive integration of salinisation signs into TKSP CR (Fluvizems, Chernices).

The TKSP CR methodology (2001) does not sufficiently describe how to classify the accumulated or eroded soils. The methodology supposes implicitly that the soils in these phases will be classified in the stage after the accumulation or erosive wash, e.g. Chernozem washed (Genetic-agronomic soil classifi-

Table 5. Laboratory analysis concerning soil pit of Kambizem arenic – KAr from the soil survey in Litoměřice district in 2006

	KAr				
	horizont (cm)				
	Ap (0–28)	Bv (28–35)	C – all layers (> 35)	C – clay (–)	C – sand (–)
Soil properties and characteristics					
Clay < 0.001 mm (%)	7.40	7.50	5.10	25.10	12.10
Clay < 0.002 mm (%)	9.10	9.60	6.20	31.20	13.60
Part. size I < 0.01 mm (%)	14.10	13.70	7.60	47.20	15.00
< 0.02 mm (%)	17.90	17.00	6.40	53.90	15.40
< 0.05 mm (%)	23.60	22.70	10.10	62.90	17.20
Part. size II 0.01–0.05 mm (%)	9.40	9.00	2.50	15.60	2.20
Part. size III 0.05–0.25 mm (%)	35.00	39.40	53.40	33.40	45.20
Part. size IV 0.25–2 mm (%)	41.40	37.90	36.50	3.70	37.70
pH active (–)	5.62	5.94	6.27	6.39	6.32
pH potential exchangeable (–)	5.50	5.25	5.75	5.44	5.47
Carbonates (%)	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Cox (%)	0.66	0.38	< 0.12	< 0.12	< 0.12
θ_{mom} (% mass)	23.27	–	–	–	–
θ_{mom} (% vol.)	34.60	–	–	–	–
θ_{MKK} (% vol.)	35.24	–	–	–	–
ρ_z (g/cm^3)	2.65	–	–	–	–
$\rho_{d\ red}$ (g/cm^3)	1.49	–	–	–	–
P (% vol.)	43.97	–	–	–	–
Vz (% vol.)	9.37	–	–	–	–
K_{MKKVZ} (% vol.)	8.73	–	–	–	–
θ_{ns} (% vol.)	40.11	–	–	–	–
θ_{BV} (% vol.)	18.60	–	–	–	–
Potential (cmol/kg)					
CEC	7.19	6.56	2.44	8.61	3.84
S	5.19	5.64	3.51	8.73	4.68
K	0.67	0.55	0.48	0.67	0.55
Na	0.54	0.55	0.58	0.56	0.59
Mg	0.42	0.46	0.45	0.98	0.43
Ca	2.96	3.65	1.86	6.41	2.95
Al	0.60	0.43	0.14	0.11	0.16
Efficient (cmol/kg)					
ECEC	3.81	4.49	2.09	7.94	3.27
S	5.05	7.27	3.44	9.08	4.63
K	0.69	0.65	0.56	0.69	0.59
Na	0.60	0.63	0.64	0.66	0.67
Mg	0.46	0.50	0.45	1.10	0.47
Ca	2.87	4.47	1.69	6.53	2.79
Al	0.43	1.02	0.10	0.10	0.11

cation) will be classified as Regozem (TKSP CR), etc. Whereas by smaller, nevertheless recognizable grade of accumulation or erosive wash also the original soils could be conserved and accordingly classified under the valid system, it is necessary to validate precisely the soil profiles to complete the TKSP CR methodology. WRB uses topsoil classification (FAO 1998), which respects the changes in classification as the result of erosion processes.

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