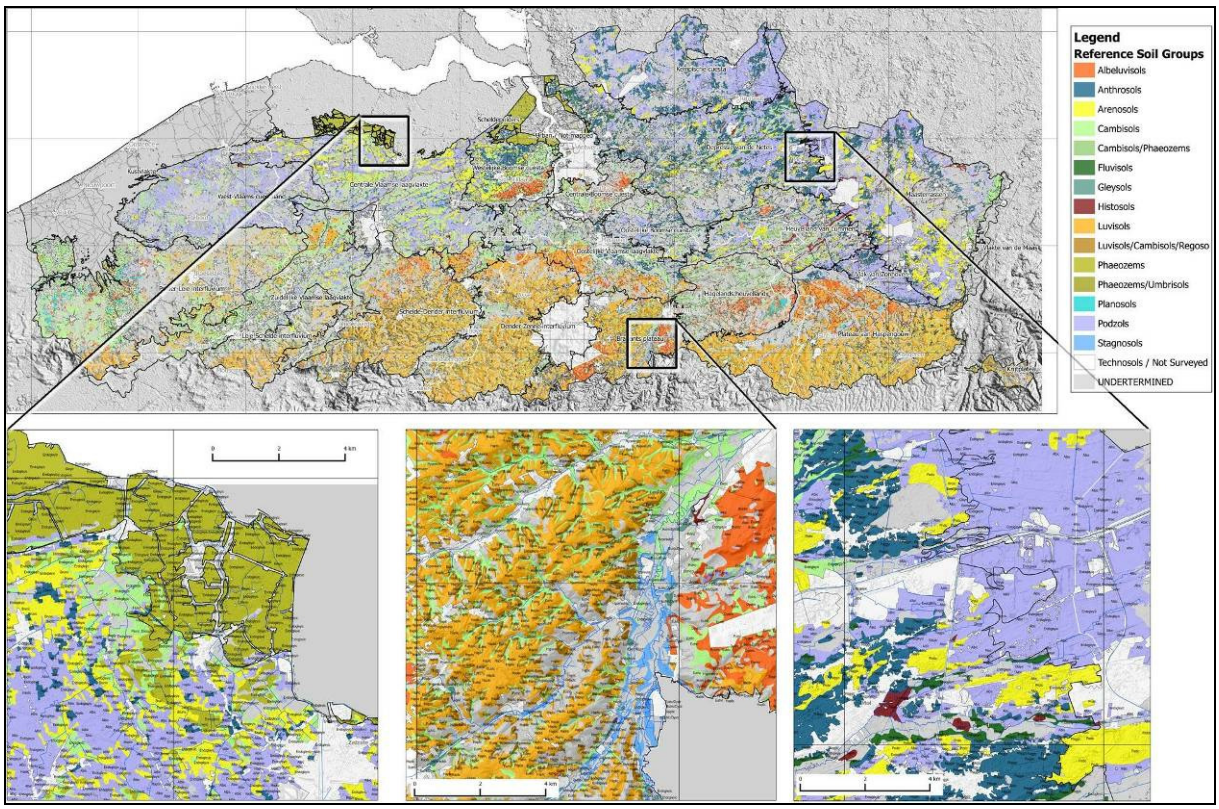
Omzetten van de Belgische Bodemkaart naar WRB legende: 30 kaartbladen op schaal 1:50.000'

The soil map of the Flemish region converted to a World Reference Base legend: the inland regions



Stefaan Dondeyne, Eric Van Ranst and Jozef Deckers

March 2013

Opdracht van de Vlaamse Overheid, Departement Leefmilieu, Natuur en Energie Afdeling Land en Bodembescherming, Ondergrond, Natuurlijke Rijkdommen

Bestek nr. BOD/STUD/2009/05bis

Contents

Acknowledgement

The authors are grateful to the administration of the Flemish region for entrusting us with the task of converting the legend of the soil map of Belgium for the Flemish region to a legend according to the international soil classification system World Reference Base for Soil Resources.

The work benefited from the contributions, critical comments and revisions of the steering committee most in particular: *Martine Swerts*, *Joost Salomez*, *Katrien Oorts*, *Carole Ampe*, *Nathalie Cools*, *Geert Baert*, *Karen Vancampenhout*, *Patrick Engels*, *Xavier Legrain*, *Roger Langohr*, *Simone Marx*, *Jérôme Juilleret*.

We also like to thank *Veronique Beckers* and *Jos Van Orshoven* for their kind cooperation in relation to the use of the AARDEWERK database. A special word of thank to *Jan Claesen* and *Anika Devroe* from ARCHEBO and *Rik van de Konijnenburg* from HAAST for inviting me to make pedologic observations at archaeological excavation sites.

Abstract

The legend of the detailed soil maps (scale 1:20,000) Of the inland parts of the Flemish region has been converted to the World Reference Base for Soil Resources (WRB). WRB is the international soil classification system, which has been adopted to harmonise soil information data within Europe. The objective of the current assignment was to make a systematic conversion of all the detailed soil maps excluding the coastal area, and such that the maps can be generalised to a 1:50,000 scale. Once the coastal area will also have been converted it will be possible to generalise these maps to a 1:250,000 scale.

The legend of the soil map of Belgium is based on soil texture, drainage status and profile development, while the WRB classification is based on diagnostic features defined by morphological, physical and chemical properties. According to the Belgian legend, more than 4000 different soil mapping are recognised for the Flemish region. To take regional variability into account, the classification of these soil mapping units has been done for 24 physiographic regions. Overall 16 Reference Soil Groups have been identified and which are further subdivided according to prefix, suffix and mapping qualifiers. The conversion of the legend to WRB is based on insights from classifying more that 350 legacy soil profile data as well as field observations. From these insights heuristic rules have been deduced for identifying Reference Soil Groups and some of the qualifiers. Furthermore, the AARDEWERK-93 and the AARDEWERK-STAT databases, containing soil chemical and physical data of legacy soil profiles, was used to determine the modal classes per physiographic region in terms of soil textural groups (*Arenic*, *Loamic*, *Siltic* and *Clayic*] and soil fertility status (*Dystric*, *Eutric*, and *Hypereutric*).

The conversion of the Belgian legend to WRB leads to a regrouping of the detailed soil types into broader WRB categories which can neatly be represented on 1:50,000 scale maps. In this project the WRB guidelines for constructing map legends have been followed quite stricktly; the final map legend may however still be adjusted to fit the needs of map users, drawing from the more detailed information provided by the original maps. Still the work of this project provides all data necessary for constructing various types of legends;

the finalisation of which should be done when the legend of the whole territory has been converted, including also the coastal area which is still left out in this study.

Converting the legend of the soil map of Belgium into WRB, does not imply substituting one classification with another one. Map users who would need detailed information, should still refer to the detailed information of the original soil map. Actually, rather than seeing the present exercise as a conversion of legends, the original *soil types* have been reorganised in higher ranked classification categories determined by the *Reference Soil Groups* and the WRB qualifiers, and this for the various physiographic regions. Such a regrouping of *soil types* has been possible thanks to the flexibility WRB offers for combining various qualifiers, and also thanks to its own low hierarchical order. For constructing map legends, WRB could still be improved by organising the qualifiers in thematic groups such that the user will have a maximal flexibility when using geographical information systems

1. Background and objectives

Within the European Union there is a general interest to prepare joint soil maps at a 1:250,000 scale in order to harmonise agricultural and environmental policies. The World Reference Base for Soil Resources (IUSS Working Group WRB, 2007), which is the international soil classification system endorsed by the International Union of Soil Sciences, has been adopted as the common classification system for Europe. As soil surveys in most European countries were conducted independently, the challenge is now to convert the national legends into a common WRB legend. The authorities of both the Flemish and the Walloon regions therefore commissioned studies to elaborate a methodology for converting the legend of the soil map of Belgium to the World Reference Base for Soil Resources (WRB) (Bouhon and Dondeyne, 2011; Dondeyne *et al*. 2012). These studies have shown that though some general rules could be established for converting mapping units from the soil map of Belgium to WRB, local particularities need to be taken into account. They have to be documented with field observations to complement legacy soil profile data.

Drawing from these experiences, the specific objective of the present assignment was to make a systematic conversion of all the mapping units of the Flemish region, excluding the coastal area (Fig. 1). The coastal province of “West Vlaanderen” was excluded as during the elaboration of the methods, as it was evident that the specific legend used for the coastal areas will need additional investigations (Dondeyne *et al*., 2012).

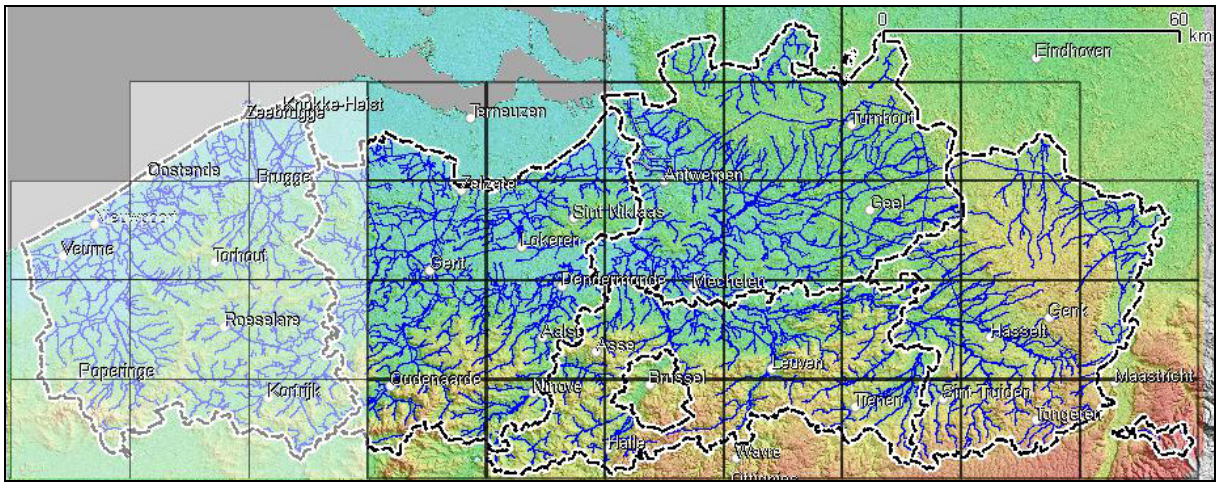


Figure 1 – This project aimed at converting the 1:20,000 scale maps of the Flemish region except for the coastal province, and such that they could be presented on 1:50,000 scale maps

The experiences have shown that in general, by using WRB Reference Soil Groups with one or two main qualifiers, the salient soil information of the original soil maps of Belgium (at a scale 1:20,000) can be captured. As the class definitions of WRB are broader than the ones of the Belgian classes, original mapping units can be generalized and adequately be presented on maps at a 1:50,000 scale. These maps have the advantage to provide the soil information in an internationally accepted legend. These maps also proved to be a good basis for further generalizing to derive maps at a 1:250,000 scale. Whereas, overall WRB is satisfactory for classifying soils at national level, the experience also shows that some WRB concepts may benefit from revisions to facilitate its correlation with national soil survey data.

2. The soil map of Belgium

2.1 The soil survey project

The systematic soil survey of Belgium started within the framework of the Committee for the Establishment of the Soil and Vegetation Map of Belgium in 1947. The soil survey was initiated just after the World War II out of an urgent concern for increasing agricultural production (Dudal *et al*., 2001). The basic aim of this committee, sponsored by the Institute for Encouraging Scientific Research in Industry and Agriculture (IWONL/IRSIA) was to identify, classify and map the soils of Belgium. The greatest part of this work has been carried out between 1947 and 1974 by the Soil Survey Centre (CVB/CCS) in Ghent under the direction of Prof. R. Tavernier. This Centre did the overall coordination, supervision and operated in close cooperation with the Faculties of Agriculture of Gembloux, Gent and Leuven. In 1975 the Soil Survey Centre of southern Belgium (Gembloux) was charged to complete the soil survey in the southern parts of Belgium.

During the fieldwork, the surveyors were using copies of the cadastral maps at a 1:5000 scale to locate their field observations and to draft mapping units. These units were then transferred on a topographic base map at a 1:10,000 scale and then finally reduced and published at a 1:20,000 scale, as illustrated in Fig. 2.

The published map sheets covered an area of 80 km² each (8 × 10 km²), and were digitized in the 1990s. The digital version can be consulted through internet applications; printed versions of the maps, together with their accompanying explanatory notes, can still be purchased at the Laboratory of Soil Science, Ghent University, for maps of the northern part of the country, and at the Gembloux Agro-Bio Tech campus of the University of Liège, for the southern part of the country.

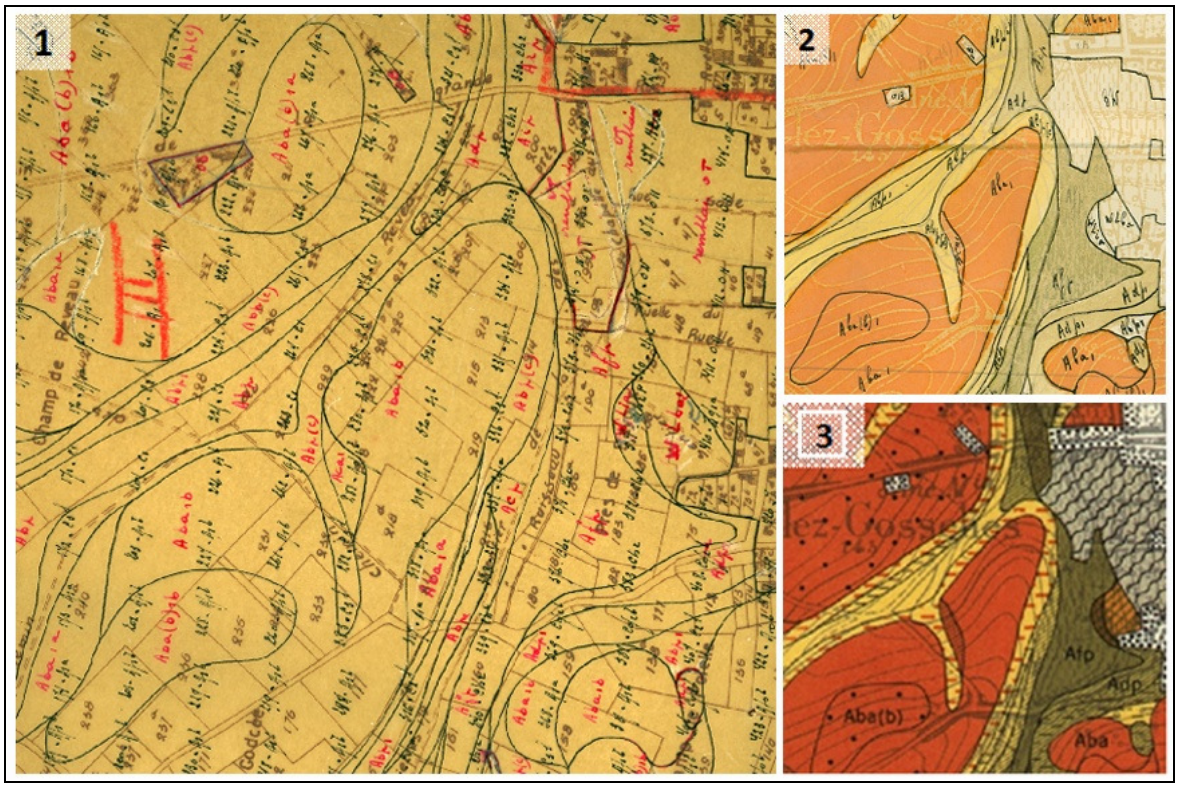


Figure 2 - Illustration of the soil mapping processes: (1) soil units and observations were drafted on copies of the cadastral plan (scale 1:5000); (2) mapping units were transposed to topographic base maps (scale 1:10,000); and (3) maps were published in colour and at a 1:20,000 scale (adapted from Legrain et al., 2012 - scales not respected)

Field observations were made with a density ranging from 1 to 2.5 per hectare done by soil auger to a standard depth of 125 cm unless impenetrable layers or rocks were encountered. Besides, over the whole territory, about 15,000 soil profiles have been described and analysed, the data of which have been entered into the soil database AARDEWERK (Van Orshoven *et al*., 1988; 1993). The database AARDEWERK has recently been revised and complemented for the Flemish region which resulted in the new AARDEWERK-Vlaanderen-2010 database (Beckers *et al*., 2011). AARDEWERK-Vlaanderen-2010 has recently be complemented with a statistical application allowing to determine average values (median and their ranges) as AARDEWERK-STAT (Beckers *et al*., 2012).

2.2 Legend of the soil map of Belgium

The legend of the soil map of Belgium[1], and the corresponding soil classification system, is based on morphogenetic properties readily identifiable in the field. The principal properties are soil texture, drainage status and profile development. Soil series are defined by a combination of class definitions of these properties, as explained below. Variants are recognized based on (i) the occurrence of lithologic discontinuities (substratum), (ii) admixtures of parent materials (e.g. limestone in a soil otherwise derived from loess), (iii) variations in the profile development (e.g. strongly mottling in and above an *Argic* horizon, or the occurrence of a *Fragic* horizon). Phases are recognized according to the depth or thickness of particular characteristics, for example whether the *Argic* horizon is immediately under the plough layer or not.

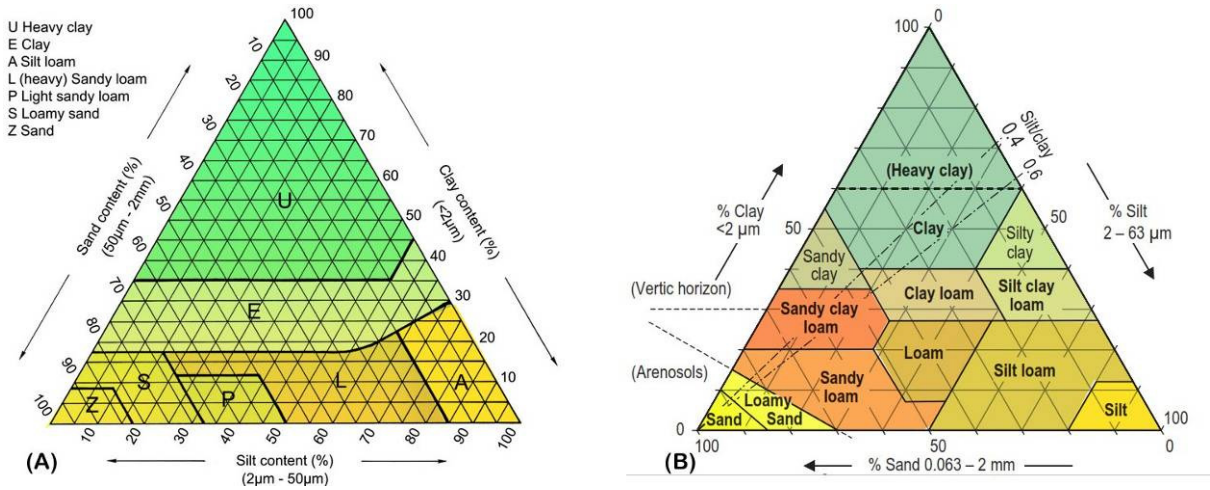


Figure 3 – Textural classes according to (A) Belgian textural classes (adapted from Van Ranst and Sys, 2000); and (B) FAO textural classes (adapted from FAO, 2006). In the Belgian classification system, the symbol for the textural classes are used as the first symbol in the code determining the soil series

The soil textural classes, given as a **first symbol** in the legend's symbol, are defined according to Fig. 3. The class definitions are based on the relative content of clay, silt and sand. These classes differ from e.g. the international commonly used USDA classes. As a consequence, the class for "heavy clay" (symbol "U") in Belgium is much wider than what

[1] For some detailed accounts of the legend see Maréchal and Tavernier (1974), Van Ranst and Sys (2000), and Bah *et al*. (2005).

is defined as heavy clay in the USDA or FAO soil textural classes (Fig. 3). The classes also differ slightly of the currently internationally used definition as the silt fraction is defined by particle size ranging from 2 to 50 µm instead of from 2 to 63 µm in the FAO textural classes used by WRB[2]. Beside these 7 textural classes, additional symbols are used for special cases. For example, when there is more than 5% (by volume) of gravel or stones the symbol G is used; the symbol V is used for peat soils saturated predominantly by groundwater, and W when they are predominantly saturated by rainwater.

The drainage status is a **second property** by which a soil series is defined. Drainage classes are defined according to depth at which oxido-reduction (gley mottling) and/or reduction occur; a differentiation in critical depth is made between the silt-loamy and clayey textures and the sandy textures (Table 1).

Table 1 - Definitions of drainage classes according to the legend of the soil map of Belgium

Symbol	Definition	Depth of occurrence (cm)			
		Silt-Loamy & Clay (A,L,E,U)		Sandy (Z,S,P)	
		Gley mottling	Reduction	Gley mottling	Reduction
.a.	excessively drained	-	-	>120	-
.b.	well drained	-	-	90-120	-
.c.	moderately well drained	>80	-	60-90	-
.d.	imperfectly drained	50-80	-	40-60	-
.e.	poorly drained	20-50	>80	20-50	>100
.f.	very poorly drained	0-20	40-80	0-20	50-100
.g.	extremely poorly drained	0	<40	0	<50
Soils with perched or seasonal groundwater					
.h.	poorly drained	20-50	-	20-40	-
.i.	very poorly drained	0-20	-	-	-

(adapted from: Van Ranst and Sys, 2000)

The soil profile development is taken as a third property (and symbol), determining the soil series. Their definition and the corresponding symbols are presented in Table 2, as well as, where applicable, the equivalent diagnostic horizons. Variants and phases of these soil

[2] The FAO textural classes use the same names and define classes on the same ratio of percentage clay, silt and sand as the USDA textural classes, but the latter also has silt defined as particles with size range of 2-50 µm.

series are defined by three properties that can be indicated by additional symbols depending on the complexity of the profile.

Table 2 - Class definitions of soil profile development and corresponding diagnostic horizons according to WRB-2007

Symbol	Definition	Diagnostic horizon
..a	soils with a texture B horizon	Argic horizon
..b	soils with a structure or colour B horizon	Cambic horizon
..c	soils with strongly mottled or broken texture B horizon	Argic horizons with albeluvic tonguing; the latter may be under expressed and then indicated as hypoalbeluvic tonguing
..d	soils with yellow-red texture B horizon	
..**e**	soils with a thick dark A horizon	Mollic or Umbric horizons
..**f**	soils with a poorly expressed iron, or humus B horizon	mostly Brunic horizons
..g	soils with a well developed iron, or humus B horizon,	Spodic horizon
..h	soils with a broken iron, or humus B horizon	-
..m	Soils with a thick anthropic humus A horizon	Plaggic, or Terric horizons
..p	Soils without any profile development often of alluvium or colluvium	
..x	poorly expressed soil profile development, of very variable soils	Cambic horizon (in most cases)

(adapted from Maréchal and Tavernier, 1974)

It can be seen that with some training and experience, all of these characteristics can readily be identified in the field, particularly as the definition of "soil profile development" did not include any chemical criteria. Soil surveyors could hence directly indicate the classification in the field, be it either while augering or when describing a soil profile pit.

To illustrate the classification system, consider for example the soil series "Zbg"; the first capital means the soil texture is sand (Z); the second symbol means the drainage status is, well drained (**.**b**.**); and the third symbol (**..**g) indicates that the soil profile development corresponds to a "*Spodic* horizon". Such well drained Podzols have in most cases a clearly bleached horizon, which qualifies as an *Albic* horizon, and in WRB would hence be classified as an *Albic Podzol.* An example of such a soil profile is shown in Fig. 4.

Figure 4 – Albic Podzol in a landscape of sand dunes in the Campine region (northern part of Flemish region, map sheets Turnhout - Arendonk); this landscape unit is actually mapped as "ZAg" being a complex of the soil series Zag, Zbg, Zcg and Zdg and this mapping unit has typically been used for sand dunes, as apparent from the shaded terrain image.

3. The World Reference Base for Soil Resources[3]

3.1 WRB as a classification system

The World Reference Base for Soil Resources (WRB) was developed drawing on the insights and experiences gained through the elaboration of the FAO-UNESCO legend of the Soil Map of the World (FAO-UNESCO, 1974; FAO, 1988). WRB is in the first place intended to facilitate the exchange of information and experience by providing a common scientific language, and so strengthening applications of soil science and enhancing communication with other disciplines. It was developed and is still being revised by an international working group of soil scientists, coordinated by the International Union of Soil Science. In the period 1998–2006, WRB became the official reference soil nomenclature and soil classification for the European Commission, and has since been widely adopted as tool to harmonize and exchange soil information.

Although WRB draws on the Legend of the Soil Map of the World, it is really conceived as a two tiers soil classification system rather than a legend. At the first level, 32 "*Reference Soil Groups*" are distinguished. At a second level, "qualifiers" are added, which serve as "adjectives" to the Reference Soil Groups. Two levels of details can be expressed with the qualifiers: Firstly prefix qualifiers are used to indicate either properties typical for the particular Reference Soil Group or properties that show some intergrading with other Reference Soil Group. Secondly, more information on the soil can be provided with the suffix qualifiers, which are meant for presenting properties that are not specific to a particular Reference Soil Group (e.g. texture, colour, or base saturation).

A determination key enables to determine to which Reference Soil Group a particular soil belongs. The key requires checking diagnostic features[4], which are defined in terms of morphology and/or analytical criteria. The soil belongs to the first Reference Soil Group for which it meets all specified requirements. The 32 Reference Soil Groups, are listed in

[3] Based on IUSS Working Group WRB 2007. World Reference Base for Soil Resources 2006, first update 2007. World Soil Resources Reports No 103. FAO, Rome

[4] These features may be diagnostic horizons, properties and/or materials

Table 3, according to a simplified key. For the full key and definitions see IUSS Working Group, (2007). For the second level of classification, qualifiers are taken from the list of prefix and suffix qualifiers as indicated in the key, corresponding to the definitions of each of the qualifiers.

Table 3 - Rationalized key to the WRB Reference Soil Groups and their occurrence in Belgium

Description	Occurrence in Belgium	
	Occur	Do not occur
A. Organic soils		
1. Soils with thick organic layers	Histosols	-
B. Mineral soils		
2. Soils with strong human influence		
Soils with long and intensive agricultural use	Anthrosols	-
Soils characterised by human artefacts (>20% volume)	Technosols	-
3. Soils with limited rooting due to shallow permafrost or stoniness		
Ice affected soils	-	Cryosols
Shallow or extremely gravely soils	Leptosols	-
4. Soils influenced by water		
Alternating wet-dry conditions, rich in swelling clays	-	Vertisols
Floodplains, tidal marshes	Fluvisols	-
Alkaline soils	-	Solonetz
Salt enrichment by evaporation	-	Solonchaks
Groundwater affected soils	Gleysols	-
5. Soils set by Fe/Al chemistry		
Allophanes or Al-humus complexes (volcanic soils)	-	Andosols
Cheluviation and chilluviation	Podzols	-
Accumulation of Fe under hydromorphic conditions	-	Plinthosols
Low-activity clay, P fixation, strongly structured	-	Nitisols
Dominance of kaolinite and sesquioxides	-	Ferralsols
6. Soils with stagnating water		
Abrupt textural discontinuity	Planosols	-
Structural or moderate textural discontinuity	Stagnosols	-
7. Accumulation of organic matter, high base status		
Typically mollic horizon (black, organic rich surface)	-	Chernozems
Transition to drier climate	-	Kastanozems
Transition to more humid climate	Phaeozems	-
8. Accumulation of less soluble salts or non-saline substances		
Gypsum	-	Gypsisols
Silica	-	Durisols
Calcium carbonate	-	Calcisols
9. Soils with a clay-enriched subsoil		
Albeluvic tonguing	Albeluvisols	-
Low base status, high-activity clay	Alisols	-
Low base status, low-activity clay	-	Acrisols

Table 3 - Rationalized key to the WRB Reference Soil Groups and their occurrence in Belgium

Description	Occurrence in Belgium	
	Occur	Do not occur
High base status, high-activity clay	Luvisols	-
High base status, low-activity clay	-	Lixisols
10. Relatively young soils or soils with little or no profile development		
With an acidic dark topsoil	Umbrisols	-
Sandy soils	Arenosols	-
Moderately developed soils	Cambisols	-
Soils with no significant profile development	Regosols	-

*(adapted from: IUSS Working Group, 2007 and complemented own information derived from the soil map of Belgium and terrain observations)

To illustrate how a soil profile is classified in WRB – and how it was classified according to the legend of the soil map of Belgium – the description of soil profile "Meerbeek-01" (province of Vlaams-Brabant) is presented (Fig. 5 & Table 4) In WRB it qualifies as an *Endogleyic Cambisol (Colluvic, Eutric, Siltic*). As the profile actually consists of colluvium in the upper 80 cm, which is overlying a buried *Luvisol* which is evident from the remains of an E horizon over and argic horizon. The latter can be refered to as "thapto *Cutanic Luvisol*; so its full name would be *Endogleyic Cambisol (Colluvic, Eutric, Siltic) thapto Cutanic Luvisol*". This name actual says that it concerns a soil which has an imperfect drainage (*Endogleyic*), as it has prominent gley mottling between 50 and 100 cm depth (*2EBg* in Fig. 5 & Table 4); in the first meter its soil profile development does not get beyond the development of soil structure and alteration of colours (*Bw* in Fig. 5 & Table 4, *Cambic horizon* – and in this case therefore a *Cambisol*). To indicate that the soil largely consist of colluvium, the suffix qualifier *Colluvic* is added; the qualifier *Eutric* indicates that its base saturation is above 50% and the qualifier *Siltic* that is a very fine texured soil. Furthermore, the buried soil profile has an *argic* horizon, evidenced by the presence of clay skins, hence the qualifier *Cutanic*. Having such an *argic* horizon (*2Btg* Fig. 5 & Table 4) with a base saturation of more than 50%, this buried soil is a *Luvisol*.

According to the legend of the soil map of Belgium, this soil is mapped as an "*Adp*" soil. The first symbol "*A..*" refers to the Silt Loam soil texture; the second symbol "*.d.*" to its imperfect drainage; and the third "*..p*" would in principle refer to soils "without any soils profile development" (see Table 2); in practice however the symbol "..p" has been used to

refer to soil of either colluvial or alluvial deposits, with or without what we now consider a *Cambic* horizon. As the argic horizon of the buried soil profile is below 1 m, it is not refered to in the legend.

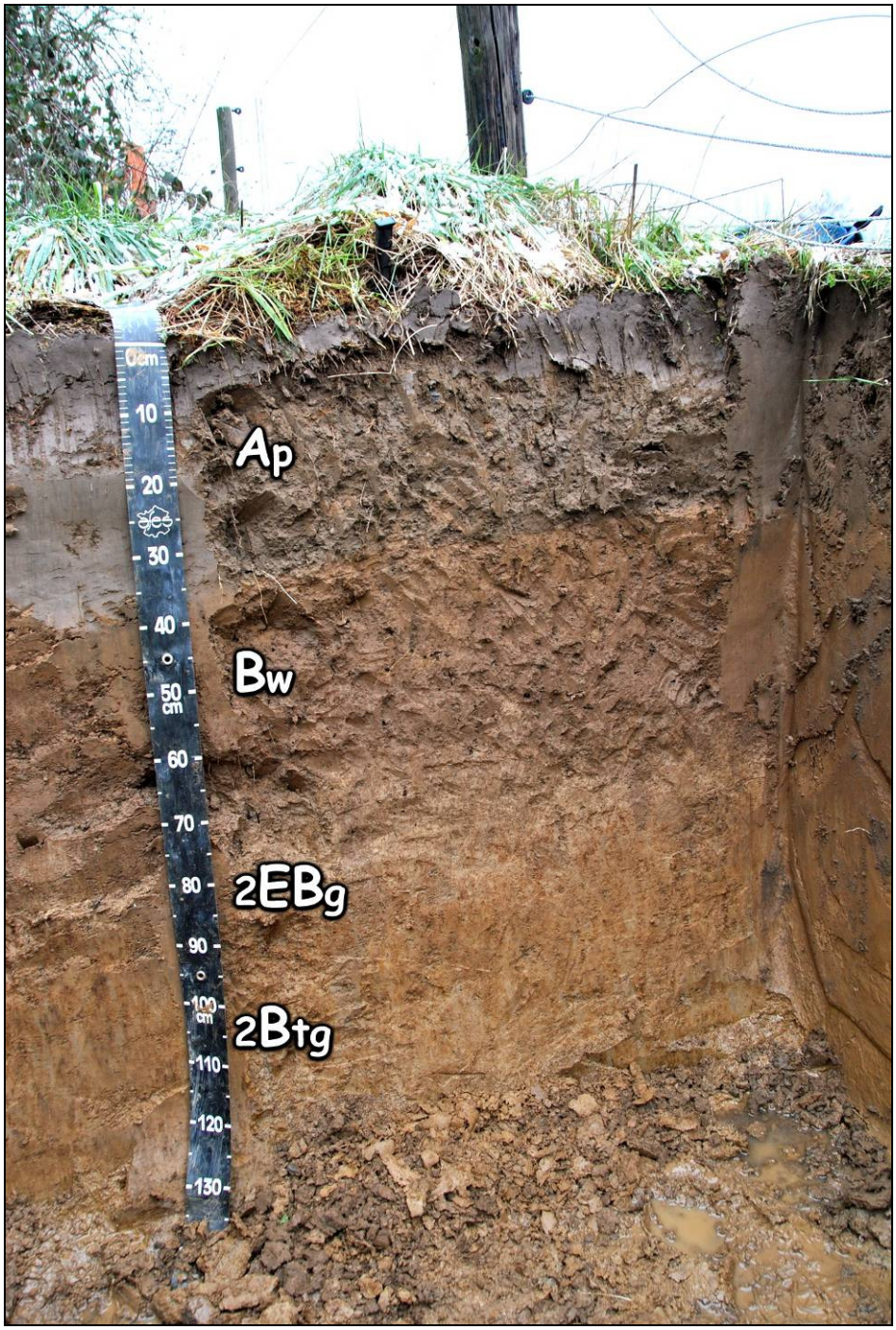


Figure 5 – Soil profile pit "Meerbeek-01", an **Endogleyic Cambisol (Colluvic, Siltic, Eutric)*****, and mapped as a*** **Adp** ***according to the legend of the soil map of Belgium (sheet Erps-Kwerps 89W); below 80 cm remains of a buried profile are found which can be referred to as*** **"thapto Cutanic Luvisol".**

Table 4 – Description and diagnostic features of soil profile "Meerbeek-01" illustrating the WRB as a classification system; all colours are moist colours

Horizon	Depth (cm)	Description	Diagnostic features
Ap	0-35	Silt Loam in USDA classes (A in Belgian textural classes); Dark brown 10YR 3/3 (moist), slightly sticky, plastic and friable moist; moderate strong, medium angular to sub-angular blocky structure; many fine and medium roots; few to common tubular and interstitial pores and many earthworm galleries; small pieces of bricks (<5 cm) and charcoal, boundary smooth and abrupt	Ochric horizon, colluvic material, Eutric
Bw	35-80	Silt Loam in USDA classes (A in Belgian textural classes); Brown 10YR 4/4 (moist), slightly sticky, plastic and friable moist; moderate to strong medium angular block structure; many fine roots; common tubular and interstitial pores and many earthworm galleries; piece of roman tile (5-10 cm), boundary smooth to wavy and clear	Cambic horizon, colluvic material, Eutric
2EBg	80-100	Silt Loam in USDA classes (A in Belgian textural classes); Dull yellowish brown 10YR 5/3 (moist); common medium distinct brown mottles (10YR 4/6) and Mn-Fe speckles (5 mm); few very fine clay coatings on pores and pedfaces; slightly sticky, plastic and friable moist; strong medium angular blocky structure; many fine roots; many tubular and interstitial pores, few earthworm galleries; boundary wavy and gradual	Gleyic properties in an eluviated horizon, Eutric
2Btg	100-140+	Silt Loam in USDA classes (A in Belgian textural classes); strongly mottled Brown 10YR 4/6 to Dull yellowish brown 10YR5/3 (moist); and Mn-Fe speckles (> 5 mm); fine, continuous clay coatings on pores and pedfaces; slightly sticky, plastic and friable moist; strong medium angular blocky structure; many fine roots; many tubular and interstitial pores	Argic horizon, Gleyic properties, Eutric

3.2 WRB for constructing map legends

WRB is a very versatile soil classification system, thanks to its low hierarchical structure. By combining a very wide range of qualifiers, it allows indicating most of the soil's properties, as the above example illustrate. However, when generalization is required, as is done when legends of soil maps are constructed, a choice has to be made on which qualifiers to retain. Therefore guidelines have been elaborated such that legends based on WRB would be internationally consistent (IUSS WRB Working Group, 2010).

To ensure that important information on certain soil characteristics would be retained, the order of priority given to qualifiers has been altered. Rather than having the "prefix" and "suffix" qualifiers of the classification system, the guidelines foresee to have main qualifiers and optional qualifiers. The main qualifiers are in a predetermined order, and this order must be followed during the identification process. The optional qualifiers are listed in alphabetical order, and can be selected from depending on the use of the map. This approach has hence led to a different organisation of the qualifiers. For example, the occurrence of clay skins (*Cutanic*) is recognized at prefix level; when generalizing by taking the first occurring prefix qualifiers many Luvisols would be pooled into *Cutanic Luvisols*, which for temperate and subtropical regions does not give satisfactory differentiation. Therefore, integrade qualifiers have been excluded from the main map unit qualifier list. Similarly, as illustrated in Fig. 6, the qualifier *Vertic* for Solonetz which is a prefix qualifier in the classification system, is an optional qualifier according to the guidelines for map legends; and the qualifiers gleyic and stagnic come into a prominent position.

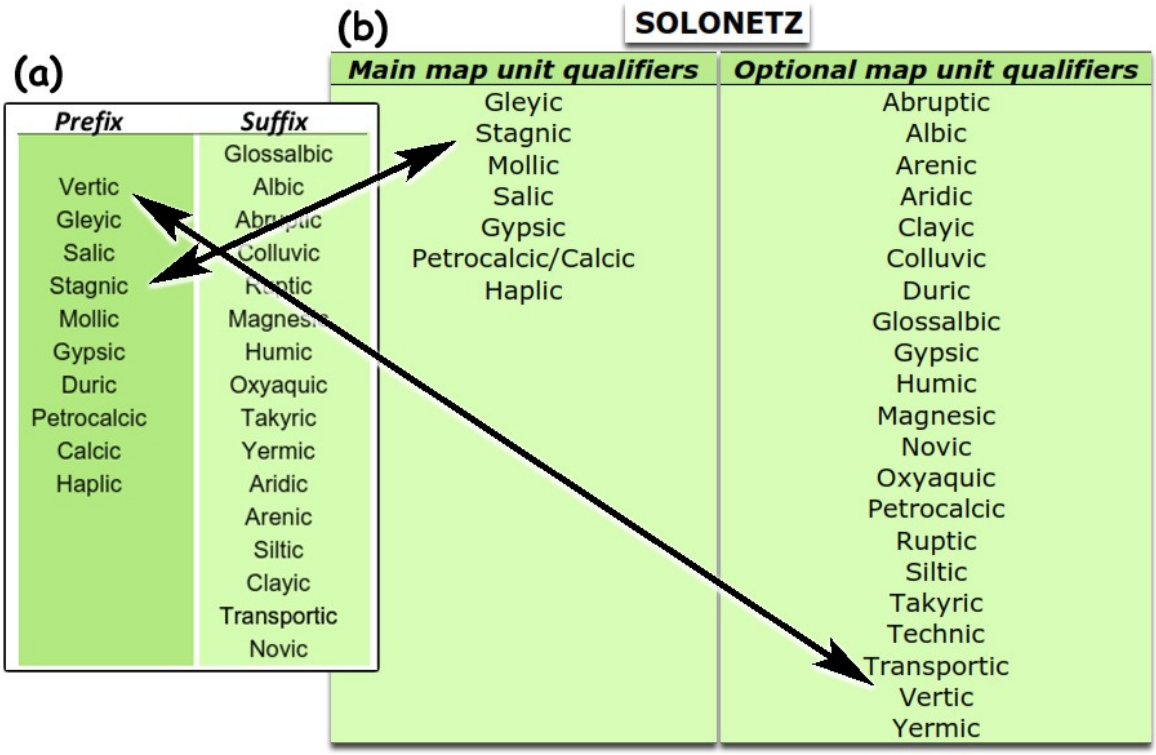


Figure 6 – Contrast in the ranking and use of (a) Prefix and Suffix qualifiers as in the WRB classification system with (b) the WRB guidelines for map legends, illustrated for the Solonetz (adapted from Schad and Dondeyne, 2012)

4. General approach

A general translation key for converting the legend of the soil map of Belgium to WRB was developed when we elaborated and tested the method (Dondeyne *et al*., 2012). However, the experience showed that such a translation often does not lead to an unequivocal conversion. Therefore, based on the insights gained from the key, and the practical knowledge acquired through classifying soil profiles, the following practical rules were applied. To take variation within the Flemish region into account – due to geology and land-use history - the conversion of the soil types from the legend of the soil map of Belgium has been done for 24 physiographic regions.

4.1 Soil variability per physiographic region

From the studies on the methodology, it appeared that there is a wide variation in soil variability over the Flemish region. The natural variation is partly due to intrinsic variations in geology, land-use and climate, but also to some variations in soil survey approaches which shifted over time. To take account for part of this variation, the soil types have been classified per physiographic regions. For this end the 24 physiographic regions which had been mapped by Honnay (1994) have been used (Fig. 7). These units are reasonably homogenous in terms of soil and landscape variability.

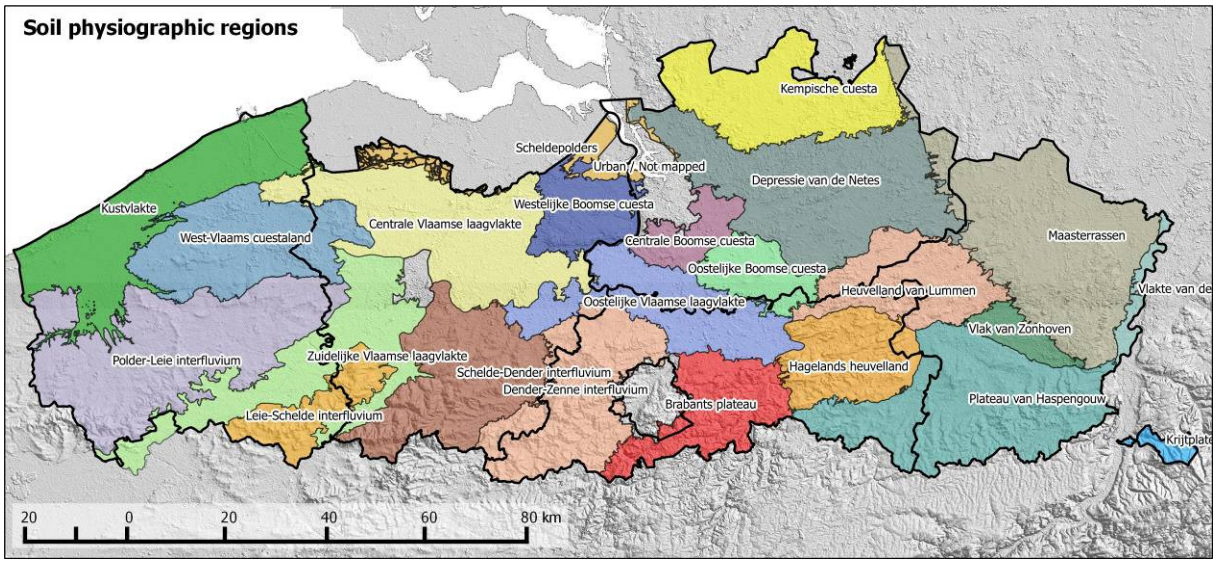


Figure 7 – Physiographic regions of the Flemish region. The legend of the soil map of Belgium has been converted to WRB for each of these region seperatly.

Overall there are 4005 different soil mapping units according to the legend of the soil map of Belgium (Table 5). These mapping units are "soil types", which are more detailed than what is commonly recognised as the core "soil series" of three letters. Hence we will refer to e.g. code "Aba" as a ***soil series***, while the variants and/or phases "wAba", "Aba(b)" or "Aba1" as ***soil types***.

Table 5 – Soil variability per physiographic region in the Flemish region, as expressed in the number of "soil types" (n), the area covered and the Shannon diversity index (H') and Evenness index (E).

Soil diversity per soil region for the Flemish region					*area covered*					
REGION	n	km2	H'	E	n-80	n-85	n-90	n-95	p90	c90
Overall Flemish region	**4,005**	**18,054**	**5.2**	**0.63**	**195**	**278**	**408**	**671**	**10**	**2**
Depressie van de Netes	1,184	1,323	4.7	0.67	107	147	210	322	18	16
Heuvelland van Lummen	511	613	4.6	0.74	75	93	121	172	24	20
Maasterrassen	662	1,314	4.6	0.70	72	94	127	182	19	10
Oostelijke Boomse cuesta	415	303	4.4	0.73	64	81	109	287	26	36
West-Vlaams cuestaland	655	779	4.4	0.68	58	79	113	179	17	14
Kempische cuesta	476	737	4.4	0.71	51	64	84	124	18	11
Polder-Leie interfluvium	673	1,314	4.3	0.67	51	69	99	161	15	8
Hagelands heuvelland	350	499	4.2	0.71	38	50	73	116	21	15
Oostelijke Vlaamse laagvlakte	556	763	4.1	0.65	55	76	105	154	19	14
Kustvlakte	308	975	4.1	0.72	42	57	77	110	25	8
Zuidelijke Vlaamse laagvlakte	418	816	4.0	0.66	38	49	67	102	16	8
Leie-Schelde interfluvium	340	329	3.8	0.66	34	47	66	104	19	20
Schelde-Dender interfluvium	481	832	3.8	0.62	33	44	59	92	12	7
Centrale Vlaamse laagvlakte	526	1,075	3.8	0.61	32	45	68	118	13	6
Plateau van Haspengouw	413	1,069	3.7	0.62	31	43	66	110	16	6
(empty)	903	1,677	3.6	0.54	63	94	145	235	16	9
Dender-Zenne interfluvium	269	872	3.5	0.63	28	36	48	69	18	6
Westelijke Boomse cuesta	237	436	3.5	0.64	29	36	46	64	19	11
Krijtplateau	107	51	3.3	0.71	16	21	29	38	27	57
Vlak van Zonhoven	184	175	3.3	0.62	20	27	37	56	20	21
Centrale Boomse cuesta	295	297	3.2	0.56	27	39	56	94	19	19
Brabants plateau	220	616	3.0	0.56	17	25	37	59	17	6
Scheldepolders	199	320	2.9	0.54	15	19	25	40	13	8
Vlakte van de Maas	85	102	2.7	0.61	9	13	17	24	20	17
Urban / "Not mapped"	341	766	2.4	0.41	13	21	36	68	11	5

Though there are 4005 soil types in the Flemish region, 90% of the territory is covered by 408 soil types, and 95% by 671 soil types. The physiographic region with the highest soil diversity is the "Depression of the Nete rivers" (*Depressie van de Netes*).

The implication of taking the "soil types" as entering point for the convertion to WRB, rather than the "soil series", is that some *soil types* belonging to one soil series are classified in very distinct WRB units; e.g. the Adp0 soil type is considered as an

Endogleyic Cambisol (*Colluvic*), while an Adp(c) is considered as a *Endogleyic Cutanic Luvisol (Colluvic).*

4.2 Use of legacy soil profile data

In total more than 363 soil profile descriptions have been checked and classified according to WRB. This list, together with heuristic rules described in the next section, served as a basis for converting soil mapping units into WRB units; the classification of the 363 legacy soil profiles is presented in Annex 1.

The databases AARDEWERK-93 (Van Orshoven et al. 1993), and AARDEWERK-STAT (Beckers *et al*., 2012) were both used for making inferences on soil qualifiers per soil type for each of the physiographic regions. AARDEWERK-93 was particularly used to determine whether soil groups of particular physiographic regions could be classified as either *Dystric, Eutric* or *Hypereutric,* depending on the soil pH-H_2O, as illustrated further down. Similarly, it was checked per soil type and per physiographic region whether soils could be qualified as *Arenic*, *Loamic*, *Siltic* and *Clayic.* As the coding of soilt types was the most homogenous in AARDEWERK-93, and as this was available in a spreadsheet format, it was most convenient for determining such qualifiers for a soil types. When specific modal values were needed for specific soil types in a particular region AW-STAT was used.

4.3 Heuristic rules

Identification of Reference Soil Groups

Overall the general rules which had been elaborated as part of the methodological study and which are summarized in Table 6 were followed. However some additional rules and refinements have been made.

Table 6 – Simplified key for identifying Reference Soil Groups based on the codes of the legend of the soil map of Belgium (as applied on the Flemish region)

Reference Soil Group	Code	Additional rule
Histosols	V	
Anthrosols	**m	if pH<7

Table 6 – Simplified key for identifying Reference Soil Groups based on the codes of the legend of the soil map of Belgium (as applied on the Flemish region)

Reference Soil Group	Code	Additional rule
Technosols / Unsurveyed areas	OA, OB, OC, OE, OH, OL, ON, OO, OS, OT, OZ	
Fluvisols/Cambisols/Regosols	**p	
Fluvisols		in valleys, close to rivers can be Fluvisols, or Fluvic Cambisols
Cambisols		in valleys, can be Fluvic Cambisols; on slopes Colluvic, ...
Regosols		on slopes, can be colluvic Regosols
Gleysols	*g*, *G*	
Podzols	**g; **h	but excluding *gg, taken as Gleysols
Planosols/Stagnosols	*h*, *i*, ...	
Planosols	u*h*, w*h*, ...	typically when there is an abrupt textural change (light to heavier)
Stagnosols	*i*, *h*	*h* if not in valley position
Phaeozems	***(h);**p	If "cambic horizon" but Mollic surface horizon and hence with BS>50%
Umbrisols	***(h);**p	If "cambic horizon" but with Umbric surface horizon and hence with BS<50%
Luvisols/Cambisols/Regosols	**B	
Luvisols	**a, **a(b), (**c ?)	if pH-H2O >= 5.5
Luvisols	**a1, **a(b)1	
Luvisols	**a0, **a(b)0	
Alisols	**a, **a(b), (**c ?)	if pH-H2O < 5.5
Arenosols	Z*x, Z*f*, Z*c, Z*p	if not Zg*, or Z*g
Cambisols	**f, **F, **b, **p, **x	if not Z*.
Regosols	**b, **p	if not not **p(c)

(Source: adapted from Dondeyne *et al.* 2012)

Qualifiers for drainage status

A first set of refining has been made with regards to the drainage status; the rules presented in Table 7 were followed for all soil types.

Table 7 – Rules applied for converting information on drainage status as indicated in the code of the legend of the soil map of Belgium to WRB qualifiers

Code	Qualifier
.a.	"dry" – no qualifier
.b.	"dry" – no qualifier
.c.	taken as "bathygleyic", so "dry" and not mentioned as a qualifier
.A. (= complex of .a. to .d.)	"dry"
.d.	**endogleyic**
.e.	**endogleyic**
.D. (= complex of .c. + .d.)	**endogleyic**
.f.	**gleyic**
.g.	"**epigleyic**" - hence ***Gleysols***
.h.	**stagnic, stagnic endogleyic**
.i. .I. (= complex of .h. + .i.)	**"epistagnic"** - hence *Stagnosols;* exception was made for mapping units in alluvial plains with these drainage classes; these were placed in the complex of "*Gleyic Fluvisols/Cambisols/Phaeozems*".

As an example of how these rules were applied, a hydrosequence of soils with a "spodic horizon" (code "..g") is given in Table 8, with their corresponding WRB classification.

Table 8 – Example of convertion of drainage classes for different Soil series with a "Spodic horizon" identified with code "..g"

Soil series	Description	WRB classification
Zag	Sandy Podzols, excessively well drained, and with a clear Albic horizon	Albic Podzols (*Arenic)
Zbg	Sandy Podzols, well drained, and with a clear Albic horizon	
Zcg	Sandy Podzols, moderately well drained, and with a clear Albic horizon	
Zdg	Sandy Podzols, imperfectly drained and with an Albic horizon	Endogleyic Albic Podzols (*Arenic)
Zeg	Sandy Podzols, poorly drained (and without an Albic horizon)	Endogleyic Podzols (*Arenic)
Zfg	Sandy Podzols, very poorly drained	Gleyic Podzols (*Arenic)
Zgg	Sandy Gleysols; extremely poorly drained, but with a Spodic horizon	Spodic Gleysols (*Arenic)

* Note: The *Arenic* is not currently foreseen as a standard qualifier for Podzols, and is therefore indicated with an asterix

Variations in parent material

Information on occurrence of substratum or variations in parent material implied by codes of phases or variants were interpreted as indicated in Tabe 8

Table 8 – Rules applied for converting information information pertaining to variations in substratum or parent material indicated as phases or variants codes

Code	Qualifier	Description (in Dutch)
w-S..	Abruptic	
l-	Ruptic	
uA..	Endoabruptic	
lS..	Endoruptic	
wP	Endoruptic	
gP…	Hyposkeletic	(grindsubstraat)
qP…	Hyposkeletic	(zandsteensubstraat)
(w)S..	Bathyabruptic	
(l)A..	Bathyruptic	
v…or v-…	Thaptohistic	
wZ..	Endoabruptic	
t-, or t...	Hyposkeletic	(grindsubstraat)
…t	Hyposkeletic	(bijmenging van grind)
…e	Hyposkeletic	(stenige bijmenging)
…(v)	Histic, except for …3(v) taken as Plaggic/Terric	
..g2	terric/anthric/plaggic for the units of the Campine where it means a thick homogenous surface organic layer (25-50 cm or 30-60 cm); not for the western part of the region, where it means relative thin organic layer <30 cm)	
..g3	Terric/Anthric/Plaggic	
..p3	terric/anthric/plaggic, if not a Fluvisol or Phaeozem/Umbrisol	
…(z)	in sandy soils means that top horizon has little humus – hence excluding e.g. Sep(z) of being *Phaeozem* or *Umbrisols*	
…(v)	in sandy soils, *Histic* qualifier.	
Aba1	Nudiargic	

Anthropogenic influence

Soils with a strong human influence, but of which the antropogenic layer is not thick enough for these to qualify as Anthrosols[5] (code "..m"), have the designated codes "…(o)", and "…3" in sandy soils (textural classes Z, S and P). These soils have been given the qualifiers "Terric", "Anthric" or "Plaggic" according; the following rules:

- *Terric* strong human influence and pH > 6 in general code "…3"

[5] For the description of such soil types in a case study in Overpelt (north-eastern part of Flemish region) see Dondeyne (2012) – available at https://lirias.kuleuven.be/handle/123456789/354115

- *Anthric* strong human influence with or without addition of materials and pH < 5, in general with code "…(o)"
- *Plaggic* addition of material and pH < 5.5 – mostly in the eastern physiographic regions, and with either code "…3" or code "…(o)"

Qualifiers pertaining to base saturation

The qualifiers *Dystric*, *Eutric* and *Hypereutric* convey some basic information on the soil fertility status[6]. *Dystric* implies that the base saturation (by 1 M NH4OAc) of the soil in the major part between 20-100 cm is less than 50%; while *Eutric* implies that it is more than 50%. A soil is *Hypereutric* when base saturation is more than 50% throughout between 20-100 cm from the soil surface and 80% or more in some layers within 100 cm. However, as base saturation has only been determined for a very limited number of the legacy soil profiles, the soil pH-H_20 was taken as a proxy. Based on the correlation which had been found between the pH value and base saturation (Dondeyne *et al*., 2012), the following rules were used:

- *Dystric*, when soil pH-H_2O of all horizons is smaller than 5.0
- Either *Dystric* or *Eutric* when soil pH-H_2O is in the range 5.0-5.5; in general *Dystric* in the eastern parts of the Flemish region, and Eutric in the western, unless other indications; e.g. pH in other horizons, or in other similar soils
- *Eutric*, when soil pH-H_2O is in the range 5.5 - 6.2
- *Hypereutric,* when soil pH-H2O is equal are greater than 6.2

For the border cases, preference was given to indicate the soil type as *Eutric*, on the consideration that due to the practise of manuring and fertiliser over the last decades most soils will rather have been subject to eutrification.

Whether soil types qualify for any of these categories has been determined using the data available in de databases AARDEWERK-93 (Van Orshoven et al. 1993) and AARDEWERK-STAT (Beckers *et al*., 2012). AARDEWERK-STAT proved very

[6] See IUSS Working Group WRB (2007), p. 99-100 for exact definitions

convienient for determining average values of specific soil types per physiographic region; AARDEWERK-93 was used to calculate average values of wider range of soil types conjunctively.

Table 9 illustrates the classification in *Dystric*, *Eutric* and *Hypereutric* of the soil types Aba(b) and Aba for the physiographic regions of "Brabants plateau" and "Schelde-Dender interfluvium". As the data shows Aba(b) are predominantly Dystric on the Brabants plateau, while these are *Hypereutric* on the Schelde-Dender interfluvium; as are the Aba soil types in both regions. On this ground, the Aba(b) are actually classified as *Alisols* on the Brabant plateau while all the other Aba(b) and Aba are classified as *Luvisols (Hypereutric)*.

Table 9 – Ilustration of classification of Aba(b) and Aba soil types for two physiographic regions, in Dystric, Eutric and Hypereutric based on their soil pH-H2O status and derived from the AARDEWERK-93 database

Physiographic region	Soil type	Qualifier	Max of count
Brabants plateau			
	Aba(b)0		**14**
	Aba(b)0	Dystric	14
	Aba(b)0	Eutric	5
	Aba(b)0	Hypereutric	4
	Aba(b)1		**11**
	Aba(b)1	Dystric	11
	Aba(b)1	Eutric	4
	Aba(b)1	Hypereutric	6
	Aba0		**13**
	Aba0	Dystric	2
	Aba0	Eutric	1
	Aba0	Hypereutric	13
	Aba1		**24**
	Aba1	Dystric	7
	Aba1	Eutric	6
	Aba1	Hypereutric	24
Schelde-Dender interfluvium			
	Aba(b)0		**5**
	Aba(b)0	Dystric	2
	Aba(b)0	Eutric	1
	Aba(b)0	Hypereutric	5
	Aba(b)1		**3**
	Aba(b)1	Dystric	2
	Aba(b)1	Eutric	2
	Aba(b)1	Hypereutric	3

Table 9 – Ilustration of classification of Aba(b) and Aba soil types for two physiographic regions, in Dystric, Eutric and Hypereutric based on their soil pH-H2O status and derived from the AARDEWERK-93 database

Physiographic region	Soil type	Qualifier	Max of count
	Aba0		**15**
	Aba0	Dystric	1
	Aba0	Eutric	3
	Aba0	Hypereutric	15
	Aba1		**20**
	Aba1	Dystric	8
	Aba1	Eutric	2
	Aba1	Hypereutric	20

Qualifiers pertaining to soil texture

The qualifiers *Arenic, Loamic, Siltic,* and *Clayic* regroup broad soil textural classes. The definitions of these qualifiers and their correspondence with the Belgian soil textural classes are shown in Fig. 8.

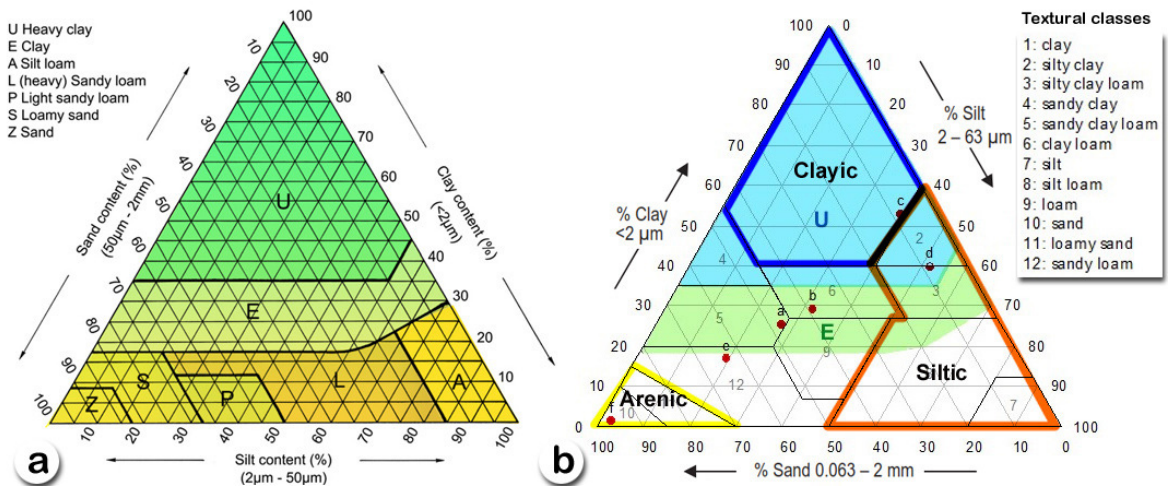


Figure 8 – (a) Definition of Belgian textural classes, compared to (b) the qualifier classes Arenic, Siltic, and Clayic; the remaining ones are refered to as Loamic; as this is currently not foreseen as a standard qualifier, it is used with an asterix (*Loamic)

As the correspondence between Belgian textural classes, and the FAO classes is not a one-to-one relationship, the general rules presented in Table 10 were applied as a first approximation. For the classes which required additional checking, the data from AARDEWERK-93 were further used, according to the following practical rules:

- if Silt content > 50% then *Siltic*, else

- if Clay content > 40% then *Clayic*, else
- if Sand content (50 µm - 2 mm) > 80%, then *Arenic*, else
- *Loamic*

Table 10 – Illustration of classification of "Lbp" soil types for two physiographic regions, in Siltic and Loamic based on the soil textural data in the AARDEWERK-93 database

Belgian soil textural class	Qualifier
A	Siltic
L	Mostly Siltic, sometimes Loamic, based on modal data derived from AARDEWERK-93
P	Loamic
S	Mostly Loamic, sometimes Arenic
Z	Arenic
E	Mostly Loamic, sometimes Siltic
U	Clayic

Table 11 illustrates that when applying the above rules soil types from the series "Lbp" are predomaninantlty *Siltic* on the Brabants plateau, while they are predominantly *Loamic* on the central plains ("centrale vlaamse laagvlakte").

Table 11 – Illustration of classification of "Lbp" soil types for two physiographic regions, in Siltic and Loamic based on the soil textural data in the AARDEWERK-93 database

Physiographic region	Soil type	Qualifier	Max of count
Brabants plateau			
	Lbp0		**12**
	Lbp0	Siltic	12
	Lbp1		**3**
	Lbp1	*Loamic	2
	Lbp1	Siltic	3
	Lbpy0		**5**
	Lbpy0	Siltic	5
	Lcp(c)		**13**
	Lcp(c)	Siltic	13
	Lcp0		**4**
	Lcp0	Siltic	4
	Lhp0		**10**
	Lhp0	Siltic	10
Centrale Vlaamse laagvlakte			
	Ldp0		**5**
	Ldp0	*Loamic	1
	Ldp0	Siltic	5

Table 11 – Illustration of classification of "Lbp" soil types for two physiographic regions, in Siltic and Loamic based on the soil textural data in the AARDEWERK-93 database

Physiographic region	Soil type	Qualifier	Max of count
	LdpcC0		**6**
	LdpcC0	*Loamic	6
	Ldpy0		**10**
	Ldpy0	*Loamic	10
	Ldpy0	Siltic	1
	Lepy0		**3**
	Lepy0	*Loamic	3
	Lepy0	Siltic	3

4.4 Deviations from standard WRB definitions

Aric-Albic and Aric-Spodic

For practical reasons some adaptations of the WRB terminologies have been made. As already mentioned when discussing the qualifiers pertaining to soil texture, the qualifier "Loamic" is added to have a qualifier refering to all textural groups; with some minor deviation from the original definition.

Similarly in WRB the qualifier *Aric* is foreseen for designating "remnants of diagnostic horizons, disturbed by deep ploughing"; and is, as a standard only foreseen for *Regosols*. Our use of the qualifier Aric deviate in two ways: (i) we propose to add the kind of diagnostic horizon of which remnants are found, for example *Aric-Albic* and *Aric-Spodic*; (ii) we do not restrict its use to the reference groups of the Regosols, as remnants of e.g. Spodic or Albic horizons can also be observed in ploughed Podzols, and Anthrosols as illustrated in Fig. 9, but also of Arenosols.

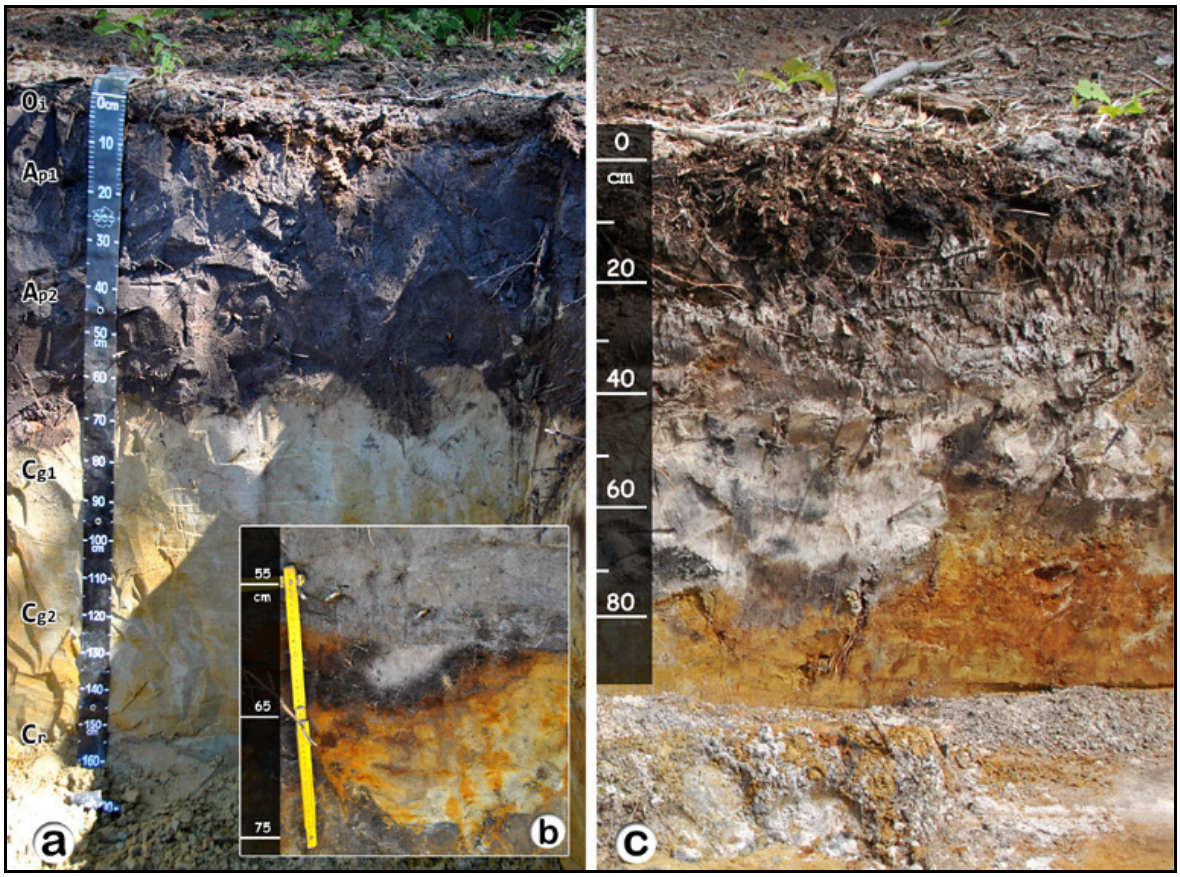


Figure 9 – Illustration of "Aric-Spodic" and "Aric-Albic" horizons; (a) a Plaggic Anthrosol with an "Aric-Spodic" horizon illustrated in (b) inset photograph - profile in Bolderberg; and (c) an "Aric-Albic" Podzol – profile in Herentals

Therefore, the qualifier *Aric-Albic* has been used, wherever soils are considered to be Podzols – indicated by the symbol "..g" following the legend of the soil map of Belgium - but where a strong anthropogenic influence is indicated with symbols "…3" or "…(o)"; typical this is for such soil types as Zag3, Zbg3, ...Scg3, Sdg3.

Hyposkeletic

The qualifier *hyposkeketic* has been used to designate soils which contain stones but less than the 40% required for the qualifier *skeletic*. The legend of the soil map of Belgium has various symbols for indicating different types of stoniness. The symbols, imply that the soil contains more that 15% but less than 40% by volume of stones. The symbols referring to stones in the Flemish region are listed below (see also Table 8):

- "g…", gravel substratum
- "q…", sandstone substratum

- "t-…," or "t…", substratum of gravel deposits of the Meuse
- "…e", admixture of sandstone
- "…f", admixture of schist
- "…k", admixture of limestone
- "…o", admixture of quartz gravel
- "…n", strong admixture of gravel (<25%) in the campine region
- "…t", admixture of Meuse gravel,
- "...x" for admixture of silex

Abruptic and Ruptic

In WRB the qualifier *Abruptic* refers to the occurrence of a sharp increase in clay content within a limited depth[7], with a very precise definition of the minimal amounts of clay increase over a specific depth. The qualifier *Ruptic* refers to soils with a lithological discountinuty within 100 cm of the soil surface, but without any precise clarification of what would constitute a "lithogic discontinuity".

The qualifier *Abruptic* is used to indicate an abrupt increase in clay content inferred from the symbols as for example: "uA.." for heavy clay under silt loam, or "wS.." for sandy clay under sandy loam.

The qualifier *Ruptic* is used where the presence of a substratum is indicated but for which a sharp increase in clay content cannot be inferred e.g. "lP…" for silt loam under sandy loam, or "wA…" sandy clay under silt loam, etc.

These two qualifiers have hence been used in as mutually exclusive, though this is not stricktly implied from their definition in WRB. Using them in this way however allowed to group meaningfully a wide set of soil types.

[7] For full definition see, IUSS Working Group WRB 2007, p. 38-39.

Anthropogenic horizons

For the anthropogenic horizons the qualifiers *Anthric*, *Plaggic* and *Terric* have been used. These are all human induced mineral surface horizons which are at least 20 cm thick but which differ in terms of soil reaction and way of formation as transpires from their definition.

The qualifier *Anthric* is intended for soils with an "*Anthric horizon*" and which are moderately thick (at least 20 cm), dark coloured surface horizons as a result of long-term cultivation. It should[8]:

- meet colour, structure and organic matter content requirement of either mollic or umbric horizons,
- show evidence of human disturbance (e.g. by ploughing), and
- have less than 5% of animal pores, coprolites or other traces of soil animal activity below tillage depth

The qualifier *Plaggic* is for soils with a "*Plaggic horizon*". A plaggic horizon is a black or brown human induced mineral surface horizon produced by long continued manuring and with an acid soil reaction (see IUSS Working Group WRB 2007, p. 36). As diagnostic features it should have[9]

- a texture of sand, loamy sand, sandy loam or loam
- contain artefacts (but less than 20%) and spade marks below 30 cm or evidence of agricultural activity below 30 cm
- moist Munsell colours with a value of 4 or less, and a chroma of 2 or less, and
- occur in locally raised land surfaces

The qualifier *Terric* is for soils with a *Terric horizon.* Terric horizons are human induced mineral surface horizons, at least 20 cm thick, and that develop through addition of earthy manures, compost, beach sands or mud over a long period. As diagnostic criteria[10] it has

[8] For full definition see, IUSS Working Group WRB 2007, p. 12-13.

[9] IUSS Working Group WRB 2007, p. 31.

[10] IUSS Working Group WRB 2007, p. 35-36.

- colour related to the source material
- contain less than 20% artefacts by volume
- a base saturation of 50% or more
- does not show stratification but has an irregular textural differentatiaion and
- has a lithological discontinuity at its base

From the above definitions it is clear that both *Plaggic* and *Terric* are formed by the addition of external material, while *Anthric* horizons are strongly influenced by their long term cultivation, but are supposedly more formed from local material. *Plaggic* horizons have an acid soil reaction, wheres *Terric* horizons are neutral to alkaline. The criteria of a *lithological discontinutity* is some what complicated as (a) this is not precily defined, and (b) if farmers over centuries have e.g. been raising their fields with coversands from nearby fields, as in the campine of northern Belgium one can not expect to have distinct mineralogical differences between these materials.

Therefore we adapted these definitions whereby:

- *Anthric* was used for soils with clear Anthropogenic influence but without indication of addition of external materials (in general code "…(o)"); and with no specification of soil reaction (either "*Dystric* or *Eutric*");
- *Plaggic* and *Terric* are used to imply that there has been a historic translocation of material (but not necessarily leading to a "lithological discontinuity" and whereby the Plaggic qualifiers imply that the soil is acid (*Dystric*), while *Terric* implies that the soil reaction is neutral to alkaline (*Eutric* or *Hypereutric*); in general code "…3", and base status verified per region based on AARDEWERK-93 data.

5. Conversion to WRB units

5.1 Classification of soil profiles

The 363 legacy soil profiles classified according to WRB were used as a guiding reference when applying the conversion principles. Qualifiers which are not foreseen as a standard in the WRB classification for the given Reference Soil Group, are indicated with an asteric "*". Examples are the use of the qualifier **Loamic*, which is not explicitly foreseen as a qualifier for the soil texture, but also for example **Humic*, which is not foreseen for *Albeluvisols*, or **Plaggic* which is not foreseen for *Arenosols*, nor for *Podzols*.

The correspondence between "soil types" from the legacy soil profile descriptions and WRB can not be used directly for converting the "soil types" of the mapping units. First, the original classification of the legacy soil profiles has been done in different phases over time, during which the classification systems have been modified. The classification of four profiles, given in Table 12 illustrate the type of difficulties which were encountered:

- Profile 103E27, has been coded as a soil type "*Aba1*" in AARDEWERK-93; this corresponds neatly with the classification in WRB of a *Cutanic Luvisol (Nudiargic, Siltic);* the soil type given in the soil profile description refers to an older classification, and does not allow any direct conversion; the soil type indicated by the mapping unit is of a different kind as it : soil type *Abp(c)* is understood to be a soil with an argic horizon (within one meter) buried under colluvial material, hence a *Cutanic Luvisol (*Colluvic, Siltic)*; so *Colluvic* rather *Nudiargic*.
- However, whereas in this first example the soil type indicated in AARDEWERK-93 corresponds beter with the WRB classification than the one of the mapping unit, for the soil profiles 103W06 and 050W34, none do really correspond nicely to what could be expected; according to the soil profile description 103W06 has no argic horizon – so an "Aba" was not an appropriate classification. It is actually a highly eroded Luvisol, were the remains of the former lower part of the argic horizon is now just below the plough layer. This horizon meets the requirements of a Cambisol, but so this soil has no colluvial material as one would expect from the mapping unit "Abp(c)". The

author[11] of the soil profile description even classified the profile as a "Regosol, Brown forest soil".

- The fourth example (067E12), just as the previous one (050W34), illustrates that profile development "..c" does not necesseraly implies the presence of an argic horizon. The mapping unit wPbc of profile 067E12 at least conveyes the information of the presence of a lithologic discontinuity; and is in this case therefore closer to the WRB classification of a *Haplic Cambisol (Ruptic)*.

Table 12 – Illustration of discrepancies between the different classifications of the Belgian soil types for four soil profiles and WRB classification; AW-93 standing for the coding in the AARDEWERK-93 database

Profile	Soil type			WRB classification
	AW-93	Profile description	Mapping unit	
103E27	Aba1	A1a	Abp(c)	Cutanic Luvisol (Hypereutric, Nudiargic, Siltic)
103W06	(s)Aba1	(s)Aba1	Abp(c)	Haplic Cambisol (Calcaric, Bathyruptic, Siltic, Bathyarenic)
050W34	Ldc1	type (O)Ca6	Ldc	Endogleyic Regosol (Hypereutric, Siltic, *Drainic, *Ruptic)
067E12	Pbc0	Pbc0	wPbc	Haplic Cambisol (Ruptic, Eutric, Bathyarenic, *Loamic)

5.2 File attribute table of the conversion

The conversion of the legend of the soil map of Belgium has been applied on an overlay of the digital version of the soil map of the Flemish region (version 2001) intersected with a layer of the physiographic regions derived from the "physiograhic systems" map prepared by Honnay (1994). The structure of the attribute table of this layer is presented in Table 13.

Table 13 – Structure of the file attribute table of the converted version of the soil map of Flemish region

Nr	Field names	Description	Source
1	CODEID	Id of soil code	digital soil map of the Flemish region
2	CODE	Code corresponding to soil type	"
3	FIRST_FYSC	Code physiographic region	Map by Honney (1994)
4	C_S_FYS	Code for "soil type" per physiographic region	Code x FIRST_FYSC

[11] The author of this profile is the late Prof. Denis Lamberts

Table 13 – Structure of the file attribute table of the converted version of the soil map of Flemish region

Nr	Field names	Description	Source
5	REGION	Name of physiogragphic region	Map by Honney (1994)
6	SQKM	Area in square kilometer	GIS operation
7	RSG	Reference Soil Group	this study
8	PRE_QUAL	Prefix qualifiers according to WRB-2007	"
9	SUF_QUAL	Suffix qualifiers according to WRB-2007	"
10	MAINQ-1	1st Main legend qualifier, according to WRB-2010	"
11	MAINQ-2	2nd Main legend qualifier, according to WRB-2010	"
12	MAINQ-3	3rd Main legend qualifier, according to WRB-2010	"
13	OPT_Q1	Optional qualifier relating to morphologic characteristics	"
14	OPT_Q2	Optional qualifier relating to fertility	"
15	OPT_Q3	Optional qualifier relating to texture	"
16	OPT_Q4	Optional qualifier relating to drainage status	"

Fieldnames and "id-codes" have been retained from the original data layers (i.e. CODEID, CODE, FIRST_FYSC). An additional field code (C_S_FYS) was created by combining "CODEID" and "FIRST_FYSC" to have a unique id-code for each combination of "soil type" per physiographic region (Table 13).

The WRB Reference Soil Groups are stored in a separate field (RSG) and so are the prefix qualifiers (PRE_QUAL) and suffix qualifiers (SUF_QUAL), following the principles of soil classification according to the WRB-2007 system. Next are three fields foreseen as *Main Qualifiers* and four fields as *Optional Qualifiers*.

The main qualifiers are recorded following the hierarchy proposed in the "WRB-2010 guidelines for map legends"; optional qualifiers are regrouped according to four themes, and for which only one qualifier has been retained per field. In the first optional field (OPT_Q1) qualifiers are that give information on morphology (e.g. *Cutanic*, *Albic*, *Endoruptic*, *Abruptic*, *Terric*, …); in the second field (OPT_Q2), qualifiers relating to fertility status are retained (e.g. *Dystric*, *Eutric* and *Hypereutric*); in the third optional field (OPT_Q3) qualifiers relating to texture (e.g. *Loamic*, *Arenic*) and in the fourth one (OPT_Q 4) qualifiers relating to drainage status (*Gleyic*, *Drainic*, …). In line with the

guidelines, however, the optional qualifiers are only given when these are not yet foreseen as one of the main qualifiers.

Currently, the conversion has been done for 5709 different *soil types* covering 83% of the Flemish region. In terms of area, this result is lower than the aimed 90% which is covered by the 408 largest soil types (see Table 5); but is much higher in terms of number of soil types. The discrepancy is due to (i) the extra time taken to nevertheless also convert soil types covering relative small areas but which are variants of major units; (ii) difficulties encountered to convert some units. When no good WRB conversion name was found, these units had been provisionally coded as "UNDETERMINED". In Annex 2 a list is given of the most common WRB Reference Soil Groups per physiographic region and their correspondence with the *soil types* (according to the legend of the soil map of Belgium).

For example once established that a soil type "*Zbg*" corresponds to an *Albic Podzol*, following the heuristic rules, it is possible to classify in a semi-automated way its variants, as illustrated in Table 14 for the seven out of the 45 varients of Zbg.

Table 14 – Illustration of classification of soil types as varients of the "Zbg" soil series

Soil type	Area (km²)	RSG	Prefix qualifier	Suffix qualifier
Zbg	75.7	Podzols	Albic	*Arenic
Zbg(b)(z)	0.15	Podzols	Albic	*Arenic
Zbg1n	0.11	Podzols	Hyposkeletic Albic	*Arenic
Zbg1t	35.09	Podzols	Hyposkeletic Albic	*Arenic
Zbgt	13.8	Podzols	Hyposkeletic Albic	*Arenic
Zbgx(o)	0.006	Podzols	Aric-Albic	Anthric, *Arenic
Zbgy	0.24	Podzols	Albic	*Arenic

Difficulties for converting some soil types

Conversion of soil series "*Sdf*" illustrates the difficulties encountered for converting some mapping units. The "*Sdf*" soil series (so with all its variants as "soil types", all together cover about 62 km² of the Flemish region. These soils are mostly sandy loam soils "*S..*", but occassionaly even more sandy, and their profile development is described as having a

"weak Podzol" development (code "..*f*"). Despite the relative large area taken by these soil types there are only about 15 to 20 corresponding legacy soil profiles[12].

As the classification of the soil profiles in Table 15 shows soil types of the "Sbf series" can be very varied ranging from *Arenosols* and *Podzols* over *Cambisols* to *Phaeozems* with regard to Reference Soil Groups. In terms of soil reaction these can be *Hyperdystric* (low base saturation, throughtout the profile) to *Eutric/Hypereutric* high base saturations, which is implicit to the concept of Phaeozems.

Table 15 - Example of the classification of soil profiles relating to the Sdf soil series; the Sdf mapping unit, with all all its variants, cover an area of about 62 km² while there area only 15 to 20 related legacy profiles of which the classification of 8 are presented here

Profiles	AW-93	Text	Mapping unit	RSG	Prefix qualifier	Suffix qualifier
103W17	Sbfc	Sbfd	S-Z	Arenosol	Brunic Lamellic	Dystric
061W50	(u)SbfcC	Sbfc	Sbfc	Cambisol	Haplic	Hyperdystric, Ruptic, *Loamic
007E24	Sdf	Sdf(m)	Pdm	Phaeozem	Endogleyic	*Loamic
007E27	uSdf2	uSdf	w-Sdh3(h)	Phaeozem	Stagnic Endogleyic	Abruptic, *Loamic
103W38	wSbfc2	wSbfd	Aba1(b)	Planosol	Endogleyic	Albic, Endoeutric, Arenic, *Humic
061W44	gSbfc2	(g)Sbfe	ZAfe	Podzol	Orsteinic	Humic, Dystric, *Abruptic, *Loamic
103E12	SbfcC	CT1	sLbc	Regosol	Haplic	Eutric, Arenic
006W20	lSdf2	uSd2 (oud symbool M1K1)	w-Seg	Umbrisol	Cambic	Anthric, Humic, Hyperdystric, *Loamic, *Ruptic

Note 103W in the physiographic region of "Brabant plateau"; 061w "Heuvelland van Lummen"; 007e "Kempische cuesta"

[12] The range depends on which classification ones follows as described in the text, or according to AARDEWERK-93.

5.3 Aspect of building a legend

As explained in the previous section, the names according to the WRB classification (IUSS Working Group WRB, 2007) as well as the qualifiers following the Guidelines for map legends (IUSS Working Group WRB, 2010) have been included in the conversion table and are stored in the file attribute table of the GIS layer. As can be seen from the example in Table 16, using directly the Prefix qualifiers from WRB-2007, would result into a rather complex legend.

Table 16 – Example of organisation of WRB qualifiers according to the principles of the WRB-2007 classification and the WRB-2010 guidelines for map legends. The latter has the advantage of allowing to generate to easily represent various degrees of detail in a mapping legend; the disadvantage is that the data are not stored according to thematic fields

	WRB-2007 classification			WRB-2010 Legend			
Soil type*	**RSG**	**Prefix qualifiers**	**Suffix qualifiers**	**Main qualifier-1**	**Main qualifier-2**	**Main qualifier-3**	**Optional qualifier**
Zbg	Podzols	Albic	*Arenic	Albic			Arenic
Zbgt	Podzols	Hyposkeletic Albic	*Arenic	Albic	Hyposkeletic	-	Arenic
Zdg	Podzols	Endogleyic Albic	*Arenic	Albic	Endogleyic	-	Arenic
Zdgt	Podzols	Endogleyic Hyposkeletic Albic	*Arenic	Albic	Hyposkeletic	Endogleyic	Arenic

* According to the legend of the soil map of Belgium

Therefore the WRB-2010 guidelines, foresee a set of main qualifiers which are ranked such that the most pertinent characteristics will be presented and, according to the scale of the map, more or less of these characteristics can be indicated. The approach proposed in the WRB-2010 guidelines offers a convenient way of classifying and storing soil information. However, as the qualifiers are not organised in a thematic way, we would argue that this system lacks some "GIS logic". The following two examples illustrate this point.

Firstly, in Table 16 Podzols are shown, of which the soil types vary in terms of drainage status (well drained or *Endogleyic*) and stoniness (*Hyposkeletic*). When a legend is made following the guidelines, at the highest levels all of these soil types would appear as *Albic Podzols*. At a more detailed level, by including the second main qualifier the *Zbgt*, and *Zdgt*, would both get the qualifier "*Hyposkeletic*", and *Zdgt* the qualifier *Endogleyic*. When two main qualifiers are retained in the legend, by applying the guidelines, soils with similar drainage limitations (*Endogleyic*) will get separated, depending on whether they

are "*Hyposkeletic*" or not (case of *Zdg* and *Zdgt* in this example); it would require including a third level to make clear that these soil types have the same constraints in terms of drainage.

If however, the qualifiers would be grouped in categorical themes e.g. one set of qualifiers relating to morphologic features (stoniness, textural changes,…), drainage status, fertility status, etc. the map user would have more flexibility for highlighting characteristics relevant to the use of the map. A map user involved in irrigation and drainage works will be more interested in knowing whether a mapping units is gleyic or not, while a project involving construction works may be more interested in the stoniness of the soils.

A second example illustrates the consequence of the differences in ranking priorities given to the qualifiers for different Reference Soil Groups (Table 17).

Table 17 – Illustration of differences in ranking for the qualifiers Brunic and Dystric, between Arenosols and Regosols according to the WRB guidelines for map legends

Soil type*	RSG	Pre-Qual	Suf-Qual	Main qualifier-1	Main qualifier-2
(w)Zcc	Arenosols	Brunic	Dystric, *Bathyabruptic	Brunic	Dystric
wZcc	Regosols	Haplic	Brunic, Dystric, Endoabruptic	Dystric	Brunic

* According to the legend of the soil map of Belgium

Soils of the soil mapping unit *(w)Zcc* and *wZcc* are both sandy soils, well drained and with a weak soil profile development. These features are summarised by the symbols of the "*Zcc*". Based on average values of their soil reaction (pH-H_2O) these soils are considered to have a base saturation below 50%, and hence get the qualifier *Dystric*.

These soil types both also have a sandy-clay substratum:

- for the *(w)Zcc* soil type this substratum occurs below 1 m depth; and therefore gets classified as an *Arenosol*.
- for the *wZcc* series, the substratum occurs somewhere between 0.5 - 1 m depth; and is therefore classified as a *Regosol*.

According to the guidelines for the legend, the *Brunic* qualifier preceeds the qualifier *Dystric* for the Arenosols; while for the Regosols the order is *Dystric*, before *Brunic*. It seems rather unfortunate that these same qualifiers, of actually rather similar soils, would get presented in such a confusing order.

5.4 Associations of Reference Soil Groups

With the current knowledge and information base on the soils of Belgium, it is not always possible to converte all the *soil types* (and or mapping units) unequivocally in unique WRB Reference Soil Groups. It has therefore been necessary to create some complex RSG units as defined below.

Alluvial soils

Soils derived from alluvial deposits are naturally very variable. When their morphology is still dominated by clear alluvial deposits they key out as *Fluvisols* at the level of Reference Soil Groups. However, when they have not been regularly subjected to flooding in recent times, soil structure will have developed and they then key out as *Fluvic Cambisols*. As in humid conditions, organic matter tends to accumulate, they may develop an organic rich black surface horizon, which if the base saturation is higher than 50% (when a neutral or alkaline soil reaction prefail), which when thick enough (25-30 cm) qualifies as a Mollic horizon. Such soils will key out as *Fluvic Phaeozems*; under more acidic conditions these soils will have an Umbric horizon, and key out as Fluvic Umbrisols.

As the legend of the soil map of Belgium does not allow to distinguish these types of soils, we opted to group them into ***complex soil mapping units*** of:

- *Fluvisols/Cambisols/Phaeozems* in the physiographic regions where soils are known to have a base saturation higher than 50% (or pH-H2O > 5.5); and as
- *Fluvisols/Cambisols/Umbrisols*, in the physiographic regions where soils are known to have a base saturation of less than 50%, or (or pH-H2O < 5.5).

As such soils could be *Gleyic Mollic/Umbric Fluvisols*, *Gleyic Fluvic Cambisols*, *Gleyic Fluvic Phaeozems* or *Gleyic Fluvic Umbrisols*; the most relevant qualifiers are pertaining

to the drainage status (*Endogleyic*, *Gleyic*, or nothing for the drier ones) and for the soil textural categories (*Arenic*, *Siltic*, *Loamic*, and *Clayic*).

Polders of the Scheldt

Soils of the polder region of the Scheldt pose similar problems of classification as those of alluvial deposits. However as these soils, due to drainage and the construction of dykes are no longer prone to flooding these are not classified as Fluvisols. For these soils a complex has been defined of *Cambisols/Phaeozems*.

Eroded areas of the silt-loam belt

The dominant soils of the silt-loam belt of Belgium are Luvisols and are known to be very sentive for soil erosion. Next to the build-up areas (OB), the soil type, *Aba1* being a *Cutanic Luvisol (Nudiargic, Siltic*) is indeed the most common soil type of the Flemish region (615 km²). On sloping areas soil erosion has often been so pronounced that only the lower part of a former argic horizon remains, and which then qualifies as a *Cambic* horizon, or even the calcaric löss is exposed. In the legend of the soil map of Belgium such areas have already been mapped as a complex as *AbB;* in WRB this mapping unit is hence converted into a complex of *Luvisols/Cambisols/Regosols*.

Buildup and unsurveyed areas

Build-up areas, and unsurveyd areas – most of which are coded as OB, OT, ON and OE – have all pooled together in a complex unit of "*Technosols/Unsurveyed areas*".

6. Discussion and conclusions

6.1 General considerations

This assignment aimed at converting the legend of the soil map of Belgium for the Flemish Region to WRB units, with the exception of the province of West Flanders (Fig. 1). The conversion has been done per 24 physiographic regions as defined by Honnay (1994) (Fig. 7). However, a great deal of the mapping units of the physiographic regions at the border of West and East Flanders have already been done.

The converted units have been stored in a file attribute table and with qualifiers according to both the WRB-2007 classification system as well as according to the WRB-2010 guidelines for legend. Once the conversion of the soil map for the Flemish region, will be completed, i.e. the soil maps of the province of West Flanders and in particular the coastal polders and dunes, it will be possible to device a consolidated legend. When doing so, some consideration should be given on whether the legend should stick to the WRB-2010 guidelines, or whether it would be preferable to have a legend meeting the specificity of the Belgian soil map and the needs at the levels of the Flemish region, and most particular which would be better compatible with the use of geographical information systems.

Having the legend of the soil map of Belgium converted into WRB, does not imply substituting one classification with another one. To put it into GIS terms, it should be realised that we merely added some extra layers of information, which are the result of a particular interpretation of the original maps. Whenever, map users will need more detailed information, they can still access the original data. Actually with the present conversion the original *soil types* have been reorganised in higher ranked classification categories determined by the *Reference Soil Groups* and the WRB qualifiers, and which vary per physiographic region. The low grade of hierarchy of classification that WRB provides, is the key that such a regrouping of *soil types* into wider categories could at all be accomplished. This aspect of WRB is defenitly one of its strength.

6.2 Insights into soil geography

Obviously, having the mapping units of the soil map of Belgium now converted to internationally accepted categories will be helpful to international communication, but also contribute to a better understanding of the local soil geography.

A particular case is the relative common occurrence of *Planosols* (and *Stagnosols*) in the Flemish region. According to the legend of the soil map of Belgium Planosols are really distinguished as a variant – e.g. by coding them as w-Pdc versus Pdc. Their occurrence has surely escaped attention of soil surveyors, researchers and land-use planners. How distinct these soils however can be is illustrated with the description of two such profiles in Annex 3.

Likewise, from our field observations it appears that *Stagnic* properties may have been underreported, and/or have been confused with groundwater gleyic properties. The user of the map should take this into account, and particularly where an abrupt textural change is present, (indicated with the qualifiers "*Abruptic*" or "*Endoabruptic*" this may be the case.

This last observation actually brings us to the observation that there is a need for a more systematic verification and updating of the current map. For example, in this conversion soils are considered "*Dystric*" – i.e. a base saturation below 50% or "*Eutric*" (or even *Hypereutric*") based on data of soil pH-H_20 measurements mostly done in the 1950s to 1970s. Given the use of fertilizers, and the practices of overmanuring over the last decades, many of the inferred soil qualifiers may not be valid today.

Furthermore, some more terrain verification should be done in areas where legacy data is incomplete and/or really old. For example, in the the physiographic regions of the lime plateau (*Krijtplateau*), the density of legacy soil profiles is rather low; the legacy data of the soils of the Scheldt (*Scheldepolders*) lack data on the Munsell colours, needed for determining whether soils are really Phaeozems or not.

6.3 Considerations with regards to the use of WRB

The low hierarchical classification structure of WRB, together with it's high flexibility for combining and using qualifiers allow to convert most of the soil types of the legend of the soil map of Belgium. However, having effectively two classification systems, one intended for classifying soil profiles (WRB-2007) and one as guidelines for the construction of map legends (WRB-2010) lead to some confussion.

As the guidelines suggest the map legend should retain qualifiers which are most relevant to land users, and to people who will use the maps for spatial modelling and inferences. From the current experience it seems that it would be better to allow organising qualifiers in a limited number of thematic groups, rather than having them partly organised in a hierachical system as is currently proposed. Ideally, the qualifiers should be arranged in such a way that the user will have the maximal flexibility when incorporating WRB qualifiers into a geographical information system.

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Annexes

Annex 1 - Classification of 363 legacy soil profiles according to WRB-2007; "soil types" are taken as coded in AARDEWERK-93 and correspond with soil mapping units of the legend of the soil map of Belgium

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
Albeluvisol				**26**
	Cutanic			**3**
		Bathyruptic, Dystric, *Loamic		**1**
			sLcc2	1
		Dystric, Siltic		**1**
			Aba(b)1	1
		Humic, Epidystric, Siltic		**1**
			Lcc0	1
	Cutanic Fragic			**3**
		Bathyruptic, Dystric, *Loamic, *Humic		**1**
			sLcc2	1
		Bathyruptic, Dystric, Siltic		**1**
			Lcc0	1
		Dystric, *Loamic		**1**
			Lcx	1
	Endogleyic			**1**
		Dystric, *Humic, *Loamic		**1**
			Pdc0	1
	Endogleyic Cutanic			**4**
		Bathyabruptic, Dystric, Siltic		**1**
			Ldc0	1
		Dystric, *Loamic		**1**
			Ldc0	1
		Eutric, *Loamic, *Humic		**1**
			Ldc(o)cC0	1
		Eutric, Endosiltic, *Epiloamic		**1**
			Ldc0	1
	Haplic			**1**
		Ruptic, Eutric, *Loamic		**1**
			Pbc0	1
	Stagnic Cutanic			**9**
		Bathyabruptic, Hypereutric, Siltic, *Terric,		**1**
			Lhc0	1
		Bathyruptic, Hypereutric, Loamic		**1**
			Lhcz0	1
		Bathyruptic, Hypereutric, Loamic, *Terric,		**2**
			Lhc0	2
		Eutric, Siltic		**2**
			Ahc0	2
		Eutric, Siltic, *Humic		**1**
			Ahc0	1

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
		Eutric, Siltic, *Terric		**1**
			LhccC1	1
		Hypereutric, Loamic		**1**
			Lhcz0	1
	Stagnic Endogleyic			**2**
		Eutric, *Loamic		**2**
			wLda2	1
			wLdacC2	1
	Stagnic Endogleyic Albic			**2**
		Bathyabruptic, Dystric, Siltic		**1**
			Lic0	1
		Eutric, Siltic, *Humic		**1**
			Lic0	1
	Umbric			**1**
		Manganiferric, Dystric, Siltic, *Humic		**1**
			-	1
Alisol				**4**
	Cutanic			**2**
		Ruptic, Humic, Hyperdystric, Bathyarenic		**1**
			(s)Pbc1	1
		Ruptic, Humic, Hyperdystric, Endoarenic, Siltic		**1**
			sLba2	1
	Endogleyic			**1**
		Ruptic, Humic, Bathyarenic		**1**
			Shcz	1
	Stagnic Cutanic			**1**
		Ruptic, Humic, Hyperdystric, Siltic, Bathyarenic		**1**
			(s)Lda1	1
Anthrosol				**15**
	Aric-Spodic Endogleyic Terric			**1**
		Eutric, Arenic		**1**
			Scc	1
	Endogleyic Plaggic			**2**
		Eutric, Hyperarenic, *Albic, *Aric-spodic		**1**
			Zdm	1
		Hypereutric, Arenic, *Albic, *Endoruptic		**1**
			Sdmc	1
	Endogleyic Terric			**4**
		Eutric, Arenic		**1**
			Scc	1
		Eutric, Arenic, *Albic, *Hypoluvic		**1**
			Zec	1
		Eutric, Bathyarenic, *Loamic		**1**
			Scc	1
		Hypereutric		**1**
			sPhpy2	1
	Endostagnic Plaggic			**1**

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
		Dystric, Arenic, *Bathyabruptic		**1**
			Zcm	1
	Epigleyic Terric			**1**
		Arenic, *Calcaric		**1**
			Zgp0	1
	Plaggic			**3**
		Dystric, Arenic, *Humic		**2**
			Zbb	1
			Zbm	1
		Hyperdystric, Hyperarenic		**1**
			-	1
	Spodic Endogleyic Plaggic			**1**
		Dystric, Hyperarenic, *Aric-albic		**1**
			Zdm	1
	Stagnic Endogleyic Plaggic			**1**
		Eutric, Endoarenic, Bathyruptic		**1**
			Sdm	1
	Terric			**1**
		Eutric, Arenic		**1**
			Zcp2	1
Arenosol				**24**
	Albic Endogleyic			**1**
		Dystric, *Humic		**1**
			wSdc	1
	Bathygleyic			**1**
		Anthric, *Arenic		**1**
			Zdg(v)	1
	Bathygleyic Brunic			**1**
		Eutric, *Humic, *Aric-spodic		**1**
			Seg	1
	Brunic			**8**
		Dystric		**3**
			Zbf	1
			Zbp0	2
		Dystric, *Aric-Spodic		**1**
			Zbf	1
		Dystric, *Plaggic		**1**
			Zbf	1
		Epicalcaric, Hypereutric, Drainic, *Humic, *Bathyabruptic		**1**
			Zcp(v)0	1
		Eutric, Bathyabruptic		**1**
			(w)Zcp	1
		Hypereutric		**1**
			Zaf	1
	Brunic Albic Hypoluvic			**1**
		Dystric		**1**
			Zac	1

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
	Brunic Lamellic			**3**
		Dystric		**1**
			Sbfc	1
		Eutric		**2**
			Zbfc	1
			Zbx	1
	Brunic Rubic Hypoluvic			**1**
		Dystric		**1**
			Zbc	1
	Endogleyic Brunic			**5**
		Dystric		**1**
			Zdp0	1
		Endoeutric		**1**
			Zdb	1
		Eutric, *Humic		**1**
			Zdpy0	1
		Eutric, *Terric		**1**
			Zdb(o)	1
		Hypereutric		**1**
			Zdb	1
	Haplic			**1**
		Eutric		**1**
			Zbx	1
	Hypoluvic			**1**
		Dystric, *Humic		**1**
			Zcg(o)	1
	Stagnic Endogleyic			**1**
		Dystric, *Humic		**1**
			Zhc	1
Cambisol				**69**
	Bathygleyic Fluvic			**1**
		Humic, Dystric, Abruptic, Ruptic, *Epiloamic, *Endosiltic, *Bathyarenic		**1**
			uEhpz3	1
	Endogleyic			**19**
		Dystric, *Loamic		**1**
			Sdpy1	1
		Eutric, *Loamic		**4**
			Pdc0	2
			Sdb	1
			Sdbz	1
		Eutric, Bathyruptic, *Loamic		**1**
			Ldc0	1
		Eutric, Endoarenic, *Loamic, *Bathyabruptic		**2**
			Sdbz	2
		Hypercalcaric, Ruptic, Abruptic, Epiarenic, Endoclayic		**1**
			sLdp3	1

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
		Hypereutric, *Loamic		**4**
			Ldc1	1
			Pcc0	2
			PcccC0	1
		Hypereutric, Bathyruptic, *Loamic		**2**
			Ldc0	1
			Ldcz1	1
		Hypereutric, Bathyruptic, Siltic		**2**
			Ldc0	1
			Ldc1	1
		Hypereutric, Loamic		**2**
			Lca0	2
	Endogleyic Fluvic			**20**
		Calcaric, Bathyarenic		**1**
			Lcp0	1
		Calcaric, Endoarenic		**1**
			sLep3	1
		Calcaric, Humic		**1**
			uEdpy3	1
		Calcaric, Humic, Endoarenic, *Loamic		**1**
			sLep(o)2	1
		Calcaric, Humic, Endoclayic, Drainic, *Abruptic, *Ruptic		**1**
			P6	1
		Calcaric, Humic, Ruptic, *Loamic, *Drainic		**1**
			sEdp2	1
		Calcaric, Humic, Ruptic, *Loamic, Endo-Bathyarenic, *Drainic		**1**
			sLepy2	1
		Calcaric, Humic, Ruptic, Episiltic, Endoloamic, *Loamic, *Bathyarenic, *Drainic		**1**
			wEdp2	1
		Calcaric, Humic, Siltic		**1**
			Eep0	1
		Endoarenic, *Loamic		**1**
			Sepz0	1
		Eutric, Endoclayic, *Loamic		**1**
			uEepcC3	1
		Humic, Dystric, *Loamic		**1**
			Sfp(v)0	1
		Humic, Eutric, Siltic		**1**
			Aep1	1
		Humic, Eutric, Siltic, *Abruptic, *Ruptic		**1**
			Efp0	1
		Hypercalcaric, Abruptic, Ruptic, *Epiloamic, *Endosiltic, *Bathyarenic		**1**
			Scpz1	1
		Hypercalcaric, Drainic, *Abruptic		**1**

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
			C5	1
		Hypercalcaric, Endosiltic, Bathyarenic, Drainic, *Abruptic, *Bathyruptic		**1**
			B4	1
		Hypercalcaric, Humic, Abruptic, Ruptic, Endoclayic		**1**
			wUdpz	1
		Hypercalcaric, Humic, Endoarenic, Drainic, *Ruptic, *Mollic		**1**
			E2	1
		Hypercalcaric, Humic, Epiclayic, Endoarenic, Drainic, *Abruptic, *Ruptic		**1**
			W1	1
	Endogleyic Terric			**1**
		Eutric, *Loamic		**1**
			Pdc0	1
	Fluvic			**2**
		Calcaric, Endoarenic		**1**
			Sdpz0	1
		Hypercalcaric, Humic, Bathyarenic, *Abruptic, *Ruptic		**1**
			sEdp2	1
	Gleyic Fluvic			**1**
		Humic, Eutric, Siltic		**1**
			Aib(1)	1
	Haplic			**20**
		Bathycalcaric, Hypereutric, Siltic		**3**
			Abb	1
			AbB3	2
		Calcaric, Bathyruptic, Siltic, Bathyarenic		**1**
			(s)Aba1	1
		Colluvic, Hypereutric		**1**
			Ldp0	1
		Colluvic, Hypereutric, Siltic		**3**
			Abp0	2
			Ahc1	1
		Dystric, *Loamic		**1**
			Pbc0	1
		Epidystric, Endoeutric, *Loamic		**1**
			Sbxc	1
		Eutric, *Loamic		**1**
			Pcc0	1
		Eutric, Ruptic, Densic, Endoarenic		**1**
			sPbc2	1
		Eutric, Siltic		**1**
			AbB2	1
		Humic, Dystric, Ruptic, Bathyarenic, Siltic		**1**
			(x)Lbc0	1
		Humic, Hypereutric, Siltic		**1**
			Lbpy0	1

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
		Hyperdystric, Ruptic, *Loamic		**1**
			(u)SbfcC	1
		Hypereutric, Endoruptic, Siltic, Endo- to Bathy-arenic		**1**
			wLda2	1
		Hypereutric, Siltic		**1**
			Lbp0	1
		Ruptic, Dystric, Siltic		**1**
			sLba2	1
		Ruptic, Eutric, Bathyarenic, *Loamic		**1**
			Pbc0	1
	Stagnic Endogleyic			**4**
		Colluvic, Humic, Hypereutric, Siltic		**1**
			Ahp0	1
		Dystric, *Loamic		**2**
			Pcc(o)0	1
			Pccz1	1
		Hypereutric, *Loamic		**1**
			Pcc0	1
	Stagnic Fluvic			**1**
		Humic, Eutric, *Bathyruptic, *Bathy-Thaptohistic		**1**
			Ehp(v)0	1
Fluvisol				**12**
	Endogleyic			**4**
		Calcaric, Endoarenic, *Abruptic		**1**
			B1	1
		Dystric, Arenic		**1**
			SepcC0	1
		Humic, Eutric, Siltic		**1**
			Lhp0	1
		Hypercalcaric, Humic, Epiarenic, *Ruptic		**1**
			uZep(v)2	1
	Epigleyic			**1**
		Hypercalcaric, Epiclayic, Drainic, *Ruptic		**1**
			C5	1
	Epigleyic Thaptohistic			**1**
		Humic, Eutric, Hyperarenic		**1**
			vZfp2	1
	Gleyic			**2**
		Calcaric, *Loamic		**1**
			?	1
		Eutric, Siltic		**1**
			Lhp0	1
	Haplic			**1**
		Hypercalcaric, Endoarenic, Drainic, *Ruptic		**1**
			A1	1
	Mollic Endogleyic			**2**

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
		Humic, Hypereutric, Siltic, *Epiruptic		**1**
			Lfp0	1
		Humic, Hypereutric, Siltic, *Ruptic		**1**
			Aep0	1
	Stagnic			**1**
		Dystric, Arenic		**1**
			Zhp(v)0	1
Gleysol				**11**
	Fluvic			**6**
		Abruptic, Hypercalcaric, Endoarenic		**1**
			C3	1
		Calcaric, Humic, Siltic		**2**
			Agp0	1
			vUfp2	1
		Calcaric, Humic, Siltic, *Ruptic		**1**
			uLhp2	1
		Humic, Dystric, Arenic		**1**
			Zgp0	1
		Humic, Dystric, Siltic		**1**
			Lgp(v)	1
	Haplic			**1**
		Calcaric, Humic, Arenic		**1**
			Zgp0	1
	Mollic Fluvic			**1**
		Humic, Eutric, Arenic		**1**
			Zgp(v)0	1
	Spodic Thaptofluvic			**1**
		Epiabruptic, Humic, Dystric, Arenic, *Endoruptic		**1**
			wZfg(o)c2	1
	Thaptohistic Fluvic			**2**
		Calcaric, Humic, Ruptic, *Epiloamic, *Endoclayic, *Endosiltic		**1**
			vUep	1
		Calcaric, Humic, Ruptic, *Loamic		**1**
			vLgp2	1
Histosol				**2**
	Sapric Rheic			**2**
		Dystric, *Endoarenic		**1**
			sVgp3	1
		Dystric, *Endofluvic, *Endoarenic		**1**
			sVepc2	1
Luvisol				**76**
	Cutanic			**49**
		Bathyruptic, Hypereutric, Nudiargic, Siltic, Bathyarenic		**1**
			(s)AbB3	1
		Bathyruptic, Siltic		**1**
			Lba1	1

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
		Endoruptic, Hypereutric, Nudiargic, Siltic		**1**
			Lca1	1
		Humic, Hypereutric, Siltic		**1**
			Aba0	1
		Humic, Ruptic, Epidystric, Siltic		**1**
			sAca(b)2	1
		Hypereutric, *Loamic		**1**
			(w)Lba0	1
		Hypereutric, Manganiferric, Siltic		**1**
			Aba(b)1	1
		Hypereutric, Nudiargic, *Bathyarenic*, Siltic		**1**
			Lba1	1
		Hypereutric, Nudiargic, Siltic		**18**
			Aba(b)1	1
			Aba1	13
			Abb	1
			AbB2	1
			Aca(b)1	1
			Aca1	1
		Hypereutric, Nudiargic, Siltic, *Bathycalcaric*		**2**
			Aba1	2
		Hypereutric, Nudiargic,Siltic		**1**
			Aba1	1
		Hypereutric, Siltic		**11**
			Aba(b)0	1
			Aba(b)1	2
			Aba0	5
			Aba1	1
			Aca1	1
			Lba1	1
		Hypereutric, Siltic, *Colluvic		**1**
			Abp(c)	1
		Hypereutric,Siltic		**1**
			Aba1	1
		Ruptic, Hypereutric		**1**
			(w)Lba2	1
		Ruptic, Nudiargic, Hypereutric, Bathyarenic, Siltic		**1**
			wAba2	1
		Ruptic,Siltic		**1**
			wLba2	1
		Siltic		**3**
			Aba(b)1	1
			Aba0	1
			Aba1	1
		Siltic, *Colluvic		**1**
			Abb	1

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
	Cutanic Fragic			**1**
		Humic, Ruptic, Dystric, Episiltic		**1**
			(s)Aba(b)1	1
	Endogleyic			**7**
		***Loamic**		**2**
			Pcc0	1
			Pcc1	1
		Hypereutric, *Loamic		**1**
			Pcc0	1
		Hypereutric, Loamic		**1**
			Lcay1	1
		Hypereutric, Nudiargic, Siltic		**1**
			Ada1	1
		Hypereutric, Siltic		**1**
			Lca0	1
		Ruptic, Hypereutric, Nudiargic, Siltic		**1**
			sLdc2	1
	Endogleyic Albic			**3**
		***Loamic**		**2**
			Pcc0	2
		Humic, *Loamic		**1**
			Pcc0	1
	Endogleyic Albic Cutanic			**1**
		Hypereutric, *Loamic		**1**
			Pcc0	1
	Endogleyic Cutanic			**5**
		***Loamic**		**1**
			Ldc0	1
		Siltic		**4**
			Ldc0	3
			Ldcc1	1
	Haplic			**5**
		Hypereutric, Nudiargic, Siltic		**1**
			Aba1	1
		Hypereutric, Nudiargic, Siltic, *Bathyruptic		**1**
			Lba1	1
		Hypereutric, Nudiargic, Siltic, *Calcaric		**1**
			Aca1	1
		Hypereutric, Siltic		**1**
			Lbp0	1
		Hypereutric, Siltic, *Colluvic		**1**
			Abp0	1
	Haplic/Cutanic			**1**
		Hypereutric, Nudiargic, Siltic		**1**
			AbB1	1
	Stagnic Bathigleyic Cutanic			**1**
		Hypereutric, Siltic		**1**
			Ada0	1

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
	Stagnic Cutanic			**2**
		Hypereutric, Nudiargic, Siltic		**1**
			Ada1	1
		Ruptic, Hypereutric, Siltic		**1**
			wLda2	1
	Stagnic Endogleyic Cutanic			**1**
		Humic, Hypereutric, Siltic		**1**
			Ahp(c)	1
Phaeozem				**29**
	Cambic Endogleyic			**2**
		Endoarenic, *Loamic		**1**
			Sepz0	1
		Endoruptic, *Loamic		**1**
			wUepz2	1
	Endogleyic			**11**
		***Loamic**		**2**
			PdccC0	1
			Sdf	1
		Calcaric, *Loamic, *Fluvic, *Drainic		**4**
			Edp0	2
			Edpy0	1
			Edpz0	1
		Calcaric, *Loamic, *Fluvic, *Drainic, *Bathyruptic		**1**
			Ldp0	1
		Calcaric, Clayic, *Fluvic, *Drainic		**2**
			Udp0	2
		Calcaric, Epiclayic, *Fluvic, *Ruptic, *Drainic		**1**
			Udpz0	1
		Endocalcaric, Clayic, *Fluvic, *Ruptic, *Drainic		**1**
			Udpz0	1
	Endogleyic *Fluvic			**6**
		Bathycalcaric, Abruptic, Ruptic, *Humic		**1**
			lUdp	1
		Calcaric, *Loamic		**1**
			Eep(v)0	1
		Calcaric, Endoarenic		**1**
			sEhp2	1
		Calcaric, Epiclayic, Endosiltic, *Abruptic, *Ruptic, *Humic		**1**
			vUep	1
		Endocalcaric, Abruptic, Ruptic, Drainic		**1**
			DC1	1
		Pachic, Siltic		**1**
			Ldc0	1
	Endostagnic *Fluvic			**1**
		Hypercalcaric, Siltic, *Humic, *Drainic, *Ruptic		**1**

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
			sUhp(v)	1
	Fluvic			**1**
		Calcaric, Humic, *Thapto-Arenic, *Ruptic		**1**
			sEdp3	1
	Gleyic			**2**
		Endoarenic, *Loamic		**2**
			Sepz0	2
	Luvic Endogleyic			**1**
		***Loamic**		**1**
			Pdc(o)0	1
	Luvic Stagnic Endogleyic			**1**
		***Loamic**		**1**
			Pdcy0	1
	Stagnic			**1**
		Bathyruptic		**1**
			(w)Lhp1	1
	Stagnic Endogleyic			**3**
		Abruptic, *Loamic		**1**
			uSdf2	1
		Calcaric, *Loamic, *Fluvic, *Drainic, *Bathyruptic		**2**
			uLdp2	1
			wLdp2	1
Planosol				**9**
	Endogleyic			**5**
		Albic, Endoeutric, Arenic, *Humic		**1**
			wSbfc2	1
		Ruptic, Eutric, *Loamic		**1**
			wLda2	1
		Ruptic, Hypereutric, *Loamic		**3**
			wLda2	1
			wLdac2	1
			wLha2	1
	Endogleyic Fluvic*			**1**
		Hypercalcaric, Drainic		**1**
			B3	1
	Haplic			**2**
		Hypereutric, Endosiltic		**1**
			uLhp2	1
		Ruptic, Hyperdystric, Epiarenic, *Endoloamic, *Humic		**1**
			wZdx2	1
	Mollic Endogleyic Fluvic*			**1**
		Hypercalcaric, Drainic		**1**
			C3	1
Podzol				**53**
	Albic			**14**
		***Arenic**		**6**
			Zag	1

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
			Zbg	2
			Zbgc	1
			Zcg	2
		***Dystric, *Arenic**		**4**
			Zbg	2
			Zcg	2
		***Hypolamellic, *Arenic**		**2**
			Zag	1
			Zag(o)	1
		Bathyruptic, *Arenic		**1**
			Zbg(o)	1
		Ruptic, *Arenic		**1**
			(w)Zcc	1
	Albic Ortsteinic			**1**
		***Arenic**		**1**
			Zbg	1
	Albic Placic			**1**
		Bathylamellic, *Arenic		**1**
			Zag	1
	Aric-Albic			**5**
		***Arenic**		**2**
			Zag(o)	2
		Anthric, *Dystric, *Arenic		**2**
			Zbg(o)	1
			Zcg(o)	1
		Dystric, Arenic, *Humic*		**1**
			Zbgc	1
	Carbic			**1**
		Bathylamellic, *Aric-Albic, *Arenic		**1**
			Zcg	1
	Carbic Endogleyic			**1**
		***Aric-albic, *Arenic**		**1**
			Zdg	1
	Endogleyic			**6**
		***Aric-albic, *Arenic**		**1**
			Zdg	1
		***Humic, *Eutric, *Arenic**		**1**
			Zdh(o)cC	1
		Anthric, Ruptic, *Aric-albic, *Arenic		**1**
			lZdg(o)2	1
		Plaggic, *Arenic*		**1**
			Zfg	1
		Plaggic, *Aric-albic, *Arenic		**1**
			Zfg(o)	1
		Ruptic, *Abruptic, *Aric-albic, *Arenic		**1**
			uZdg2	1
	Endogleyic Albic			**8**
		***Abruptic, *Humic**		**1**

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
			Sec	1
		***Arenic**		**1**
			Zdg	1
		***Humic, *Dystric, *Arenic**		**3**
			Zdg	1
			Zdg(o)	2
		***Loamic**		**3**
			SDg	1
			sLbc2	1
			sPbf2	1
	Endogleyic Albic Carbic			**2**
		***Abruptic, *Humic, *Arenic**		**1**
			Zdg	1
		***Arenic**		**1**
			Zdg	1
	Endogleyic Aric-Albic			**1**
		Eutric, *Terric		**1**
			Zdb	1
	Endogleyic Carbic			**2**
		***Aric-albic, *Arenic**		**1**
			Zeg	1
		Anthric, Aric-albic, *Arenic		**1**
			Zegc	1
	Entic			**1**
		***Arenic**		**1**
			Zbg	1
	Entic Endogleyic			**1**
		***Humic, *Abruptic**		**1**
			wSdc	1
	Gleyic Carbic			**1**
		Anthric, Bathyruptic, *Bathyabruptic, *Arenic*		**1**
			(w)Zeg(v)c	1
	Orsteinic			**1**
		Humic, Dystric, *Abruptic, *Loamic		**1**
			gSbfc2	1
	Ortsteinic			**1**
		Ruptic, *Arenic		**1**
			Sbgc	1
	Placic			**4**
		***Arenic**		**3**
			Zbg	3
		Ruptic, *Aric-albic, *Arenic		**1**
			Zcg	1
	Stagnic Bathygleyic			**1**
		Anthric, Ruptic, *Bathyabruptic, *Aric-albic, *Endoarenic		**1**
			wPdg(v)2	1
	Umbric Endostagnic Bathygleyic Albic			**1**

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
		Anthric, Arenic, Endo/Bathyloamic, *Abruptic		**1**
			wZdg(o)2	1
Regosol				**24**
	Colluvic			**8**
		Calcaric, Siltic		**1**
			Abp0	1
		Eutric, Siltic		**2**
			Abp0	1
			Lbp0	1
		Eutric, Siltic, *Bathyruptic*		**1**
			Abp0	1
		Hypereutric, Siltic		**4**
			Abp0	4
	Endogleyic			**3**
		Brunic, Humic, Eutric, Arenic, *Endoloamic, *Abruptic, *Ruptic		**1**
			wZchc2	1
		Brunic, Hypercalcaric, Endoarenic, Drainic, *Abruptic, *Ruptic		**1**
			W2	1
		Hypereutric, Siltic, *Drainic, *Ruptic		**1**
			Ldc1	1
	Endogleyic Aric-Spodic			**1**
		Humic, Epidystric, Endoarenic, *Novic*		**1**
			Sec	1
	Endoleptic			**1**
		Humic, Eutric, Siltic		**1**
			-	1
	Endostagnic			**1**
		***Abruptic, Humic, Dystric, Epiarenic, Endosiltic**		**1**
			(w)Zcx	1
	Haplic			**9**
		Brunic, Calcaric, Arenic, *Ruptic*		**1**
			Zbbc	1
		Brunic, Dystric, Arenic		**1**
			Zbf	1
		Brunic, Humic, Endoarenic, *Ruptic		**1**
			Sbgz	1
		Calcaric, Siltic		**3**
			AbB2	1
			AbB3	2
		Dystric/Eutric?, Arenic		**1**
			SbfcC	1
		Eutric, Endoarenic, *Ruptic		**1**
			sLbp2	1
		Eutric, Endoarenic, Siltic, *Ruptic		**1**
			sLbp2	1
	Stagnic			**1**

Reference soil groups	Prefix qualifier	Suffix qualifier	Soil type	*n*
		Eutric, Ruptic		**1**
			Edp0	1
Stagnosol				**4**
	Endogleyic			**1**
		Eutric, Siltic		**1**
			Lip0	1
	Endogleyic *Fluvic			**1**
		Albic, Ruptic, Bathycalcaric, Hypereutric, Epiloamic, Endoarenic, Drainic, *Humic		**1**
			sEhp2	1
	Mollic Endogleyic			**1**
		Eutric, *Loamic		**1**
			Pdc0	1
	Umbric Luvic			**1**
		Albic, Bathyruptic, Siltic, *Humic		**1**
			Aia0	1
Umbrisol				**5**
	Cambic			**2**
		Anthric, Humic, *Loamic		**1**
			Pcc0	1
		Anthric, Humic, Hyperdystric, *Loamic, *Ruptic		**1**
			lSdf2	1
	Cambic Endogleyic			**2**
		Endoeutric, *Loamic		**1**
			Sep0	1
		Endoeutric, *Ruptic, *Loamic		**1**
			Sepz0	1
	Endostagnic Fluvic			**1**
		Endoeutric, Humic, Siltic, Drainic, *Ruptic		**1**
			Uhp(v)0	1
Grand Total				**363**

Annex 2 – Correspondence between most common Reference Soil Groups and soil types of the legend of the soil map of Belgium grouped per physiographic region; percentage of area of the Flemish region

REGION	RSG	CODE	Area km²	Area %
Brabants plateau			**477**	**2.6**
	Albeluvisols		**33**	**0.2**
		Abc0	26	0.1
		sLbc	7	0.0
	Alisols		**19**	**0.1**
		Aba1(b)	19	0.1
	Cambisols		**36**	**0.2**
		Abp	29	0.2
		ADp	6	0.0
	Fluvisols/Cambisols/Phaeozems		**6**	**0.0**
		Aep	6	0.0
	Luvisols		**127**	**0.7**
		Aba0	9	0.1
		Aba0(b)	23	0.1
		Aba1	67	0.4
		Abp(c)	8	0.0
		Lba0	9	0.0
		sLba	11	0.1
	Luvisols/Cambisols/Regosols		**14**	**0.1**
		AbB	14	0.1
	Technosols / Not Surveyed		**243**	**1.3**
		OB	230	1.3
		OT	13	0.1
Centrale Boomse cuesta			**177**	**1.0**
	Albeluvisols		**11**	**0.1**
		Lhc	11	0.1
	Cambisols		**20**	**0.1**
		Pdcz	20	0.1
	Luvisols		**15**	**0.1**
		Lca	7	0.0
		LDa	8	0.0
	Technosols / Not Surveyed		**131**	**0.7**
		OB	124	0.7
		OE	7	0.0
Centrale Vlaamse laagvlakte			**784**	**4.3**
	Anthrosols		**20**	**0.1**
		Zbm	6	0.0
		Zcm	14	0.1
	Arenosols		**136**	**0.8**
		Zcc(h)	11	0.1
		Zcp	17	0.1
		Zdb	36	0.2
		Zdp	72	0.4
	Cambisols		**95**	**0.5**

REGION	RSG	CODE	Area km²	Area %
		Sdb	39	0.2
		Sdb(k)	12	0.1
		Sdp	44	0.2
	Fluvisols/Cambisols/Phaeozems		**26**	**0.1**
		Sep	26	0.1
	Podzols		**288**	**1.6**
		Sch	6	0.0
		Sdh	13	0.1
		Zbg	21	0.1
		Zbh	14	0.1
		Zcg	47	0.3
		Zch	106	0.6
		Zdg	10	0.1
		Zdh	71	0.4
	Technosols / Not Surveyed		**218**	**1.2**
		OB	198	1.1
		ON	12	0.1
		OT	9	0.0
Dender-Zenne interfluvium			**676**	**3.7**
	Albeluvisols		**60**	**0.3**
		Ldc	12	0.1
		Ldcz	40	0.2
		Lhcz	8	0.0
	Cambisols		**68**	**0.4**
		Abp	8	0.0
		Acp	35	0.2
		ADp	13	0.1
		Ahp	6	0.0
		LDp	6	0.0
	Fluvisols/Cambisols/Phaeozems		**49**	**0.3**
		Aep	16	0.1
		AFp	12	0.1
		Eep	6	0.0
		Efp	7	0.0
		Lep	8	0.0
	Luvisols		**321**	**1.8**
		Aba0	8	0.0
		Aba1	148	0.8
		Abp(c)	25	0.1
		Aca0	11	0.1
		Aca1	49	0.3
		Acp(c)	20	0.1
		ADa1	21	0.1
		Adp(c)	6	0.0
		Lba	13	0.1
		Lca	11	0.1
		Lcaz	9	0.0
	Technosols / Not Surveyed		**178**	**1.0**

REGION	RSG	CODE	Area km²	Area %
		OB	166	0.9
		OT	12	0.1
Depressie van de Netes			**821**	**4.5**
	Anthrosols		**190**	**1.1**
		Sbm(b)	6	0.0
		Scm	11	0.1
		Scm(b)	11	0.1
		Scmx	6	0.0
		Sdm	12	0.1
		Zam	10	0.1
		Zbm	32	0.2
		Zbm(g)	8	0.0
		Zcm	40	0.2
		Zcm(g)	9	0.0
		Zcmb	6	0.0
		Zdm	23	0.1
		Zdm(g)	7	0.0
		Zdmb	10	0.1
	Arenosols		**62**	**0.3**
		X	52	0.3
		Zep	10	0.1
	Cambisols		**14**	**0.1**
		Sep3z	14	0.1
	Fluvisols/Cambisols/Umbrisols		**35**	**0.2**
		Sep	6	0.0
		Sepz	20	0.1
		Sfpz	9	0.1
	Histosols		**9**	**0.0**
		V	9	0.0
	Podzols		**245**	**1.4**
		Sdgx	9	0.0
		w-Zdgb	10	0.1
		Zag	8	0.0
		Zcg	22	0.1
		Zcgb	10	0.1
		Zdg	85	0.5
		Zdg3	11	0.1
		Zdgb	14	0.1
		Zdgy	7	0.0
		Zeg	38	0.2
		Zeg3	6	0.0
		Zegb	19	0.1
		Zegy	8	0.0
	Technosols / Not Surveyed		**266**	**1.5**
		OB	243	1.3
		ON	6	0.0
		OT	18	0.1
Hagelands heuvelland			**303**	**1.7**

REGION	RSG	CODE	Area km²	Area %
	Albeluvisols		**43**	**0.2**
		Lhc	37	0.2
		sLhc	6	0.0
	Cambisols		**53**	**0.3**
		Lbp(c)	21	0.1
		SAfd	7	0.0
		ZAfe	24	0.1
	Fluvisols/Cambisols/Phaeozems		**29**	**0.2**
		AFp	9	0.0
		Eep	10	0.1
		Efp	10	0.1
	Luvisols		**109**	**0.6**
		Lca	14	0.1
		Lca0	19	0.1
		LDa	8	0.0
		Lda0	14	0.1
		Ldp(c)	15	0.1
		sLca	8	0.0
		sLda	6	0.0
		uLDa	8	0.0
		wLca	17	0.1
	Planosols		**23**	**0.1**
		uLhc	9	0.1
		wLDc	13	0.1
	Technosols / Not Surveyed		**46**	**0.3**
		OB	46	0.3
Heuvelland van Lummen			**229**	**1.3**
	Anthrosols		**18**	**0.1**
		Scm	8	0.0
		Zcm	11	0.1
	Arenosols		**36**	**0.2**
		X	27	0.2
		Zbfc	9	0.0
	Cambisols		**14**	**0.1**
		ZAfe	14	0.1
	Cambisols/Phaeozems		**7**	**0.0**
		wSdfc	7	0.0
	Fluvisols/Cambisols/Phaeozems		**7**	**0.0**
		Eep	7	0.0
	Histosols		**17**	**0.1**
		V	17	0.1
	Podzols		**36**	**0.2**
		Sdg	6	0.0
		Zcg	12	0.1
		Zdg	19	0.1
	Technosols / Not Surveyed		**94**	**0.5**
		OB	94	0.5
Kempische cuesta			**449**	**2.5**

REGION	RSG	CODE	Area km²	Area %
	Anthrosols		**74**	**0.4**
		Scm	12	0.1
		Sdm	16	0.1
		Zbm	9	0.0
		Zcm	21	0.1
		Zdm	17	0.1
	Arenosols		**21**	**0.1**
		X	21	0.1
	Podzols		**282**	**1.6**
		l-Zdgb	6	0.0
		Sdg	7	0.0
		w-Seg	21	0.1
		w-Zdg	12	0.1
		w-Zdgb	8	0.0
		w-Zeg	12	0.1
		Zag	6	0.0
		ZAgb	6	0.0
		Zcg	20	0.1
		Zcgb	21	0.1
		Zdg	61	0.3
		Zdgb	26	0.1
		Zdgy	23	0.1
		Zeg	29	0.2
		Zegb	15	0.1
		Zegy	10	0.1
	Technosols / Not Surveyed		**72**	**0.4**
		OB	63	0.4
		OE	9	0.0
Krijtplateau			**7**	**0.0**
	Luvisols		**7**	**0.0**
		Aba1	7	0.0
Kustvlakte			**107**	**0.6**
	Luvisols		**6**	**0.0**
		Lca	6	0.0
	Technosols / Not Surveyed		**101**	**0.6**
		OB	95	0.5
		ON	6	0.0
Leie-Schelde interfluvium			**202**	**1.1**
	Albeluvisols		**23**	**0.1**
		Ldc	23	0.1
	Cambisols		**32**	**0.2**
		ADp	14	0.1
		LDp	12	0.1
		Pcc	6	0.0
	Luvisols		**96**	**0.5**
		Aca	14	0.1
		Ada	28	0.2
		Lba	9	0.0

REGION	RSG	CODE	Area km²	Area %
		Lba0	13	0.1
		Lca	22	0.1
		LDa	10	0.1
	Technosols / Not Surveyed		**52**	**0.3**
		OB	52	0.3
Maasterrassen			**868**	**4.8**
	Anthrosols		**54**	**0.3**
		Scm	8	0.0
		Sdm	7	0.0
		Zbm	11	0.1
		Zbmt	10	0.1
		Zcm	11	0.1
		Zdm	8	0.0
	Arenosols		**181**	**1.0**
		Sbf	8	0.0
		Sbft	13	0.1
		Scft	26	0.1
		X	48	0.3
		Zbf	15	0.1
		Zbf1t	30	0.2
		Zbft	32	0.2
		Zcft	9	0.0
	Cambisols		**9**	**0.1**
		Sbb	9	0.1
	Histosols		**19**	**0.1**
		V	19	0.1
	Podzols		**381**	**2.1**
		Sdg	16	0.1
		Sdgt	14	0.1
		Sdgz	6	0.0
		Seg	9	0.1
		t-Seg	8	0.0
		t-ZAg	13	0.1
		t-Zbg	10	0.1
		t-Zcg	17	0.1
		t-Zdg	17	0.1
		t-Zeg	11	0.1
		Zag	12	0.1
		Zag1t	6	0.0
		Zbg	16	0.1
		Zbg1t	31	0.2
		Zbgt	12	0.1
		Zcg	38	0.2
		Zcg1t	11	0.1
		Zcgt	20	0.1
		Zdg	71	0.4
		Zdgt	11	0.1
		Zeg	33	0.2

REGION	RSG	CODE	Area km²	Area %
	Technosols / Not Surveyed		**223**	**1.2**
		OB	196	1.1
		OE	9	0.1
		ON	7	0.0
		OT	11	0.1
Oostelijke Boomse cuesta			**78**	**0.4**
	Anthrosols		**11**	**0.1**
		Scm	11	0.1
	Cambisols		**8**	**0.0**
		Pdc	8	0.0
	Podzols		**8**	**0.0**
		Sdgy	8	0.0
	Technosols / Not Surveyed		**51**	**0.3**
		OB	51	0.3
Oostelijke Vlaamse laagvlakte			**449**	**2.5**
	Albeluvisols		**133**	**0.7**
		Lcc	6	0.0
		Lccz	10	0.1
		Ldc	38	0.2
		Ldcz	60	0.3
		Lhc	8	0.0
		Lhcz	11	0.1
	Anthrosols		**20**	**0.1**
		Scm	12	0.1
		Sdm	9	0.0
	Arenosols		**6**	**0.0**
		X	6	0.0
	Cambisols		**63**	**0.3**
		ADp	8	0.0
		LDp	8	0.0
		Pcc	15	0.1
		Pdc	21	0.1
		Pdc(h)	9	0.1
	Fluvisols/Cambisols/Phaeozems		**18**	**0.1**
		Eep	18	0.1
	Luvisols		**15**	**0.1**
		Lba	7	0.0
		Lca	9	0.0
	Podzols		**6**	**0.0**
		Pdh	6	0.0
	Technosols / Not Surveyed		**188**	**1.0**
		OB	177	1.0
		OT	11	0.1
Plateau van Haspengouw			**781**	**4.3**
	Albeluvisols		**122**	**0.7**
		Lccz	7	0.0
		Ldc	10	0.1
		Ldcz	49	0.3

REGION	RSG	CODE	Area km²	Area %
		Lhc	15	0.1
		Lhcz	42	0.2
	Cambisols		**110**	**0.6**
		Abp	76	0.4
		Acp	9	0.0
		ADp	25	0.1
	Fluvisols/Cambisols/Phaeozems		**18**	**0.1**
		Aip	6	0.0
		Eep	12	0.1
	Luvisols		**380**	**2.1**
		Aba0	52	0.3
		Aba0(b)	17	0.1
		Aba1	224	1.2
		Aba1(b)	6	0.0
		Abp(c)	66	0.4
		Aca	6	0.0
		Aca0	9	0.0
	Luvisols/Cambisols/Regosols		**20**	**0.1**
		AbB	20	0.1
	Planosols		**18**	**0.1**
		wLDc	10	0.1
		wLhc	8	0.0
	Technosols / Not Surveyed		**114**	**0.6**
		OB	90	0.5
		ON	7	0.0
		OT	17	0.1
Polder-Leie interfluvium			**796**	**4.4**
	Albeluvisols		**39**	**0.2**
		Lcc	6	0.0
		Lhc	23	0.1
		Lhcz	9	0.1
	Cambisols		**270**	**1.5**
		Ldc	130	0.7
		Ldcz	34	0.2
		LDp	42	0.2
		Ldp(o)	6	0.0
		Pbc	18	0.1
		Sbc	11	0.1
		Sbc(h)	4	0.0
		Sbcz	1	0.0
		Scc	10	0.1
		Scc(h)	13	0.1
		Sccz(h)	1	0.0
	Fluvisols/Cambisols/Phaeozems		**22**	**0.1**
		Eep	22	0.1
	Luvisols		**300**	**1.7**
		Ada	26	0.1
		Lba	8	0.0

REGION	RSG	CODE	Area km²	Area %
		Lca	66	0.4
		Lcaz	13	0.1
		Pcc	87	0.5
		Pcc(h)	12	0.1
		Pdc	76	0.4
		Pdc(h)	11	0.1
	Planosols		**49**	**0.3**
		uLhc	24	0.1
		wLhc	8	0.0
		w-Lhc	18	0.1
	Podzols		**8**	**0.0**
		Sch	8	0.0
	Technosols / Not Surveyed		**107**	**0.6**
		OB	99	0.5
		OT	9	0.0
Schelde-Dender interfluvium			**555**	**3.1**
	Albeluvisols		**57**	**0.3**
		Lcc	8	0.0
		Ldc	39	0.2
		Ldcz	9	0.1
	Cambisols		**74**	**0.4**
		Abp	13	0.1
		Acp	24	0.1
		ADp	21	0.1
		LDp	16	0.1
	Fluvisols/Cambisols/Phaeozems		**6**	**0.0**
		Eep	6	0.0
	Luvisols		**244**	**1.3**
		Aba	11	0.1
		Aba0	17	0.1
		Aba1	93	0.5
		Abp(c)	12	0.1
		Aca0	11	0.1
		Aca1	42	0.2
		Acp(c)	11	0.1
		ADa1	16	0.1
		Lba	19	0.1
		Lca	11	0.1
	Technosols / Not Surveyed		**175**	**1.0**
		OB	164	0.9
		OT	11	0.1
Scheldepolders			**241**	**1.3**
	Phaeozems/Cambisols		**104**	**0.6**
		Eep	13	0.1
		Pep	13	0.1
		s-Edp	12	0.1
		sEep	6	0.0
		s-Ldp	7	0.0

REGION	RSG	CODE	Area km²	Area %
		sPep	9	0.0
		sUep	6	0.0
		Udp	13	0.1
		Uep	18	0.1
		zEdp	8	0.0
	Technosols / Not Surveyed		**137**	**0.8**
		OB	129	0.7
		ON	8	0.0
Urban / Not mapped			**565**	**3.1**
	Cambisols		**6**	**0.0**
		LDp	6	0.0
	Fluvisols/Cambisols/Phaeozems		**17**	**0.1**
		Eep	17	0.1
	Luvisols		**22**	**0.1**
		Aba1	22	0.1
	Technosols / Not Surveyed		**519**	**2.9**
		OB	452	2.5
		ON	22	0.1
		OT	9	0.0
		Pdcz	16	0.1
		Udp	21	0.1
Vlak van Zonhoven			**108**	**0.6**
	Anthrosols		**7**	**0.0**
		Zcm	7	0.0
	Podzols		**57**	**0.3**
		Zcg	13	0.1
		Zdg	29	0.2
		Zeg	15	0.1
	Technosols / Not Surveyed		**44**	**0.2**
		OB	38	0.2
		ON	6	0.0
Vlakte van de Maas			**64**	**0.4**
	Cambisols		**30**	**0.2**
		Lbp	18	0.1
		Lbpy	12	0.1
	Technosols / Not Surveyed		**33**	**0.2**
		OB	26	0.1
		OE	7	0.0
Westelijke Boomse cuesta			**269**	**1.5**
	Albeluvisols		**27**	**0.1**
		Lcc	9	0.0
		Ldc	18	0.1
	Anthrosols		**44**	**0.2**
		Scm	21	0.1
		Sdm	6	0.0
		Zbm	6	0.0
		Zcm	11	0.1
	Arenosols		**25**	**0.1**

REGION	RSG	CODE	Area km²	Area %
		Zbp	6	0.0
		Zcp	10	0.1
		Zdp	9	0.0
	Cambisols		**28**	**0.2**
		Scb	13	0.1
		Sdb	8	0.0
		Sdp	7	0.0
	Technosols / Not Surveyed		**146**	**0.8**
		OB	132	0.7
		ON	8	0.0
		OT	6	0.0
West-Vlaams cuestaland			**398**	**2.2**
	Arenosols		**8**	**0.0**
		Zdp	8	0.0
	Cambisols		**32**	**0.2**
		Sdp	32	0.2
	Phaeozems		**22**	**0.1**
		Sep	22	0.1
	Podzols		**261**	**1.4**
		Sch	44	0.2
		Sdg	6	0.0
		Sdh	44	0.2
		wSdh	7	0.0
		w-Sdh	9	0.1
		Zbg	14	0.1
		Zbh	9	0.0
		Zcg	47	0.3
		Zch	41	0.2
		Zdg	15	0.1
		Zdh	25	0.1
	Technosols / Not Surveyed		**75**	**0.4**
		OB	75	0.4
Zuidelijke Vlaamse laagvlakte			**527**	**2.9**
	Albeluvisols		**73**	**0.4**
		Ldc	62	0.3
		Ldcz	12	0.1
	Arenosols		**29**	**0.2**
		Zcc(h)	15	0.1
		Zdb	6	0.0
		Zdp	7	0.0
	Cambisols		**135**	**0.7**
		LDp	39	0.2
		Pbc	20	0.1
		Pcc	46	0.3
		Pdc	16	0.1
		Sdp	13	0.1
	Fluvisols/Cambisols/Phaeozems		**20**	**0.1**
		Eep	20	0.1

REGION	RSG	CODE	Area km²	Area %
	Luvisols		**40**	**0.2**
		Ada	12	0.1
		Lba	10	0.1
		Lca	18	0.1
	Phaeozems/Cambisols		**25**	**0.1**
		Lep	25	0.1
	Podzols		**47**	**0.3**
		Sch	6	0.0
		Zcg	12	0.1
		Zch	17	0.1
		Zdg	7	0.0
		Zdh	6	0.0
	Technosols / Not Surveyed		**158**	**0.9**
		OB	153	0.8
		ON	6	0.0
Grand Total			**9930**	**55.0**

Annex 3 - Fieldnotes concerning the soils of site "Izegemseaardeweg, Roeselare"[13]

Situering

Het perceel bevindt zich ten noord-oosten van de stad Roeselare in een zwak golvend landschap. Het gebied wordt ingesneden door talrijke, smalle beekvalleien die via de Mandel naar de Leie draineren. Het perceel op de Izegemseaardeweg bevindt zich op de grens van wat gekarteerd staat als w-Pdc en Pdc (kaartblad Roeselare 67E, Fig. A.1). Het geologisch substraat bestaat uit tertiaire kleiige en zandige mariene sedimenten van het Ieperiaan[14].

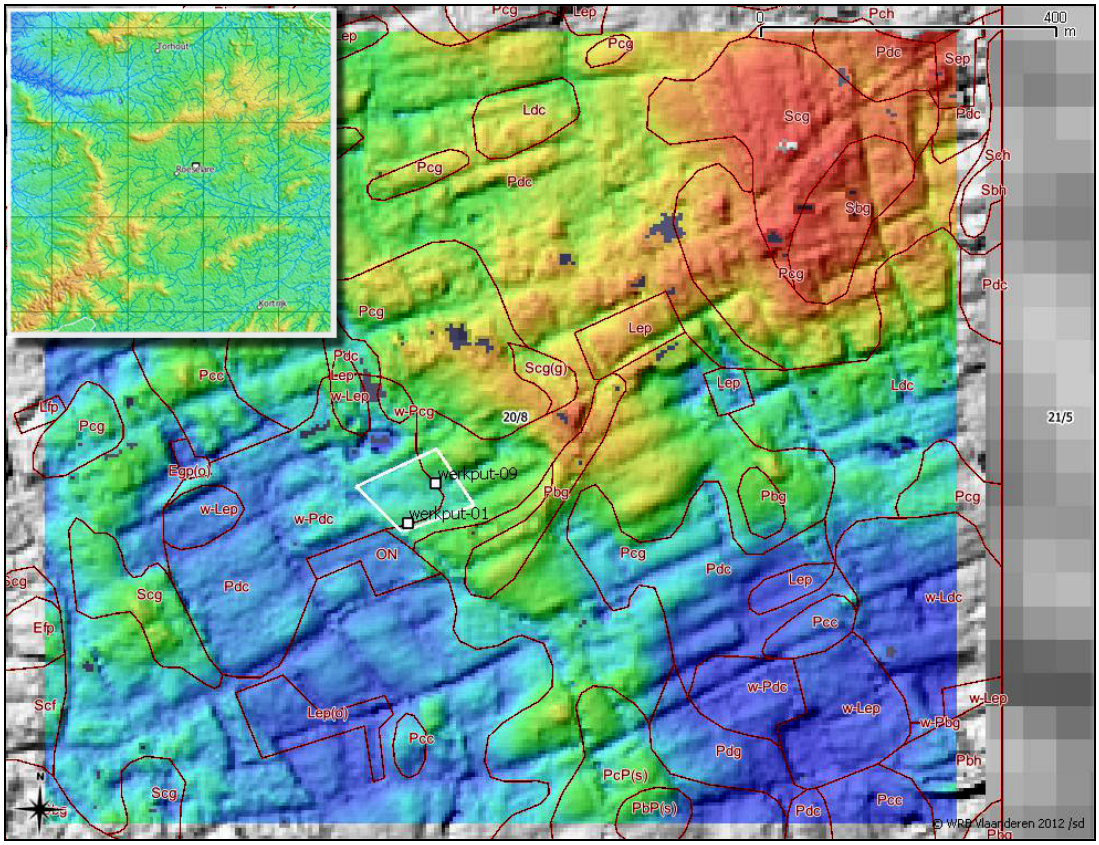

Figure A.1 – Location of the study site "Izegemseaardeweg, Roeselare" on the digital soil map ; two profiles have been described falling on the boundary between unit "w-Pdc" and "Pdc"

[13] Observations made by Stefaan Dondeyne, KU Leuven, Dept. Aard- en Omgevingswetenschappen in collaboration with ARCHEBO, 1 Oct. 2012

[14] Ameryckx 1958. Verklarende tekst bij het kaartblad Roeselare 67E, IWONL.

Figuur A.2 – Bolle weide, net ten noorden van het perceel; **(convex field adjacent to the study site)**

Door het voorkomen van het klei-zand substraat op relatief geringe diepte (20-120 cm) is het perceel onderhevig aan stuwwater en dus matig slecht gedraineerd. Daarom zijn er ooit drainagebuizen gelegd, zowel klei-pijpen als machinaal. De eeuwenoude bewerking heeft ook geleid tot de vorming van een landschap van bolle akkers en weiden; dit is te zien op het LIDAR beeld als ook op het terrein (Fig. A.1 en Fig. A.2).

Profile - Roeselare werkput-01

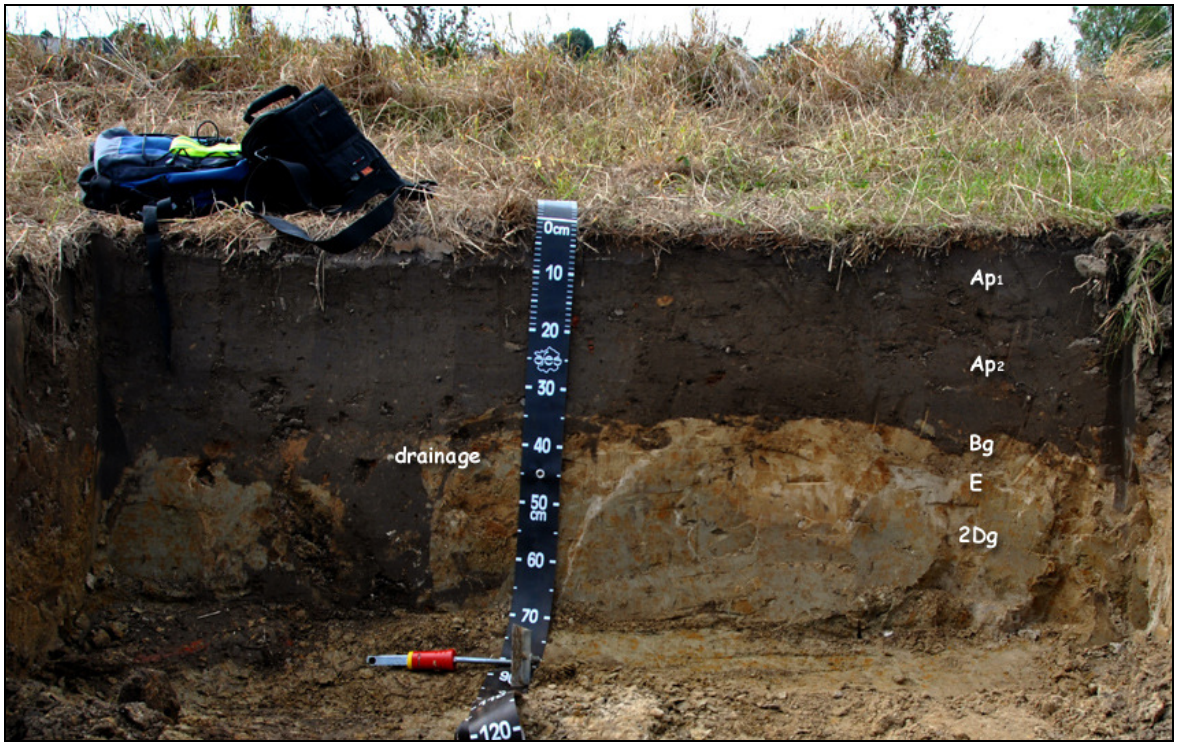

Figure A.3 – Profile "Werkput-01", soil has been mapped as "w-Pdc', an Endogleyic Planosol with a clear anthropogenic surface horizon taken as Terric surface horizon

Observaties

Dit profiel (Fig. 3) komt overeen met een w-Pdc bodem: zandige textuur in de bouwvoor (P in Belgische textuur driehoek, of LS tot SL in USDA), over zware compacte klei (E in Belgische textuur driehoek, SCL in USDA). Het profiel vertoont duidelijke tekenen van stagnatie van water (Bg horizont) met volledige uitgeloogd fijn zand en silt in een discontinue E horizont, net boven het kleisubstraat; de klei heeft ook tekenen van oxido-reductie (Dg horizont) en is verder redelijk compact.

Volgens het internationaal bodemclassificatiesysteem "*World Reference Base for Soil Resources*" (WRB)[15] is dit profiel een *Endogleyic Planosol (Terric, Ruptic, Loamic, Drainic).*

[15] IUSS Working Group WRB. 2007. World Reference Base for Soil Resources 2006, first update – beschikbaar op www.fao.org/fileadmin/.../wrb2007_red.pdf

Profile: Roeselare werkput-09

Figure A.4– Profile "Werkput-09", mapped as a Pdc, and corresponding to a Stagnic Endogleyic Luvisol in WRB-2007; note the thick anthropogenic suface layers, here also taken as "Terric"

In dit profiel (Fig. 4) was de teelaarde iets dikker dan in werkput-01 (> 40 cm versus <40 cm). De onderste horizonten (2ABg, 2Bt en 2Cr) hadden duidelijk meer klei dan de bouwvoor, maar niet genoeg om als een klei-substraat beschouwd te kunnen worden. De 2ABg horizont vertoonde wel duidelijke tekenen van stagnatie, terwijl de 2Bt duidelijke kleihuidjes had; de 2Bt en 2Cr horizonten hadden beide opvallend veel poriën en goed ontwikkelde bodemstructuren.

In WRB wordt dit profiel geclasseerd worden als een *Stagnic Endogleyic Luvisol (Terric, Drainic, Loamic).*

Soil profile description (werkput-09)

Date: 1 Oct 2012; Author: Stefaan Dondeyne

Dry weather, Sunny to slightly overcast; soil moist.

Located in middle of field; this field and surrounding fields are convex fields; profile is at about 10 m from two drainage ditches; had also traces of former drain pipes in clay

Location: N 50° 57' 21.23"; E 3° 9' 44.80", alt 24 m asl (according to LIDAR data)

Horizon	Depth (cm)	Description	Diagnostic features
Ap1	0-20	Greyish yellow brown 10YR 4/2 (moist); Sandy Loam (P in Belgian classes), no mottles, but pieces of charcoal and bricks; weak fine to medium subangular blocky structure, almost massive; very friable when moist, not plastic, not sticky; few pores, few fine roots; Gradual and smooth boundary	Terric horizon
Ap2	20-45	Greyish yellow brown 10YR 4/2 (moist); Sandy Loam (P in Belgian classes), few fine distinct mottles, besides pieces of charcoal and bricks; weak fine to medium subangular blocky structure, almost massive; very friable when moist, not plastic, not sticky; few pores, very few fine roots; Clear, wavy to irregular boundary	Terric horizon
2ABg	45-50	Brownish black 10YR 3/2 (moist); Sandy Loam to Sandy Clay Loam; many medium distinct brown (10YR4/4) mottles; moderate medium subangular blocky structure; very friable when moist, slightly plastic, slightly sticky; with common tubular pores, no roots; Abrupt and smooth boundary	Stagnic properties
2Btg	50-100	Dull yellowish brownish 10YR 5/3 (moist); Sandy Clay Loam (E in Belgian classes), abundant medium distinct brown (10YR4/6) mottles; moderate to strong medium to coarse angular blocky structure; friable when moist, plastic, sticky; with many tubular pores, no roots; clay cutans on pedfaces and lined along pores; Abrupt and smooth boundary	Argic horizon with gleyic properties (oxic)
2Cr	100-120+	Yellowish brownish 2.5YR 5/3 (moist); Sandy Clay Loam but less clay than horizon above (E in Belgian classes), many medium distinct brown (10YR4/6) mottles; moderate to strong medium to coarse angular blocky structure; friable when moist, plastic, sticky; with many tubular pores, no roots; no clay cutans; Abrupt and smooth boundary	Gleyic properties / (reduced)

Classification

Mapped as Pdc

WRB-2007: Stagnic Endogleyic Luvisol (Terric, Drainic, Loamic)