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Soil Profile Description and Classification (WRB-2006) of the 11 Flemish Level II Intensive Monitoring Plots

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1. Introduction

In the late '80s Flanders set up a forest monitoring network within the framework of the International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) operating under the UN/ECE Convention on Long-Range Transboundary Air Pollution. ICP Forests monitors the forest condition in Europe in cooperation with the European Commission using two different monitoring intensity levels. The first level (Level I) is based on about 6000 observation plots on a systematic transnational grid of 16 x 16 km throughout Europe. The intensive monitoring level comprises about 800 Level II plots in selected forest ecosystems in Europe. At present the Flemish network comprises 11 international Level II plots. Within the EU demonstration project 'BioSoil', Flanders made a soil inventory on these 11 Level II plots. This document reports on the soil survey which includes a detailed profile pit description and soil characterisation complemented by laboratory data. The finality of this characterisation was to come to a soil classification name for the concerning Level II plot according to the World Reference Base for Soil Resources (IUSS Working Group WRB, 2006).

BioSoil is a demonstration project covering one soil module for Level I and one for Level II as well as a biodiversity module. The overall goal of the soil module is to test the ICP Forests soil manual. The project will mainly deliver the data, which are required by the Community to contribute to the discussion concerning soil monitoring at Community level. The following specific objectives have been defined for the soil module Level II:

1. To establish an improved common European baseline of forest soils for environmental applications
2. To finalise the common European methodology for (forest) soil monitoring on the basis of the ICP Forests Manual and other relevant guidelines
3. To upgrade the quality of the existing forest soil database
4. To quantify spatial variability on the basis of information available and supplementary field experiments.
5. To detect and explain temporal changes in forest soils.
6. To improve the actual evaluation concepts, in specific by more advanced statistical analysis procedures including estimation of uncertainties
7. To evaluate the applicability of the methodology adopted by the European forest soil monitoring programme before setting up the monitoring for other land use types
8. To improve the existing QA/QC strategy for European forest soil condition survey

2. Materials and methods

2.1. Field survey

At the onset of the monitoring programme on Level II in 1991, the soil profile was already described and characterised by means of a profile description although only limited laboratory analyses were conducted on the horizon samples (Roskams et al. 1997). Based on the available field information, the soils were classified according to 1) the Belgian soil classification system, 2) the American soil classification system of Soil Taxonomy and 3) according to the original FAO classification system. The profile description was supported by a limited set of chemical and physical soil analyses (pH, OC and textural analyses). The profiles were re-classified following the key of Soil Taxonomy (Soil Survey Staff, 1991) and the Revised Legend of the FAO-Unesco soil map of the World (FAO, 1988) (Roskams et al. 1997). See Table 1.

The available information from this survey was clearly not sufficient to accurately classify the soil type according to the International World Reference Base for Soil Resources (IUSS Working Group WRB, 2006) which was required for the BioSoil project. For example, based on the chemical analyses of the exchangeable elements in the texture B-horizon, it should possible to come to one single major reference soil group for profile N°12.

Nearly 20 years after the first soil characterisation it was still possible to locate the old profile pit on most of the Level II plots. In the summer of 2007, 10 profiles were deepened and widened and a new profile description was made and soil samples from the horizons were taken. The fieldwork was conducted with the help of the guidelines produced for BioSoil by the Forest Soil Co-ordinating Centre (Mikkelsen et al., 2006). One profile, plot N° 19 in the Pijnven forest in Hechtel-Eksel, was already described and analysed in the winter of 2005-2006. This profile served as an example during the excursion of a training course on WRB 2006. On this profile no aqua regia extractable elements were measured.

Table 1: The FAO (1988) soil classification of the 11 Flemish Level II plots in the 1991 survey

Code plot	Location	Forest	FAO (1988)
11	Torhout (Ichtegem)	Wijnendalebos	Gleyic Dystric Cambisol
12	Bierbeek	Meerdaalwoud	Haplic Alisol
13	Halle	Hallerbos	Haplic Alisol
14	Ravels	Ravelsbos	Haplic Podzol
15	Brasschaat	De Inslag	Umbric Regosol
16	Gontrode	Aalmoeseneiebos	Dystric Podzoluvisol
17	Buggenhout	Buggenhoutbos	Haplic Acrisol
18	Houthulst	Houthulstbos	Stagnic Podzoluvisol
19	Hechtel-Eksel	Pijnven	Haplic Podzol
20	Maasmechelen	Heiwijk	(Rudi-) Haplic Podzol
21	Hoeilaart	Zoniënwoud	Dystric Podzoluvisol

2.2. Laboratory analyses

The laboratory analyses on the samples taken in the profile pits were done in the course of 2007 and 2008. The laboratory analytical methods follow partly the references methods described in the ICP Forests Manual (2006) and partly the standard reference methods at the Analytical laboratory of the Research Institute for Nature and Forest, with some additional analyses for some profiles. An overview of the analytical methods is presented in Table 2 and Table 3. Note that some of the methods of the derived soil variables in Table 3 might differ from the methods that will be applied on the data in the central BioSoil database.

Table 2: Overview of the analytical methods used for analysis of the horizon samples of the profile pits

Soil variable	**Method**	**Remarks**
Particle size distribution	Pipette method, SA03, ICP Forests Manual (2006) and ISO 11277	Following fraction limits are handled: 2, 10, 20, 50, 63, 100, 125, 250, 500, 1000 and 2000 µm. 50 µm is included to compare with national data. 125 µm included for classification purposes (Cambic horizon).
Coarse fragments	SA05, ICP Forests Manual (2006)	Laboratory measurement: mass % of total sample
$CaCO_3$	Acid – Base titration method	
Total N (Kjeldahl), Modified	SA09B, ICP Forests Manual (2006)	
Total N (Kjeldahl), Standard	Kjeldahl method	
Org. Carbon, TOC	SA08, ICP Forests Manual (2006)	
Org. Carbon, W&B	Walkley and Black Organic Carbon	unmodified method (no external heat applied)
OM LOI	Organic matter by Loss on Ignition	Combustion temperature: 550°C for 3 hours

Table 2 (continued): Overview of the analytical methods used for analysis of the horizon samples of the profile pits

Basic cations by NH_4OAc	NH_4OAc method	Only Ca, Mg, Na and K are measured. Detection limits are rather high. Required for proper classification of the soils according to WRB-2006 (IUSS Working Group WRB, 2006).
CEC(NH_4OAc)	Titration	
Dithionite extractable Al and Fe	Van Ranst et al. 1999	Expresses the content of free iron and aluminium (oxides) in the soil
Oxalate extractable Al and Fe	SA13, ICP Forests Manual (2006), ISRIC (2002)	
Exchangeable elements, Free H^+ and exchangeable acidity	ISO 11260 (1994) and ISO 14254 (1994)	Triple $BaCl_2$ extraction; Free H^+ and exchangeable acidity by titration
CEC($MgSO_4$)	ISO 11260 (1994) "Compulsive method"	Total CEC measured for comparison with sum of cations and free H^+
pH, 1:1, water	Potentiometric	Water soil relation 1:1; mass based
pH, 1:5, water	Potentiometric	Water soil relation 1:5; mass based
pH, 1:5, $CaCl_2$	Potentiometric	$CaCl_2$ solution to soil relation 1:5; mass based
Aqua regia extractable elements	SA11, ICP Forests Manual IIIa (2006)	Microwave digestion Extraction with HCl:HNO_3 of 1:3
Electric Conductivity (EC)	Potentiometric	Measured concomitantly with pH
Actual water content		The sample is dried at 30-35°C sufficiently long that no more humidity is lost. The weight loss expresses the actual water content (assuming no loss of humidity between sampling time and measuring the weight before drying.
BD_S soil (Bulk Density)	SA04, ICP Forests Manual IIIa (2006)	
BD_{FE} fine-earth	SA04, ICP Forests Manual IIIa (2006)	
pF values		On BD rings pF 0 to 2.7 is determined. On separate samples the pF at 3.4 and 4.2 is measured.

Table 3: Overview of the methods of the derived soil variables on the horizon samples of the profile pits

Derived/calculated soil variables	**Description**
BS % (Base saturation)	Ratio of the basic cations to the total measured CEC using NH_4OAc. Values below quantification limit (LOQ) are included for half of the LOQ value.
CEC of the clay	The CEC clay is first corrected by CEC coming from the organic matter (where CEC = 200 cmol(+)/kg OM). The remaining CEC is related to the clay content. Unreliable data are not presented (expert judgement). Values below LOQ are included for half of their LOQ value.
CEC (sum)	CEC obtained by the sum of the basic cations and Al^{3+}, Fe^{3+}, Mn^{2+}, Free H^+ by the $BaCl_2$ compulsive method
BS by CEC($MgSO_4$) %	The base saturation expressed as the ratio of the sum of the basic cations to the CEC measured by the $MgSO_4$ method. Values below LOQ are counted with for half of their LOQ value only.
Acidity (sum)	Sum of Al^{3+}, Fe^{3+}, Mn^{2+} and Free H^+ determined on the triple $BaCl_2$ extraction
C/N	C/N ratio's discussed in this report are based on either: [(%LOI/2)/%TotalN$_{modified}$] for the organic layers, or [%TOC/TotalN$_{modified}$] for the mineral horizons

2.3. Classification

The soils are all classified according to World Reference Base for Soil Resources version 2006 (IUSS Working Group WRB, 2006). At the onset of BioSoil the most recent version of the World Reference Base was the one dating from 1998 (FAO, ISRIC and ISSS, 1998). After the training courses had taken place and during the first field season a second version was launched. This version is the latest official version published and it was agreed among the BioSoil partners to apply throughout Europe the most recent version, i.e.2006. Later, a corrected version of WRB-2006 was realised (IUSS Working Group WRB, 2007), but this version is only available over internet since 2007 and is not registered as a separate publication. Although several mistakes and important clarifications have been made in the version of 2007, this version WRB-2007 was not used in BioSoil.

The Flemish Level II soil profiles were classified on 3-4 levels. These are:

1. Simplified classification name, this includes the reference soil group (RSG) and the two most important prefix qualifiers if any present. Although it was decided within Biosoil to make full classifications for all profiles, having more experience at the end of the project, this is not a realistic target mainly due to 1) lack of experience in soil taxonomy among the participating countries and 2) lack of sufficient field and laboratory data or even geological, hydrological, historical… data. If we could build a database of a few thousand soil profiles classified with a good accuracy to the level of RSG with 1-2 prefix qualifiers, the classification part of BioSoil would be a success.
2. Full classification name without specifiers, here all prefix and suffix qualifiers present in the soil are listed. This is the BioSoil level that normally should be reported as a minimum.
3. Full classification name with specifiers. Due to the arbitrary nature of most specifiers (when is a certain characteristic weak, normal or strongly developed?) it was agreed to keep this level on a voluntary basis.
4. For a few soils facing classification problems an advanced classification name has been provided. When the classification key does not offer a solution due to the soil complexity a solution is suggested.

Although fieldwork and selection of samples for further laboratory analyses were carried out with uppermost care, during the process of classification problems of insufficient data or information were faced. Where possible these data were collected (e.g. asking for additional laboratory data), consulting the digital photographic material, etc. If the required data could not be achieved and an expert judgement did not solve the problem a particular qualifier was ignored and the classification continued.

In the profile description the mentioned depths take into account any variation of the horizon boundary. They are indicated as the upper and lower limit of the begin and the end of the horizon limit, e.g. H3: 22/25-37/45 cm, means that the upper limit of H3 is found between 22 and 25 cm depth measured from the transition between horizon H2 and horizon H3. The lower limit of H3 is found between 37 and 45 cm.
In the tables of analytical data the indicated depths are usually simplified. Here the mean upper and lower horizon limits are presented. The mean has been obtained by estimating the mean from the profile sketches. A horizon boundary that as an example remains at 20 cm over 80% of the boundary and at the end dips to 30 cm will get the mean depth 22 cm (In the profile description it will be written 20/30 cm). These simplified depth have also been reported to the BioSoil database.

2.4. Structure of the report

In the following each of the soil profiles is described in a separate chapter. In each chapter 1) the site and profile description is given, followed by 2) the analytical lab data, 3) the classification according to WRB 2006 and 4) the discussion focusing on how well the new classification name characterises the soil.

3. Profile P11, Wijnendalebos, West Flanders

3.1. Site and profile description

Profile 11	**Wijnendalebos (Level 2 forest plot)**
1.2 Date of description:	4/5/2007
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, West Flanders, Ichtegem municipality,"Wijnendale" forest. Arriving in Torhout located about 15 km to the southwest of Brugge, take road N33 towards Oostende, follow this road for 2250 m, just before Castle of Wijnendale when the road makes a right turn, drive to the left along a small paved road and turn immediately to the right. This road is a gravel road, and the Wijnendalebos is visible on the right hand side. After about 1700 m the road turns 90° west (right) and after 200 m a T-junction appears. Take the small road towards north (right), which is blocked more or less immediately. Park the car here and walk into the forest. In the forest follow the road running parallel with the southern forest edge, take the second forest road towards north and follow this road until the experimental plot is reached after about 600 m.
1.5 Profile coordinates:	*ICP Forests Level II plot nr.:* 1102 *Latitude, longitude:* 51° 04' 10" N, 03° 02' 10" E
1.6 Elevation:	20 m a.s.l.
2.1 Atmospheric climate and weather condition:	During the description, the temperature was 18-20°C. The nights prior were generally chilly and the days sunny and warm. No rain since more than a month no rain.
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	*Macro topography:* The north western part of the forest and the immediate area to the west and north, including the village of Wijnendale, is situated on altitudes around 35 m with peaks as high as 50 m. This area stands out like an island with rather steep slopes towards north, with at the footslope the villages of Koekelare and Ichtegem located at altitudes of 12-15 m. Further to the north, the polder region is reached with altitudes generally not exceeding 5 m. South of the Wijnendalebos the landscape is gently sloping towards the Krekelbeek, running at about 4-5 m altitude. The Krekelbeek merges with other tributaries, which ultimately merges with the Ijzer river. *Meso topography:* Summit of a very gentle rolling almost flat landscape Micro lows and micro highs dominate the immediate surroundings of the profile. This pattern may reflect old wind throws of threes. *Landscape position:* Intermediate part *Slope form:* - *Slope gradient:* Flat *Slope length:* - *Slope orientation:* -
2.4 Land-use:	Original plantation forestry with selective felling. Today it is a nature reserve. *Wildlife:* is protected *Grazing:* is not allowed
2.5 Human influence:	Vegetation is moderately disturbed, because the plot is intensively monitored (water samples taken every 2 weeks etc.).

	Hereby a series of walking trails have developed between the different sampling points. In the past, the forest was part of a military domain, which may explain some of the ditches found in the landscape that seems to have little drainage function. Elsewhere in the forest, real drainage ditches are common. Probably the slightly higher landscape position at the level of the profile has made ditches obsolete here.
2.6 Vegetation:	Deciduous woodland. The forest plot is dominated (±80%) by beech (*Fagus sylvatica*). Corsican pine (*Pinus nigra subsp. laricio*) is co-dominating (10-20%). No shrub or ground vegetation in the immediate surrounding of the profile; the soil is largely bare.
2.7 Parent material:	Cover sand (7220)
2.8 Drainage class:	Moderately well drained *Availability of water:* Sufficient
2.9 Internal drainage:	Never saturated
2.10 External drainage:	Neither receiving nor shedding water
2.12 Groundwater:	Very deep (150-200 cm). At the moment of profile description water was standing at a depth of 170 cm below the mineral surface.
2.13 Rock outcrop:	None
2.14 Coarse surface frag.:	None
2.15 Erosion, sedimentation:	None
2.17 Surface cracks:	None
Humus classification:	No faunal activity observed; presence of mycelia. Horizon sequence: OL-OFnoz-OHnoz-Ae *Classification name:* Hemimor
Remarks:	Positive reaction to α,α-dipyridyl from about a depth of 100 cm in an auger observation. Due to wetness in the more clayey horizon, presence/absence of clay coatings was not possible to confirm.

No.		**Horizon description**
H1	OL	-15 till -10 cm
H2	OFnoz	-10 till -2 cm
H3	OHnoz	-2 - 0 cm
H4	Ae/A1	0-5/12 cm; loose dark brown horizon with some subsoil fragments probably remnants of the first soil profile description in 1991; very dark grey 10YR 3/1 (M), dark greyish brown 10YR 4/2 (D); sandy loam; single grain; very friable; few very fine to fine roots; smooth clear boundary
H5	A2	5/12-25 cm; brown horizon with some fragments of B-horizon material; very dark greyish brown 10YR 3/2 (M), greyish brown 10YR 5/2 (D); sandy loam; very week angular blocky; very friable; few very fine to fine roots, slightly less roots than in underlying horizon; smooth gradual boundary
H6	A3	25-40/44 cm; very dark greyish brown 10YR 3/2 (M), dark greyish brown to greyish brown 10YR 4.5/2 (D); sandy loam; weak angular blocky; very friable; common very fine to fine and very few medium roots; smooth clear boundary
H7	Bhgbi	40/44-50/62 cm; dark greyish brown 10YR 4/2 (M), light brownish grey to pale brown 10YR 6/2.5 (D); many (±30%), coarse, distinct, diffuse, rusty brown mottles; sandy loam; coarse angular blocky; friable; few very fine and common fine roots; clear wavy boundary
H8	Bh(g)	50/56-56/90 cm; very dark greyish brown 1.5Y 3/2 (M); brown to light olive brown 1.5Y 5/3 (D); common (10-15%), very fine, distinct, sharp, black Mn mottles, and many (20-25%), coarse, distinct, diffuse, rusty brown mottles; loamy sand; single grain; very friable; very few fine roots; clear broken boundary (pocket)
H9	Cgc	56/62-90 cm; light olive brown 2.5Y 5/4 (M); light yellowish brown 2.5Y 6/4 (D); common (10-15%), coarse, distinct, diffuse, rusty brown mottles; sand;

		single grain; loose; Mn stains; no roots; abrupt smooth boundary
H10	Cg	90-92/100 cm; transition horizon between the overlying sandy horizons and the underlying silt and clayey layers; light olive brown 2.5Y 5/3 (M); light yellowish brown to pale yellow 2.5Y 6.5/3 (D); many (15-20%), coarse, distinct, diffuse, rusty brown mottles; few, sub-rounded, fine, fresh or slightly weathered gravels, concentrated in a stone line; single grain; loose; no roots; irregular clear boundary
H11	2Cg	92/100-97/145 cm (pocket); silty layer; olive brown 2.5Y 5/3.5 (M); light yellowish brown 2.5Y 6/4 (D); many (30-40%), coarse, prominent, diffuse, orange brown mottles, best developed ones have colour 10YR 5/6; sandy loam; massive; very friable; no roots; wavy abrupt boundary
H12	3Cg	93/96-… cm; clayey layer; olive 5Y 5/3 (M); pale olive 5Y 6/3 (D); many (20-30%), coarse, distinct, diffuse, orange brown mottles; sandy clay loam; massive; very friable; common very fine and fine roots

Colour measurements: M= Moist; MC= Moist-crushed; D= Dry; DC= Dry-crushed; W= Wet. The "bi" subordinate symbol in H7 refers to a biologically active horizon.

3.2. The physical and chemical laboratory data

The soil has developed in the cover sand region of Belgium and has a C/N ratio between 11 and 18. See Table 4. A high content of organic carbon is found in H4 (Ae/A1: 6.7%) and a moderately high content is characterising H6 (A3: 3.5%). In H5, the content of organic carbon is 1.72%. H12a contains 1.7% of organic material, which is, considering the depth, relatively high. This high organic material content might be an artefact inherent to the analytical method of the loss-on-ignition test (De Vos et al., 2005). See also the discussion of profile N° 13 in Haller forest.
The pH(H_2O) drops to values below four in the deeper organic and the upper mineral horizons. In the subsoil and substratum, the pH(H_2O) remains around 4.5.
The particle size distribution in H4-9 is bimodal with a peak in the coarse silt fraction and a second peak in the fraction 125-250 µm. In H11 the clay content increases slightly compared with the horizons above, but what is more deviating is the very high content (68%) in the fraction very fine sand (63-100 µm). H12 forms yet a different parent material as it contains 22% clay and the sand peak is in the fraction 100-125 µm.
The content of basic cations is extremely low, particular in the upper mineral soil horizons. In H12, some basic cations are stored. Aluminium saturation is a fertility-limiting problem for this soil. In H4, it is 54% but increases with depth to more than 90% before it drops to about 80-85%. To the extent that it is possible to calculate the base saturation, when most cations are below detection limit, the soil has base saturations below 10%.
A slight increase in the content of oxalate extractable iron and aluminium has been measured in H7, which may indicate that the process of podzolisation is active here, but without other characteristics for a Spodic horizon, this remains a hypothesis. The values on aqua regia all remains within the expected levels.

Table 4: Analytical data for profile P11, West Flanders, Belgium. Profile studied 4/5/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth	Total N Modified	C/N	OC TOC	Organic matter W&B	Organic matter LOI	pH H_2O	pH $CaCl_2$	EC dS/m	Coarse frag. >2mm
		cm	%		%	%	%	1:5	1:5	1:5	%-wght
1	OL	15-10	1.490	28			84.8	5.0	4.5	0.36	
2	OFnoz	10-2	1.947	21			83.4	3.7	2.9	0.10	
3	OHnoz	2-0	1.666	20			65.8	3.6	2.7	0.13	
4	Ae/A1	0-5/12	0.380	18	6.71	10.4	11.2	3.8	3.1	0.07	
5	A2	5/12-25	0.112	15	1.72	3.6	3.4	4.0	3.5	0.04	
6	A3	25-40/44	0.205	17	3.54	6.0	5.6	4.1	3.7	0.04	
7	Bhgbi	40/44-50/62	0.053	15	0.82	1.2	2.4	4.3	4.1	0.02	
8	Bh(g)	50/56-56/90	0.031	11	0.34	1.4	1.0	4.4	4.1	0.02	
9	Cgc	56/62-90			0.09		0.9	4.5	3.9	0.02	
9b	with Mn							4.5	4.1	0.02	
10	Cg	90-92/100						4.5	3.8	0.03	
11	2Cg	92/100-97/145					0.9	4.6	3.7	0.03	
12a	3Cg	93/96-…					1.7	4.3	3.5	0.05	
12b	3Cg	93/96-…						4.6	3.6	0.03	

Table 4 (continued): Analytical data for profile P11, West Flanders, Belgium. Profile studied 4/5/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Particle size distribution (fractions in µm) 0-2	2-10	10-20	20-50	50-63	63-100	100-125	125-250	250-500	500-1000	1000-2000
	%										
1											
2											
3											
4	5.3	3.5	2.0	17.9	3.6	15.9	12.8	33.2	5.7	0.2	tr
5	3.2	1.6	1.4	18.4	3.7	17.2	13.5	35.6	5.3	0.2	0.0
6	7.2	3.3	2.0	17.1	3.5	16.3	12.5	32.2	5.2	0.4	0.1
7	4.3	1.5	2.3	14.7	3.2	13.5	13.0	40.4	6.9	0.2	tr
8	2.3	1.5	1.0	11.2	2.6	13.4	14.0	46.0	7.9	0.2	0.0
9	4.9	1.5	0.6	3.1	1.0	13.8	17.4	52.6	5.0	0.1	0.0
9b											
10											
11	7.5	1.2	0.6	7.5	7.2	68.0	6.7	1.1	0.2	tr	tr
12a	22.2	2.6	0.8	7.3	2.0	18.6	38.3	7.8	0.2	tr	tr
12b											

Horizon nr.	Mg++	Na+	K+	Ca++	Al+++	Fe+++	Mn++	Free H+	CEC sum	CEC measured	BS by CEC-m
	by $MgSO_4$ (compulsive method) cmol(+)/kg soil								cmol(+)/kg		%
1											
2											
3											
4	<0.46	<0.07	0.13	0.13	5.61	0.63	<0.009	3.85	10.3	7.0	<8
5	<0.24	<0.04	0.05	0.05	3.65	0.36	<0.005	1.10	5.2	5.0	<5
6	<0.25	<0.04	0.05	<0.05	5.41	0.37	<0.005	0.91	6.7	6.0	<4
7	<0.12	<0.02	<0.01	<0.02	2.12	0.13	<0.002	0.24	2.5	2.0	<5
8	<0.15	<0.02	0.02	<0.03	2.56	0.05	<0.003	0.19	2.8	2.0	<7
9	<0.12	<0.02	0.06	0.04	3.66	0.03	<0.002	0.28	4.1	3.0	<6
9b											
10	<0.12	0.02	0.12	0.16	5.06	0.21	0.003	0.45	6.0	6.0	<6
11											
12a	0.76	0.05	0.30	0.76	9.04	0.08	0.003	0.15	11.1	12.0	<16
12b											

Horizon nr.	Horizon symbols	Depth	Mg++	Na+	K+	Ca++	CEC	BS	CEC/ clay	Acidity sum	titrated
		cm	by NH_4OAc cmol(+)/kg soil'					%		cmol(+)/kg	
1	OL	15-10									
2	OFnoz	10-2									
3	OHnoz	2-0									
4	Ae/A1	0-5/12	0.15	0.07	0.19	0.18	22.1	3		10.1	10.9
5	A2	5/12-25	0.06	0.03	0.08	0.08	7.5	3	49	5.1	5.7
6	A3	25-40/44	0.08	0.05	0.09	0.10	12.0	3		6.7	7.7
7	Bhgbi	40/44-50/62	0.03	0.02	0.03	0.06	4.5	3	40	2.5	3.0
8	Bh(g)	50/56-56/90	0.02	0.02	0.03	0.05	3.3	4	91	2.8	3.4
9	Cgc	56/62-90	0.10	0.03	0.08	0.09	4.5	6	86	4.0	4.8
9b	with Mn										
10	Cg	90-92/100	0.28	0.05	0.14	0.22	6.5	11		5.7	6.7
11	2Cg	92/100-97/145									
12a	3Cg	93/96-...	1.23	0.08	0.27	0.88	13.3	19	60	9.1	9.6
12b	3Cg	93/96-...									

Horizon nr.	Horizon symbols	Depth	Al	Fe	K	Ca	Mg	Na	P	S	Lab nr.
			Oxalate		Aqua Regia						
		cm	%		mg/kg						
1	OL	15-10									JM199
2	OFnoz	10-2			642	1844	468	151	512	2222	JM200
3	OHnoz	2-0			586	1411	506	151	534	2488	JM201
4	Ae/A1	0-5/12				571			291	480	JM202
5	A2	5/12-25	0.076	0.281	1538	551	785	74	155	147	JM203
6	A3	25-40/44	0.143	0.263	1535	539	807	79	233	289	JM204
7	Bhgbi	40/44-50/62	0.122	0.329	1295	361	705	56	105	114	JM205
8	Bh(g)	50/56-56/90	0.081	0.070	2016	429	1065	55	67	51	JM206
9	Cgc	56/62-90	0.079	0.142	2503	514	1393	57	48	32	JM207
9b	with Mn		0.094	0.145							JM208
10	Cg	90-92/100									JM209
11	2Cg	92/100-97/145									JM210
12a	3Cg	93/96-...	0.136	0.168	5345	511	3361	93	65	56	JM211
12b	3Cg	93/96-...									JM212

Horizon nr.	Al	As	Cd	Co	Cr	Cu	Fe	Mn	Pb	Ni	Zn
	Aqua Regia mg/kg										
1											
2	528	0.44	0.34	0.53	2	11.0	1001	56	20.7	4.0	58
3	3951	3.57	0.35	2.01	9	24.5	4480	29	110.8	9.8	55
4											
5	6646	2.77	<0.50	1.41	18	<2.50	8816	33	8.0	2.5	12
6	7819	3.96	<0.50	1.62	19	2.6	8987	26	14.5	3.2	14
7	6830	2.54	<0.50	1.53	16	<2.50	11074	36	4.8	2.8	10
8	7123	<2.50	<0.50	2.01	17	<2.50	8987	28	2.5	3.9	11
9	8834	3.91	<0.50	3.10	24	<2.50	12491	40	3.7	5.5	16
9b											
10											
11											
12a	17657	10.08	<0.50	5.93	53	3.2	30503	29	6.7	10.9	32
12b											

Legend: tr = traces

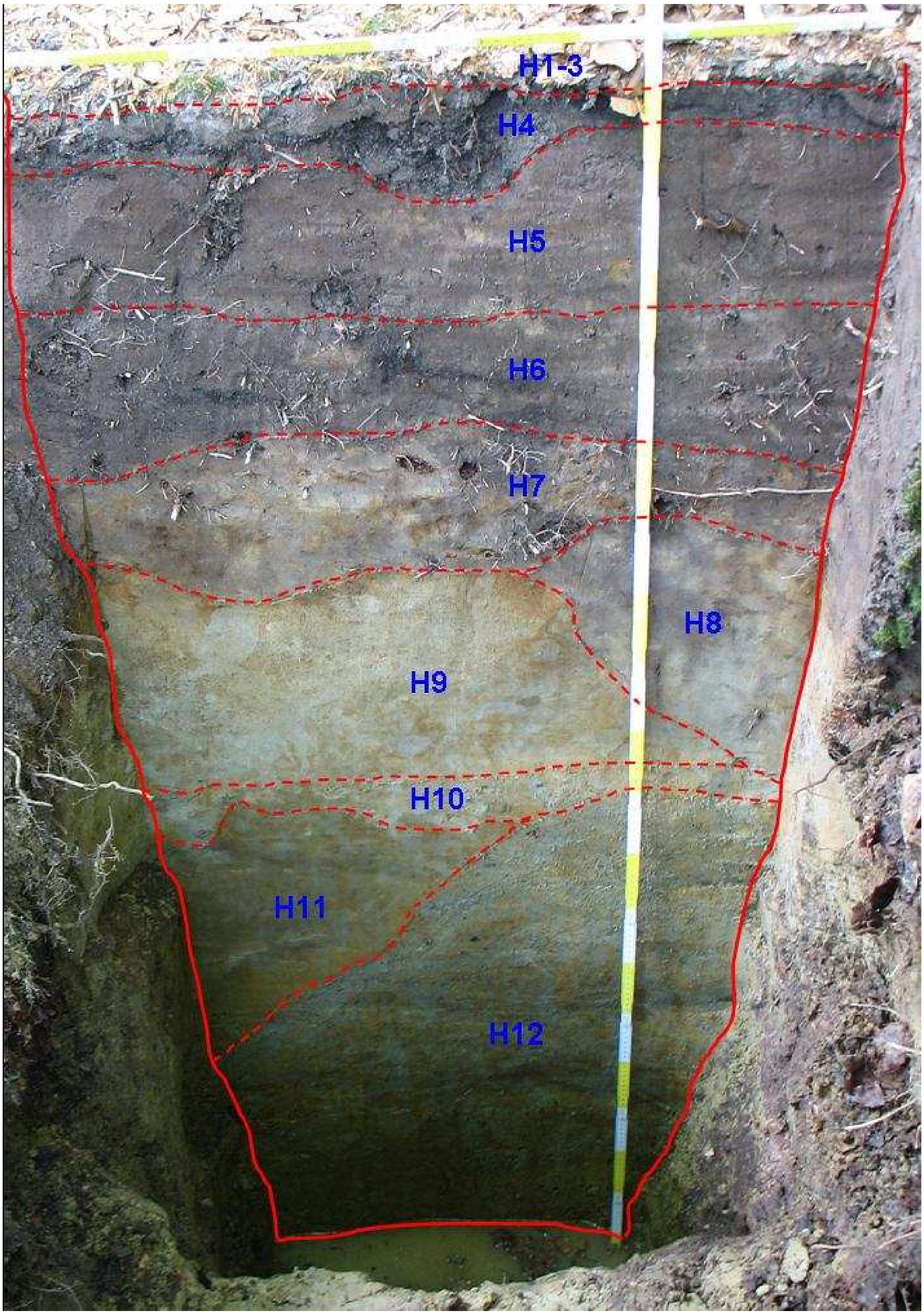

Photo 1: Soil profile P11 with the horizons indicated (Photo JM).

3.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks
Albic	-	
Argic	-	H12 contains 22.2% clay, but is separated from the horizon above by a lithological discontinuity. As the illuvial character could not be documented for this horizon it can not qualify for Argic
Cambic		H6 qualifies but a Cambic horizon cannot be present in a horizon also qualifying for Umbric. H7 and H8 both have a too coarse texture
Folic	H1-3	The thickness is obtained even without counting the OL layer
Plaggic	-	No artefacts, no evidences of raised land
Umbric	H4-6	Colours ok. Base saturation is far below 50%
Abrupt textural change	H11-12	Increase from 7.5% in H11 to 22.2% in H12
Reductomorphic colours	H10-12	Gleyic colour pattern
Lithological discontinuity	H11-12	Based on the abrupt textural change
Reducing conditions	H10-12	In a fresh auger observation positive reaction to α,α-dipyridyl was found from about 100 cm depth

Simplified classification name
Endogleyic Folic Umbrisol

Full classification name without specifiers
Endogleyic Folic Umbrisol (Brunic, Humic, Alumic, Hyperdystric, Arenic) • Alumic and Hyperdystric based on the $MgSO_4$ compulsive method

H6 has a texture fine enough to qualify for Cambic, but this horizon also qualifies for Umbric. As by definition they cannot be present in the same horizon, the soil has no Cambic horizon. Below H6 are two horizons that have redder hue's than the underlying horizons but they have a loamy sand texture. That implies that these two horizons qualify for the qualifier Brunic.

BioSoil classification name (WRB 2006), with specifiers
Endogleyic Hyperfolic Umbrisol (Brunic, Humic, Hyperalumic, Hyperdystric, Arenic) • Hyper is added to Folic because the required thickness is reached by the OF+OH horizon alone. Most Flemish Folic horizons require the litter layer (OL) to fulfil the minimum required thickness • Hyper is added to Alumic because aluminium makes up more than 80% of the cations extracted by the $MgSO_4$ method

3.4. Discussion

The soil is characterised by three humiferous A horizons. The original surface horizon contains 3.5% organic carbon (A3), in the second A horizon (A2) the content of organic carbon drops to 1.7%. Furthermore, in this horizon fragments of B-horizon material were observed during fieldwork. In the present day A-horizon (A1), the content of organic carbon is 6.7%. This pattern suggests following:

- In the soil an A-B-C horizon sequence developed.
- Considering the rather homogeneous greyish colour and the thickness of 15-20 cm, H6 (A3) may have been cultivated for a period. Because of the cultivation, part of the B-horizon was destroyed and the A horizon became thicker. This may have happened around World War 1 if the age of the trees is correctly estimated to be around 80-90 years old.
- Later the soil was raised when about 25-30 cm of humiferous soil materials was added on top. In this material fragments of B horizon material was found as well. Maybe the raising of the land was local and linked with some past military activity, where material from the A and B-horizons coming from elsewhere was dumped in top of the soil. Additional auger observations can clarify this.
- The soil developed further and organic matter accumulated in the upper 10 cm; here also the faunal activity is the highest.

In 1991, the soil was classified as Gleyic Dystric Cambisol (FAO, 1988), although the field classication added the qualifier 'anthropic' to stress the human influence in this soil. According to WRB (2006), the soil is an Endogleyic Folic Umbrisol. Morphologically this is a soil, which is rather young and characterised by a poorly developed B-horizon. If the anthropogenic influence on the very thick A-horizon can be documented, the soil should key out in the Anthrosols rather than in the Umbrisols. The very thick humiferous topsoil is clearly not the product of a soil with a good biological activity that sufficiently long has prevailed for a thick organic rich Umbric horizon to develop.

4. Profile P12, Meerdaalwoud, Flemish Brabant

4.1. Site and profile description

Profile 12	**Meerdaalwoud (Level II forest plot)**
1.2 Date of description:	23/7/2007
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, Flemish Brabant, St-Joris-Weert municipality, "Meerdaal" forest Coming from Brussels along highway E40, take exit 23 in southern direction and drive along N25 for 5500 m. Just before the wooden ecobridge where the road drives underneath, take the forest road on the right side (in western direction). Inside the forest, the road divides after 100 m, take the left road and continue for about 300 m. The forest plot is located on the right side (north of the road).
1.5 Profile coordinates:	*ICP Forests Level II plot nr.:* 1202 *Latitude, longitude:* 50° 47′ 50″ N, 04° 50′ 00″ E
1.6 Elevation:	± 65 m a.s.l.
2.1 Atmospheric climate and weather condition:	Frequent showers sometimes heavy, interfered by sunny warm weather in the weeks prior to the fieldwork. Light rain during profile description.
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	*Macrotopography:* The regional landscape has a gently rolling morphology incised by the Dijle river to the west of the forest. *Mesotopography:* The profile is located between two slight depressions (relicts of gullies?) of about 40-50 cm depth *Landscape position:* Upper slope *Slope form:* Convex, convex (VV) *Slope gradient:* 1.5° *Slope length:* 300 m *Slope orientation:* around the profile 310° north-west. On a macro scale, the slope is dipping towards a small water stream in east-south-eastern direction.
2.4 Land-use:	Plantation forestry with selective felling, no traces of recent felling though. *Wildlife:* No traces of hunting activities *Grazing:* No grazing
2.5 Human influence:	No influence
2.6 Vegetation:	Deciduous woodland with deciduous shrubs, deciduous dwarf shrubs and herbs. *Dominant canopy position:* >90% *Quercus robur* *Co-dominant canopy position:* >50% *Quercus robur* <10% *Acer pseudoplatanus* <10% *Fagus sylvatica* *Suppressed canopy position:* >50% *Fagus sylvatica* >10% *Quercus robur* *Shrub layer:* >80% *Quercus robur* seedlings
2.7 Parent material:	Loamy loess (7110)
2.8 Drainage class:	Well drained *Availability of water:* sufficient

2.9 Internal drainage:	Never saturated
2.10 External drainage:	Slow run-off
2.12 Groundwater:	Groundwater table very deep (>2m)
2.13 Rock outcrop:	None
2.14 Coarse surface frag.:	None
2.15 Erosion, sedimentation:	Evidences of severe gully erosion covering 25-50% of the surface, active in ancient time. No erosion at present nor in historical time.
2.17 Surface cracks:	Few very closely spaced cracks just below the O-horizon. Roots prefer the polygonal cracks.
Humus classification:	Earthworms, woodlouses, spiders and many orange slugs observed. The forest floor is composed of an OL, OFz, OHz-continuous, Ajz horizon sequence. *Classification name:* Moder → Eumoder
Remarks:	Waste soil material from when the soil was studied the first time has buried the original forest floor. For this reason, the humus classification was studied in a small pit on a sufficient distance. Horizon H3b and H4b have been sampled together with the organic layers in a mini pit on about 10 m distance from the soil profile. When brackets are used around subordinate symbols it indicates that the feature is weakly developed, e.g. (t)

No.		**Horizon description**
H1	OL	-6 till - 4 cm
H2	OFz	-4 till -0.5 cm
H3	OHz	-0.5 - 0 cm
H4	A/Ajz	0-8/17 cm; brown 10YR 4/3 (M); no reaction to α,α-dipyridyl; silt loam; fine to medium (±1 cm) subangular blocky, friable, medium porosity, very few very fine, few fine and very few medium roots; clear complex boundary
H5	Bbi1	8/17-30 cm; yellowish brown 10YR 5/4 (M); no reaction to α,α-dipyridyl; silt loam; incomplete coarse angular blocky; friable; clay coatings in open pores (possible related to dirt on top of the profile); medium porosity; penetration resistance 3-4.5 MPa; very few very fine and fine roots; smooth diffuse boundary
H6	Bbi2	30-47/75 cm; light yellowish brown to brownish yellow 10YR 6/5 (M); no reaction to α,α-dipyridyl; silt loam; incomplete coarse (2-4 cm) subangular blocky, locally medium (2-4 mm) granular; friable; no clay coatings observed; high porosity; penetration resistance 2.25-3.25 MPa; very few fine, few medium and very few coarse roots; clear complex boundary
H7	Bt1	47/75-102 cm; yellowish brown 10YR 5/4 (M); silt loam; one coarse distinct oxido-reduction mottle, whitish grey inside, orange brown outside, probably root gley; no reaction to α,α-dipyridyl; complete coarse (2-5 cm) angular blocky; firm; siltans, no clay coatings observed, except one dusty coating; medium porosity; penetration resistance >5 MPa; very few fine and medium roots; smooth diffuse boundary
H8	B(t)2	102-133 cm; yellowish brown 10YR 5/4 (M); no reaction to α,α-dipyridyl; silt loam; massive; friable; medium porosity; penetration resistance >5 MPa; no roots; clear smooth boundary
H9	BC1	133-168 cm; yellowish brown 10YR 5/5 (M); no reaction to α,α-dipyridyl; massive; friable; siltans; medium porosity; penetration resistance >5 MPa; no roots; smooth diffuse boundary
H10	BC2	168-… cm; yellowish brown 10YR 5/5 (M); no reaction to α,α-dipyridyl; silt loam; massive; friable; no clay coatings; medium porosity; penetration resistance 3.0 MPa; no roots

Colour measurements: M= Moist; MC= Moist-crushed; D= Dry; DC= Dry-crushed; W= Wet. The "bi" subordinate symbol in H5 and H6 refers to a biologically active horizon.

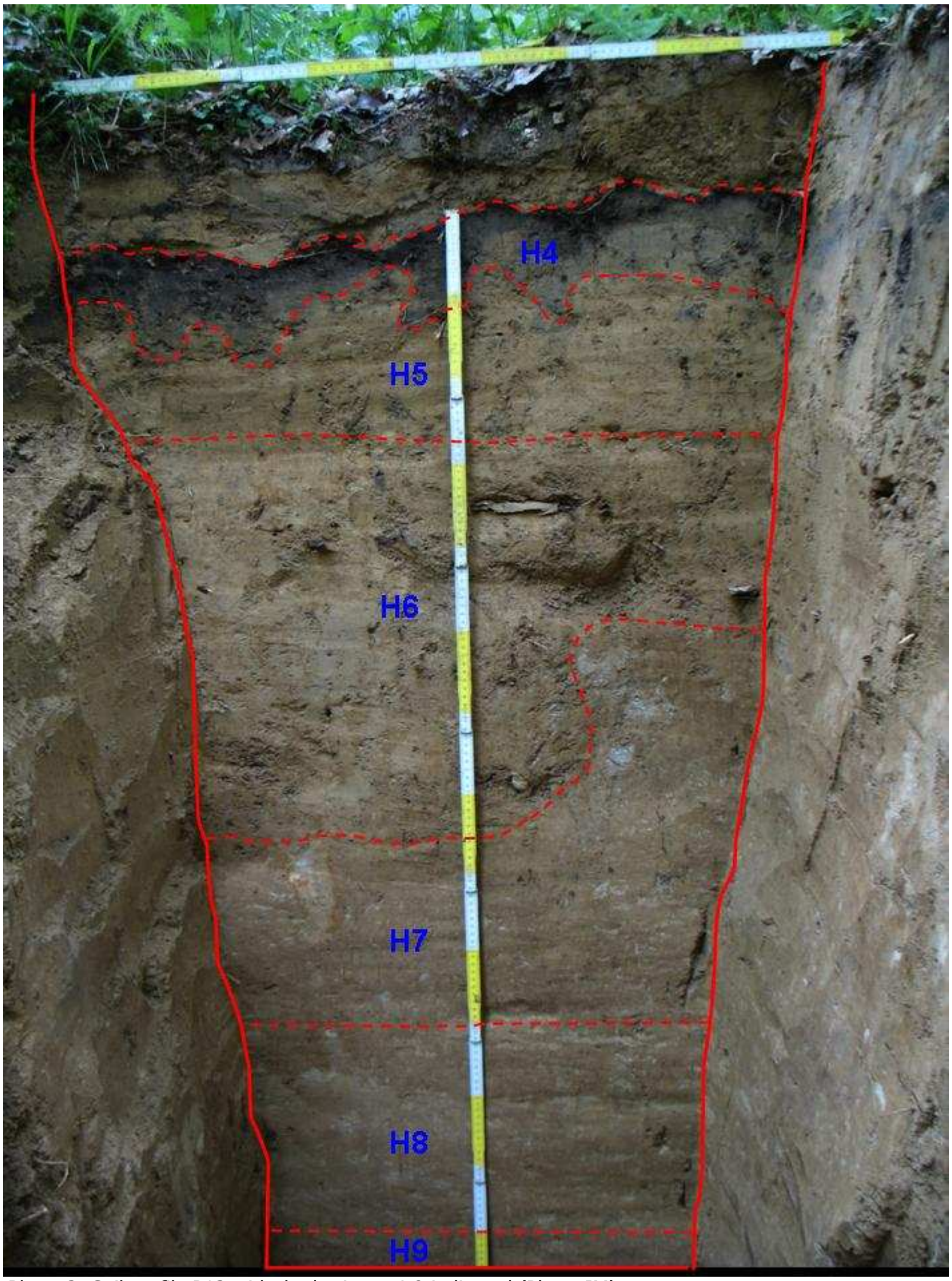

Photo 2: Soil profile P12 with the horizons 4-9 indicated (Photo JM).

4.2. The physical and chemical laboratory data

Table 5 shows that he C/N ratio of this soil is for a forest soil rather good, with most values ranging between 7 and 13. Only H4b, which is the mineral soil horizon sampled in a mini pit at about 10 m distance together with the organic layers, has a higher ratio. The content of organic carbon is 3.4% in the A horizon of the soil profile.

This horizon is buried today under a 10 cm thick layer of material which are remnants of the former profile pit described in 1991. In the A horizon sampled in the mini pit the content of organic carbon is with 6.8% almost the double. The pH(H_2O) drops from 5.5 in the OL horizon to 3.9 in the A-horizon. In the deeper pedon, the pH increases again.

Table 5: Analytical data for profile P12, Flemish Brabant, Belgium. Profile studied 23/7/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth	Total N Modified	C/N	OC TOC	Organic matter W&B	Organic matter LOI	pH H_2O	pH $CaCl_2$	EC dS/m	Coarse frag. >2mm
		cm	%		%	%	%	1:5	1:5	1:5	%-wght
1	OL	6-4	1.96	21			83.5	5.5	5.0	0.38	
2	OFz	4-0.5	2.11	18			77.6	4.9	4.2	0.29	
3	OHz	0.5-0									
3b	OHz	mini pit	2.05	15			60.2	3.7	3.1	0.11	5.0
4	A/Ajz	0-8/17	0.26	13	3.40		7.7	4.0	3.4	0.07	0.0
4b	Ah/Ajz	mini pit	0.36	19	6.78			3.9	3.2	0.09	0.0
5	Bbi1	8/17-30	0.06	7	0.40		2.1	4.2	3.7	0.04	0.0
6	Bbi2	30-47/75	0.05	9	0.49		3.2	4.3	3.7	0.04	0.0
7	Bt1	47/75-102					1.7	5.1	4.1	0.02	0.0
8	B(t)2	102-133					1.4	5.5	4.4	0.02	0.0
9	BC1	133-168						5.6	4.6	0.02	0.0
10	BC2	168-…					1.8	5.8	4.7	0.02	0.0

Horizon nr.	Particle size distribution (fractions in µm) 0-2	2-10	10-20	20-50	50-63	63-100	100-125	125-250	250-500	500-1000	1000-2000
	%										
1											
2											
3											
3b											
4	14.2	5.1	8.1	66.8	3.0	1.5	0.2	0.7	0.3	0.0	0.0
4b											
5	19.7	3.9	6.6	63.8	3.8	1.4	0.2	0.4	0.1	0.0	0.0
6	14.8	6.4	10.7	62.4	2.6	1.7	0.2	0.7	0.3	0.0	0.0
7	18.8	5.3	8.3	63.4	2.7	1.1	0.1	0.1	0.1	0.0	0.0
8	14.8	5.1	8.9	65.8	3.3	1.3	0.2	0.4	0.1	0.0	0.1
9											
10	14.6	12.7	12.1	55.0	2.1	1.7	0.4	1.1	0.3	0.0	0.0

Horizon nr.	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	Al^{+++}	Fe^{+++}	Mn^{++}	Free H^{+}	CEC sum	CEC measured	BS by CEC-m
	by $MgSO_4$ (compulsive method) cmol(+)/kg soil								cmol(+)/kg		%
1											
2											
3											
3b											
4	<0.24	<0.04	0.17	0.56	7.30	0.24	0.070	0.31	8.6	8.0	
4b	<0.24	<0.04	0.36	2.22	5.92	0.59	0.188	1.85	11.1	10.0	
5	<0.03	0.16	0.13	<0.16	6.13	0.01	0.048	0.12	6.6	7.0	
6	<0.17	<0.03	0.11	0.10	5.03	<0.01	0.056	<0.10	5.3	6.0	
7	1.31	<0.04	0.19	3.34	2.07	0.02	0.038	<0.10	7.0	8.0	
8											
9											
10	1.69	0.04	0.18	7.99	0.22	0.01	0.023	<0.10	10.1	9.0	

Horizon nr.	Horizon symbols	Depth	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	CEC	BS	CEC/ clay	Acidity sum	Acidity titrated
		cm	by NH_4OAc cmol(+)/kg soil					%		cmol(+)/kg	
1	OL	6-4									
2	OFz	4-0.5									
3	OHz	0.5-0									
3b	OHz	mini pit									
4	A/Ajz	0-8/17	0.32	0.03	0.21	0.64	14.8	8	22	7.9	9.2
4b	Ah/Ajz	mini pit	0.55	0.03	0.40	2.01	21.5	14		8.6	9.0
5	Bbi1	8/17-30	0.22	0.02	0.19	0.22	10.7	6	47	6.3	6.6
6	Bbi2	30-47/75	0.15	0.02	0.14	0.17	9.0	5	49	5.1	6.2
7	Bt1	47/75-102	2.09	0.07	0.24	3.76	10.4	60	55	2.1	2.9
8	B(t)2	102-133									
9	BC1	133-168									
10	BC2	168-…	2.19	0.07	0.24	7.54	9.8	102	67	0.2	0.4

Table 5 (continued): Analytical data for profile P12, Flemish Brabant, Belgium. Profile studied 23/7/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth	Al	Fe	K	Ca	Mg	Na	P	S	Lab nr.
			Oxalate		Aqua Regia						
		cm	%		mg/kg						
1	OL	6-4									JM295
2	OFz	4-0.5			1415	8149	962	66	1011	1976	JM296
3	OHz	0.5-0									JM297
3b	OHz	mini pit			897	3209	829	55	803	2076	JM297b
4	A/Ajz	0-8/17									JM298
4b	Ah/Ajz	mini pit	0.162	0.454	2583	862	1748	76	581	436	JM298b
5	Bbi1	8/17-30	0.219	0.390	4917	1236	3381	166	280	98	JM299
6	Bbi2	30-47/75									JM300
7	Bt1	47/75-102	0.170	0.303	4929	1708	3730	168	418	54	JM301
8	B(t)2	102-133									JM302
9	BC1	133-168									JM303
10	BC2	168-…	0.137	0.327	4497	2632	4060	145	425	49	JM304

Horizon nr.	Al	As	Cd	Co	Cr	Cu	Fe	Mn	Pb	Ni	Zn
	Aqua Regia										
	mg/kg										
1											
2	1466	0.69	0.53	1.16	11	17.8	2034	2641	20.4	11.7	57
3											
3b	3855	7.23	0.25	4.21	21	42.8	20225	553	88.5	16.2	45
4											
4b	11788	9.16	<0.50	4.24	24	13.8	16769	195	43.8	10.8	40
5	24156	8.21	<0.50	8.19	38	9.3	24593	315	10.9	17.7	58
6											
7	23176	9.21	<0.50	10.82	38	10.5	25358	398	9.8	22.4	42
8											
9											
10	19810	8.62	<0.50	8.47	35	11.9	24361	435	9.8	24.3	46

Throughout the profile the particle size distribution is rather homogeneous with a very strong peak in the fraction 20-50 µm. H10 has a slightly deviant distribution with less coarse silt and more fine and medium silt, but the difference is minor and by no means indicating the presence of a lithological discontinuity.
In the upper horizons the content of basic cations is very low, but from H7 onwards a moderate content of calcium and magnesium cations is seen. The aluminium saturation is in the upper horizons high but drops to 30% in H7 and 2% in H10.

4.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks
Albic	-	
Argic	H5, H7	CEC of the clay is above 24
Cambic		
Fragic	H7-9	It is assumed that the soil has a polygonal system of closed boxes and tongues, although not visible because the soil is well drained.
Albeluvic tonguing	-	Probably tonguing is present but not visible

Simplified classification name
Haplic Alisol
• The CEC of the clay is more than 24 cmol(+)/kg clay and the Base Saturation (BS) is less than 50% • Cutanic should not be applied, as the clay coatings observed in H5 probably is related to the dirt on top of the profile • It is not Hyperdystric because in H7 the BS is higher than 50%

Opmerking [NC1]: Show this in the table because according to me the BS in horizon 7 which forms the major part between 50 and 100 cm is 60%

Full classification name without specifiers
Haplic Alisol (Fragic, Siltic)

BioSoil classification name (WRB 2006), with specifiers
Haplic Alisol (Fragic, Siltic)

4.4. Discussion

Soil profile P12, Meerdaalwoud is characterised by its silty texture, as it is situated in the Belgian Loess belt. The contrast with this soil compared with e.g. the loess soils observed in the Zonian forest is the absence of any fragipan, or bleached tongues. The soil is therefore not classified as an Albeluvisol. Obviously, this soil has been sufficiently long under some kind of agricultural management, which has enhanced the biological activity and caused the degradation of the original closed box soil type.
A large difference in the content of organic carbon was measured between the sample taken in the A horizon of the mini pit and the A horizon of the soil profile. Considering the short distance of merely 10 m between the two sampling points, three suggestions are given on how the large difference may be explained:

- Simply lateral heterogeneity, after all most lateral variability is observed in the topsoil
- The organic matter decomposes but in the buried, A-horizon no new material is added on top, in contrast to the unburied A horizon. Because of the burial nature of the horizon, the content of organic matter will reduce with time, partly because of a continuous decomposition of existing stock partly because addition of fresh organic matter is largely reduced to what the fauna will bring into the subsoil. It can therefore be questioned whether a drop of 50% organic carbon could occur over a period from 1991 to 2007.
- The horizons are sampled differently, possibly the mini pit sample was taken in the upper part of the horizon and the sample originating from the buried A horizon was a weighted average sample (Mikkelsen et al., 2006: appendix E).

According to FAO (1988) this soil was also classified as a Haplic Alisol after first being described as a Orthic Acrisol or Orthic Luvisol in the filed. The full WRB-2006 classification name supports the revised soil classification name (Roskams et al., 1997) and provides us now with some additional information on the siltic nature and the presence of a fragic horizon within 100 cm from the soil surface.

5. Profile P13, Hallerbos, Flemish Brabant

5.1. Site and profile description

Profile 13	**Hallerbos (Level II forest plot)**
1.2 Date of description:	31/5/2007
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, Flemish Brabant, Halle municipality, "Haller" forest On highway E19 in southern direction, take exit 20 direction Dworp. Once in Dworp take on the right side the small road Vroenenbosstraat, after 50 m follow the Kerkstraat, which after 125 m becomes Waterstraat. Follow this road to its end and turn right along Molenveld, after 50 m turn left and immediately to the right along Rilroheidestraat. After a while, the street is named Kampendaal. Follow Kampendaal southwards until entering the Hallerbos. Inside the forest, after about 900 m the level II plot is located on the right side.
1.5 Profile coordinates:	*ICP Forests Level II plot nr.:* 1302 *Latitude, longitude:* 50° 42' 30'' N, 04° 18' 20'' E
1.6 Elevation:	± 115 m a.s.l.
2.1 Atmospheric climate and weather condition:	In the night before the profile description it was raining. During the fieldwork, it remained dry. In the month prior to the fieldwork, the weather was mostly unstable with day temperatures of 15-20°C.
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	*Macrotopography:* The Hallerbos is located between two west-east oriented tributaries. The area is relatively undulating with many water stream incisions. *Mesotopography:* Rolling landscape *Landscape position:* Midslope *Slope form:* CC (concave, concave) *Slope gradient:* No data *Slope length:* About 150 m *Slope orientation:* The slope is dipping in 320° (NNW) direction
2.4 Land-use:	Plantation forestry with selective felling *Wildlife:* Probably protected *Grazing:* No grazing
2.5 Human influence:	No ditches observed, but wheel tracks are visible on the surface morphology and vegetation. The tracks show no particular pattern. Vegetation slightly disturbed.
2.6 Vegetation:	Deciduous woodland composed for 100% by *Fagus sylvatica* in a dominant canopy position. The beech stand is relatively young and too densely planted whereby a number of trees already have died, though still standing vertical. The ground vegetation is composed of ferns and wood/wild Hyacinthus.
2.7 Parent material:	Loamy loess (7110)
2.8 Drainage class:	Well drained *Availability of water:* Sufficient
2.9 Internal drainage:	Never saturated
2.10 External drainage:	Slow run-off
2.12 Groundwater:	*Highest groundwater table:* Extremely deep (>200 cm) *Lowest groundwater table:* Extremely deep (>200 cm) *Type of water table:* Not known

2.13 Rock outcrop:	None
2.14 Coarse surface frag.:	None
2.15 Erosion, sedimentation:	No erosion in the forest, but along the forest dirt roads colluvial erosion is a problem.
2.17 Surface cracks:	None
Humus classification:	The forest floor is composed of the horizon sequence OLn, OFz, OHz-continuous, Aze. *Classification name:* Moder, subdivision: Eumoder
Remarks:	The original profile (dating from 24/4/1991) was located perpendicular to the slope direction. The new profile was opened at the one end of the original pit, with its long axis parallel with the slope. No reaction to α,α-dipyridyl and no rock fragments throughout the profile

No.		**Horizon description**
H1	OLn	- 6 till - 4 cm
H2	OFz	- 4 till -0.5 cm; common very fine to fine roots; millipedes, beetles, insect eggs
H3	OHz	-0.5 - 0 cm; continuously distributed; few charcoal fragments; many cracks in the Ah horizon filled with OHz material; abrupt irregular boundary
H4	Ah/Aze	0-10/15 cm; slightly bleached matrix, very dark greyish brown 10YR 3/2 (M); silt; granular; friable; medium porosity; few very fine roots; two filled large crotovinas; clear wavy boundary
H5	Bbi	10/15-38 cm; yellowish brown 10YR 5/4 (M); silt loam; subangular blocks; friable; medium porosity; few very fine to coarse roots; abrupt smooth boundary
H6	Bdtx1	38-60 cm; brown to dark yellowish brown 8.5YR 4/4 (M); silt loam; prisms breaking to moderate angular blocks; firm; low porosity; no roots; gradual smooth boundary
H7	Eg	38-73/120 cm; the horizon is composed of bleached tongues (root gley?) stretching into the Bt horizons; yellowish brown 10YR 5/5 (M); very few very fine distinct, sharp, black Mn mottles; orange, rusty rim on the boundary between H5 and H7; silt loam; weak angular blocks; friable; very few, faint clay and iron oxide coatings; low porosity; very few, very fine to medium roots; clear irregular boundary
H8	Bdtx2	60-80 cm; brown to yellowish brown 8.5YR 5/4 (M); silt loam; prisms breaking to moderate angular blocks; firm; few, faint clay coatings; common, distinct siltans (silt coatings); low porosity; very few, very fine to fine roots; diffuse smooth boundary
H9	Bdt	80-111/122 cm; dark yellowish brown to yellowish brown 10YR 4.5/4 (M); silt loam; prisms breaking to weak, coarse angular blocks; firm; clay coatings in pores; siltans; medium porosity; very few very fine roots; gradual smooth boundary
H10	Bt1	111/122-145 cm; dark yellowish brown 10YR 4/4 (M); silt loam; moderate, coarse angular blocks; few, distinct clay coatings along pores; common, distinct siltans; high porosity; very few very fine roots; gradual smooth boundary
H11	Bt2	145-… cm; yellowish brown 10YR 5/4 (M); silt loam; incomplete, coarse angular blocks; friable; few clay coatings along macro pores; high porosity; no roots

Colour measurements: M= Moist; MC= Moist-crushed; D= Dry; DC= Dry-crushed; W= Wet.

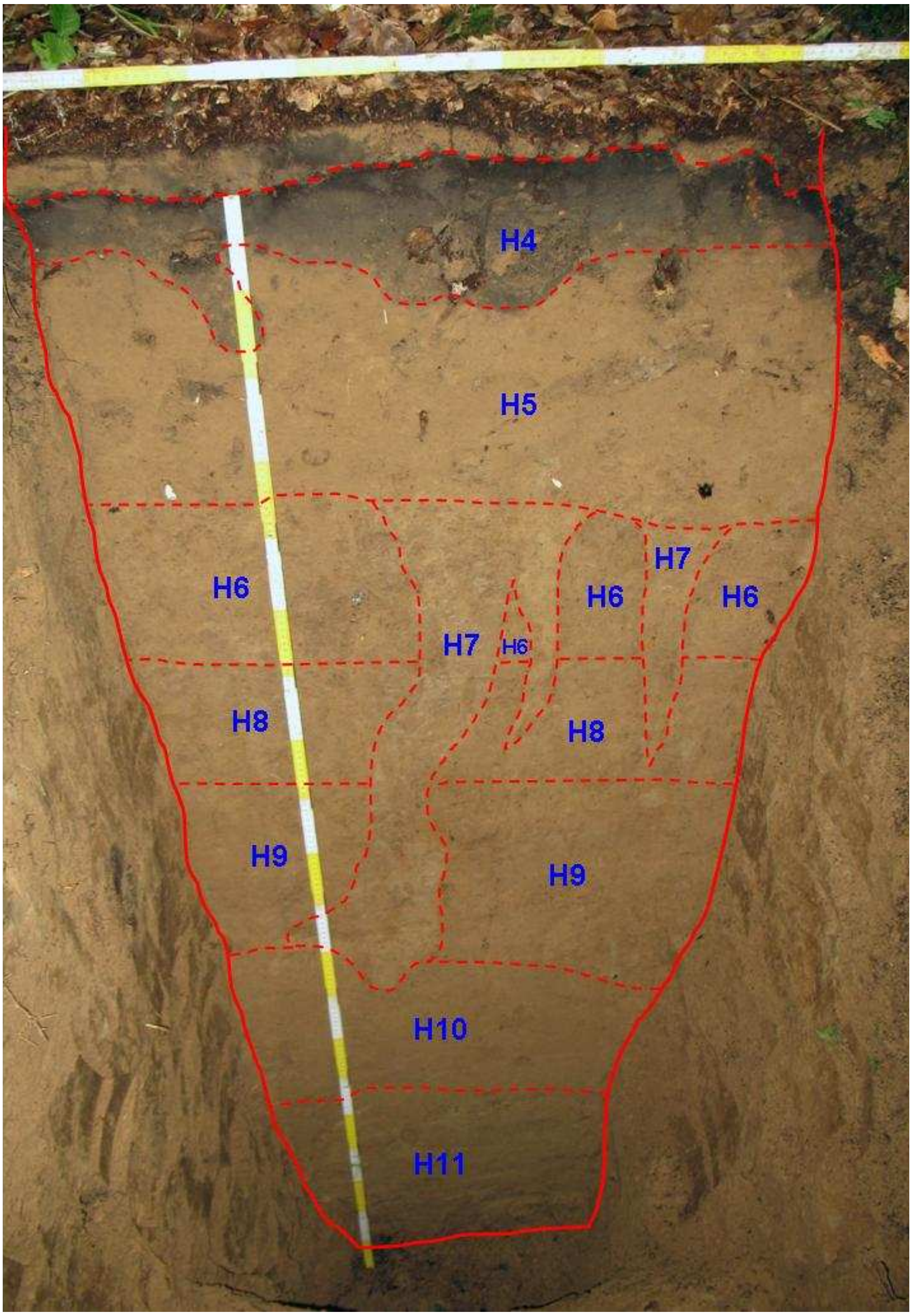

Photo 3: Soil profile P13 with the horizons indicated (Photo JM).

5.2. The physical and chemical laboratory data

The C/N ratio show two peaks, one in the OL horizon and one in the Ah horizon, below these peaks the ratio drops. The highest ratios are observed in the horizons with a moderate to high content of organic carbon. These are the litter layers and the Ah horizon. Below the surface mineral horizon, the content of organic carbon is very low.

Table 6: Analytical data for profile P13 Hallerbos, Flemish Brabant, Belgium. Profile studied 31/5/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth	Total N Modified	C/N	OC TOC	Organic matter W&B	LOI	pH H_2O	$CaCl_2$	EC dS/m	Coarse frag. >2mm
		cm	%		%	%	%	1:5	1:5	1:5	%-wght
1	OLn	6-4	1.228	32			78.5	5.6	5.1	0.47	
2	OFz	4-½	1.254	21			53.1	4.8	4.3	0.29	
3	OHz	½-0	1.735	17			59.8	4.0	3.4	0.21	
4a	Aze/Ah	mini pit	0.199	16	3.23	5.1	6.5	3.8	3.3	0.09	0.2
4b	Aze/Ah	0-10/15	0.231	15	3.50	6.3	6.7	4.0	3.4	0.08	
5	Bbi	10/15-38	0.064	9	0.55	1.2	2.0	4.3	3.8	0.04	0.1
6	Bdtx1	38-60	0.037	3	0.12		1.6	4.3	3.8	0.05	tr
7	Eg	38-73/120	0.042	4	0.16		1.7	4.3	3.7	0.05	0.0
8	Bdtx2	60-80			0.13		1.9	4.3	3.7	0.06	0.0
9	Bdt	80-111/122			0.11		2.0	4.7	3.8	0.04	0.0
10	Bt1	111/122-145					2.0	5.4	4.3	0.03	tr
11	Bt2	145-...					1.9	5.5	4.4	0.03	0.0

Horizon nr.	Particle size distribution (fractions in µm) 0-2	2-10	10-20	20-50	50-63	63-100	100-125	125-250	250-500	500-1000	1000-2000
	%										
1											
2											
3											
4a	11.6	8.6	11.5	61.5	2.8	1.5	0.2	0.9	1.1	0.1	tr
4b	10.8	9.2	13.2	60.2	2.2	1.6	0.2	1.2	1.3	0.1	tr
5	12.3	8.8	15.7	56.6	2.7	1.4	0.2	1.0	1.2	0.1	tr
6	15.9	7.5	9.4	63.0	2.2	1.2	0.1	0.3	0.4	0.1	tr
7	21.2	7.3	12.6	54.7	2.4	1.1	0.1	0.3	0.3	tr	tr
8	20.7	10.2	12.7	51.8	2.4	1.4	0.1	0.3	0.3	tr	tr
9	22.4	8.4	7.5	56.9	2.8	1.4	0.1	0.3	0.3	tr	tr
10	20.7	10.6	14.0	51.9	1.6	0.9	0.1	0.1	0.1	tr	tr
11	19.6	8.4	13.6	54.4	2.3	1.2	0.1	0.2	0.3	tr	tr

Horizon nr.	Mg++	Na+	K+	Ca++	Al+++	Fe+++	Mn++	Free H+	CEC sum	CEC measured	BS by CEC-m
	by $MgSO_4$ (compulsive method)										
	cmol(+)/kg soil								cmol(+)/kg		%
1											
2											
3											
4a	<0.24	<0.04	0.13	0.63	5.36	0.34	0.138	1.57	8.2	6.0	<15
4b	<0.23	<0.03	0.09	0.59	5.07	0.33	0.060	1.38	7.5	6.0	<14
5	<0.16	<0.02	0.07	0.09	3.82	0.02	0.094	0.13	4.2	4.0	<6
6	<0.13	<0.02	0.17	0.13	5.32	0.02	0.052	1.11	6.4	7.0	<5
7	<0.16	<0.03	0.21	0.14	7.04	0.01	0.046	1.15	8.6	8.0	<6
8	<0.16	<0.02	0.23	0.24	7.14	0.02	0.064	0.93	8.6	9.0	<6
9	1.06	0.06	0.22	2.28	5.17	0.02	0.105	0.38	9.3	10.0	36
10											
11											

Horizon nr.	Horizon symbols	Depth	Mg++	Na+	K+	Ca++	CEC	BS	CEC/ clay	Acidity sum	titrated
			by NH_4OAc								
		cm	cmol(+)/kg soil					%		cmol(+)/kg	
1	OLn	6-4									
2	OFz	4-½									
3	OHz	½-0									
4a	Aze/Ah	mini pit	0.21	0.03	0.16	0.64	13.7	8	22	7.4	8.7
4b	Aze/Ah	0-10/15	0.23	0.04	0.13	0.58	13.5	7	13	6.8	8.2
5	Bbi	10/15-38	0.10	0.02	0.10	0.19	7.4	5	45	4.1	5.1
6	Bdtx1	38-60	0.13	0.03	0.21	0.22	9.2	6	55	6.1	6.4
7	Eg	38-73/120	0.15	0.03	0.22	0.21	12.7	5	57	8.2	9.4
8	Bdtx2	60-80	0.22	0.03	0.27	0.32	12.7	7	59	8.1	9.7
9	Bdt	80-111/122	1.45	0.04	0.26	2.39	13.8	30	60	5.7	6.9
10	Bt1	111/122-145									
11	Bt2	145-...									

Table 6 (continued): Analytical data for profile P13 Hallerbos, Flemish Brabant, Belgium. Profile studied 31/5/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth	Al	Fe	K	Ca	Mg	Na	P	S	Lab nr.
			Oxalate		--------Aqua Regia--------						
		cm	%		----------mg/kg----------						
1	OLn	6-4									JM213
2	OFz	4-½			1409	7462	1212	80	819	1429	JM214
3	OHz	½-0			1173	4836	957	85	1015	2317	JM215
4a	Aze/Ah	mini pit	0.129	0.465	2621	1219	1708	120	401	294	JM216A
4b	Aze/Ah	0-10/15	0.130	0.459	2671	1240	1641	179	469	312	JM216B
5	Bbi	10/15-38	0.157	0.409	2501	836	2090	160	217	113	JM217
6	Bdtx1	38-60	0.167	0.304	4213	766	3338	130	291	109	JM218
7	Eg	38-73/120	0.197	0.234	5209	643	4106	202	272	126	JM219
8	Bdtx2	60-80			5780	864	4370	204	355	116	JM220
9	Bdt	80-111/122	0.203	0.287	5629	1228	4653	229	374	81	JM221
10	Bt1	111/122-145									JM222
11	Bt2	145-…									JM223

Horizon nr.	Al	As	Cd	Co	Cr	Cu	Fe	Mn	Pb	Ni	Zn
	--------Aqua Regia--------										
	----------mg/kg----------										
1											
2	4987	2.68	0.43	2.75	11	14.5	7118	2118	42.3	10.5	75
3	4988	4.25	0.64	3.17	17	23.6	10550	474	205.6	19.4	101
4a	14238	9.82	<0.50	4.36	26	7.4	15289	269	56.8	10.5	45
4b	14567	11.54	<0.50	4.14	28	8.7	15577	220	58.5	9.8	38
5	16334	5.84	<0.50	6.81	27	3.7	15979	546	13.1	10.1	33
6	22444	8.33	<0.50	8.22	34	7.7	22844	409	9.9	17.8	51
7	27864	9.59	<0.50	10.55	41	11.2	28444	442	11.7	21.9	64
8	30047	10.79	<0.50	10.13	44	12.1	29556	415	11.8	23.1	60
9	28988	10.67	<0.50	10.48	46	13.0	30458	420	11.9	26.1	58
10											
11											

In H4-5 the content of organic carbon and organic matter was measured by three different analytical methods (1) Total Organic Carbon, (2) Walkley and Black and (3) Loss on Ignition. When the conversion factor of 1.72 is applied between organic carbon and organic matter (see Table 7), very good similarity between the different methods is found in H4.

Table 7: The content of organic matter measured by 3 different laboratory methods

Horizon nr.	Organic matter TOC	W&B	LOI
	%	%	%
1			78,5
2			53,1
3			59,8
4a	5,6	5,1	6,5
4b	6,0	6,3	6,7
5	1,0	1,2	2,0
6	0,2		1,6
7	0,3		1,7
8	0,2		1,9
9	0,2		2,0
10			2,0
11			1,9

Particular from H6 and further in depth the content of organic matter by the LOI method is highly overestimated. The subsoil is relatively clayey and clay contains always a certain percentage of chemical bound water. Upon heating, this fraction of water may at least partly escape due to the high temperature. The result is a weight loss that is recorded as a loss on ignition (De Vos et al., 2005), and interpreted as coming from burning of organic matter.

Like for profile P12 this soil too has a higher pH in the upper organic layers. The lowest pH is found in the upper mineral horizons and slowly increases with depth in the soil. Less weathering and less organic acids in the deeper subsoil are probably the main reasons why a higher pH prevails here.

Traces of coarse fragments are found in a few horizons. During sieving, no difference is made between coarse fragmented organic tissues and gravels stones etc. Anyhow, very fine gravels were present in very low quantities also in the deeper horizons.

The particle size distribution provides an interesting picture. The clay content increases towards H7-9 and then slowly drops again. What is interesting is that H7 contains as much clay as H8 and 9. H8-9 are the clay illuviation horizons but H7 was interpreted in the field as the E horizon.

The content of basic cations and the distribution of cations in this profile illustrate very well the major problem for Belgian loess soils kept unfertilized. The base saturation is at most 15% but drops to less than 5-6% in the subsoil. First from 80 cm, depth (H9) some basic cations are stored mainly magnesium and calcium. The aluminium saturation remains above 50% through all analysed horizons, and peaks to values above 80-90%. The oxalate extractable aluminium increases with depth; for iron, the trend is rather a decrease with depth. The content of aqua regia extractable elements is within the expected limits, although a slightly elevated content of lead of 200 mg/kg is found in the OH horizon.

5.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks
Albic	-	
Argic	H6-11	CEC of the clay exceeds 24 cmol(+)/kg clay
(Fragic)	H6, H8	In the field tongues were observed interfingering into the Bt horizons. The pipette texture analysis though shows similar clay content for the tongues as for the surrounding soil. H6 and H8 are both firm and were added the subordinate symbols m and x in the field. It is assumed that they will qualify for Fragic, although information is missing about the penetration resistance at field capacity.
Albeluvic tonguing	-	Colour of H7 has a too high chroma to match that requirement for an Albic horizon

Simplified classification name
The CEC of the clay is higher than 24 cmol(+)/kg clay and the base saturation is lower than 50%. **Haplic Alisol**

Full classification name without specifiers
Haplic Alisol (Fragic, Alumic, Hyperdystric, Profondic, Siltic) • Fragic, with the assumption that the penetration resistance is at least 5 MPa

BioSoil classification name (WRB 2006), with specifiers
Haplic Alisol (Epifragic, Hyperalumic, Hyperdystric, Profondic, Episiltic)

5.4. Discussion

The soil has irregular eluvial tonguing into the Bt horizon as illustrated by photo 3. That the clay content in the eluvial horizon (H7) is as high as for the Bt horizons demands an explanation. One possible explanation is incorrect sampling. Sampling correctly vertical tongues, that often follow an irregular path downwards, can sometimes be difficult, surely for these tongues, as they appear only faintly visible. Another explanation is that the tongues

indeed are eluvial, but not as a result of clay migration but rather due to oxido-reduction with leaching of part of the iron. To the extent that oxalate extractable iron can be applied, the E horizon is indeed the one with the lowest content. On the other hand it has a quite high aqua regia extractable Fe content.
If the clay content in the E horizon would have been clearly lower than what is measured, then the soil would still not key out in Albeluvisols because the colour of the albeluvic tongues have a too high chroma. That illustrates a well know problem for Albeluvisols. To key out in Albeluvisols the presence of vertical bleached tongues is a diagnostic criterion. If we would have two similar soils with firm to very firm Bt horizons (of the fragipan type) fractured by tongues of Albic material, but where one soil is well drained and the other is not, then the tongues in the well drained soil will at most be faintly visible, while in the poorly drained soil, the tongues become bleached because the soil sometimes has water stagnation in its subsoil. These two soils only have different drainage classes and yet they will key out in respectively Alisols and Albeluvisols. This is a weakness in the classification system. The ultimate problem with this kind of soils is the impermeable subsoil for fauna, flora and even for water. At the level in the soil where a fragipan is present, the active soil volume is reduced to about 10%. Whether the 10% of the soil that is available for roots is bleached is in this respect irrelevant. It is recommended that soils having a closed box system with Albeluvic tongues (bleached or not) all are included in Albeluvisols. As an example, when penetration resistance measurements are made of the fragipan and of the Albeluvic tongues and a major difference is found, it should be enough to have Albeluvic tongues (if indeed the tongues are present in a polygonal pattern).
The tongues present in this soil are not very well developed with rather irregular sizes and mutual distance. A classification as Alisol therefore seems more correct than Albeluvisol for this particular soil. Fortunately, it is possible to include the Fragic qualifier for Alisols so the information about the firm subsoil is taken into account.

According to FAO (1988) this soil was also classified as a Haplic Alisol. The full WRB-2006 classification name gives us more detailed information on additional soil characteristics.

6. Profile P14, Ravels, Antwerp

6.1. Site and profile description

Profile 14 (2007)	**Ravels North (Level 2 forest plot)**
1.2 Date of description:	3/5/2007
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, Province of Antwerp, Ravels municipality, Witgoor, Ravels North From Turnhout take road N12 direction Ravels. In Ravels, follow N137 towards Eel. In Eel, just before the church, follow Eelstraat on the right side. After a while turn right into Hofstraat, which leads into the forest. Drive through the forest, at the sigh for the Dutch border turn left and follow the edge of the forest. After about 500 m, only the left side of the road is covered by forest, as the right side is agricultural land. Shortly after both sides again are planted with forest, the level II plot is located on the left side of the road.
1.5 Profile coordinates:	*ICP Forests Level II plot nr.:* 1402 *Latitude, longitude:* 51° 24′ 11″ N, 05° 03′ 25″ E
1.6 Elevation:	±30 m a.s.l.
2.1 Atmospheric climate and weather condition:	Sunny and clear sky. Temperature expected to rise to 24°C. Past more than one month no rain, easterly winds and sunny. April was the warmest April ever recorded.
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	*Macro topography:* Almost flat landscape with no clear slope direction. Some smaller water streams. *Meso topography:* Profile located on a crest position *Landscape position:* Intermediate position in an almost flat landscape *Slope form:* Convex both along the vertical and the horizontal contour *Slope gradient:* 1/3° *Slope length:* Estimated about 150-200 m down slope and 15-20 m upslope *Slope orientation:* -
2.4 Land-use:	Plantation forestry with selective felling *Wildlife:* probably protected *Grazing:* No grazing
2.5 Human influence:	Vegetation slightly disturbed; single time ploughing; artificial drainage (ditches)
2.6 Vegetation:	Evergreen woodland. Tree level: dominant canopy position, 100% frequency, Corsican Pine *(Pinus nigra subsp. laricio)* Shrub level: European Holly *(Ilex aquifolium)* Ground level: fern, grasses, black cherry *(Prunus serotina)*
2.7 Parent material:	Cover sand (7220)
2.8 Drainage class:	Well drained *Availability of water:* water is probably insufficient at moments of longer drought during the summer
2.9 Internal drainage:	Never saturated
2.10 External drainage:	Slow run-off
2.12 Groundwater:	At about 2 m depth to judge from the nearby water stream
2.13 Rock outcrop:	None

2.14 Coarse surface frag.:	None
2.15 Erosion, sedimentation:	No erosion observed. The soil is stabilized and protected by the forest floor.
2.17 Surface cracks:	None
Humus classification:	Horizon sequence: OL-OFnoz-OHnoz-Ae *Classification name:* Mor → Hemimor
Remarks:	The profile remained partly opened for the past several years. In a fresh auger observation at a few meters distance from the profile, a positive reaction to ɑ,ɑ-dipyridyl was recorded from 65 cm depth onwards (corresponding to H7: Bg1). No stones were observed throughout the profile, no reaction to ɑ,ɑ-dipyridyl in H4-10 and no cementations recorded.

No.		Horizon description
H1	OL	-17 till - 15 cm
H2	OFnoz	-15 till - 3 cm
H3	OHnoz	-3 - 0 cm
H4a	Ap/Ae	0-27/32 cm; horizon formed through a single time ploughing of the original Ah, E and Bs horizons, the plough furrows are oriented about 40° on the profile wall; Ah: black 7.5YR 2.5/1 (M), loamy sand; very friable; E: grey 10YR5/1 (slightly M), sand; Bs (fragments only): dark yellowish brown to dark brown 8.5YR3/4 (slightly M); single grain; loose ; few very fine to fine and very few medium to coarse roots; a new discontinuous whitish E horizon is developing on the border between H2 and H3, where present it is 0.5-1 cm thick; abrupt smooth boundary
H5	B(h)s	27/32-40/47 cm; lower part of the original Bs (the upper part is today included in the plough layer); dark yellowish brown 10YR 4/4 (slightly M); loamy sand; single grain; very friable; few very fine to fine and very few medium roots; gradual smooth boundary
H6	B	40/47-57/85 cm; light yellowish brown 10YR 6/4 (slightly M); sand; loose; very few, very fine to fine roots; gradual smooth boundary
H7	Bg1	57/85-110 cm; horizon under influence of oxido-reduction; bleached part: 2.5Y 7/3 (slightly M), mottled part: strong brown 7.5YR 5/8, abundant (±40%), coarse, prominent, clear to diffuse mottles; sand; single grain; loose; no roots observed; diffuse smooth boundary
H8	Bg2	110-130 cm; light brownish grey 2.5Y6/2 (M); many (20-25%), coarse, prominent, clear to diffuse, yellowish brown to light olive brown 1.5Y 5/6 (M) mottles; single grain; loose; very few very fine to fine roots; gradual smooth boundary
H9	2Cg	130-142/165 cm; clayey and mottled horizon; light yellowish brown 2.5Y 6/3 (M); many (30-40%), coarse, distinct, diffuse, rusty brown mottles; silt loam; massive; friable; no roots; clear smooth boundary
H10	3Cg	146-154 cm; thin oxido-reduction horizon (fluctuating groundwater table); many (±75%), coarse, prominent, diffuse, yellowish brown 10YR 5/8 (M) mottles; single grain; loose; no roots; clear smooth boundary
H11	3Cr	155/165-… cm; permanently reduced horizon (permanent groundwater level), with very slow permeable water standing at 2 m depth; pale olive 5Y 6/3 (M); faint reaction to ɑ,ɑ-dipyridyl; sand; single grain; loose; no roots

Colour measurements: M= Moist; MC= Moist-crushed; D= Dry; DC= Dry-crushed; W= Wet.

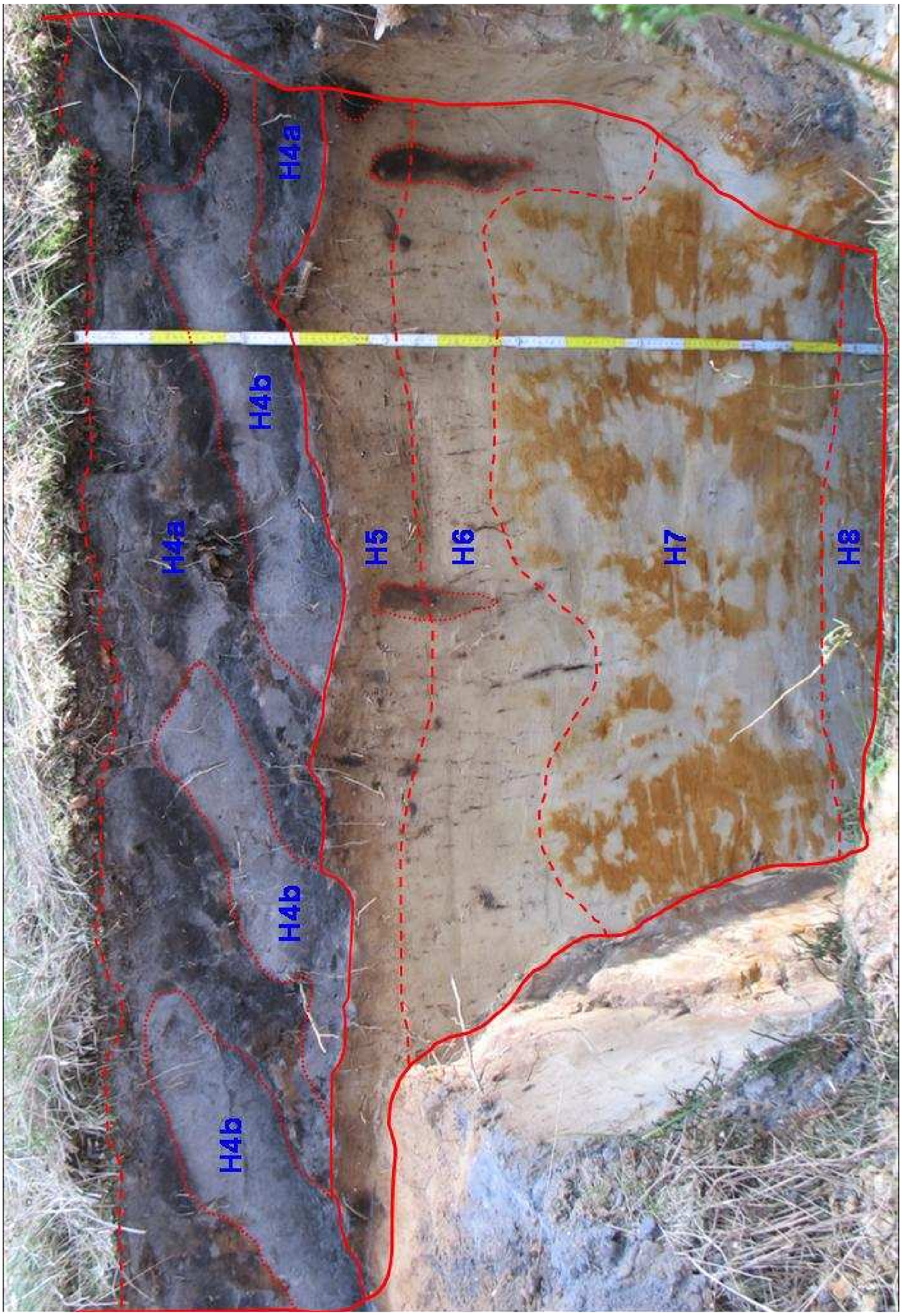

Photo 4: Soil profile P14, Ravels, with the upper horizons indicated (Photo JM).

From Photo 4; the single time ploughing is obvious. H4 is composed of A-horizon material (H4a), E horizon material (H4b) and fragments of Bhs horizon material See also photo 5 for the deeper horizons.

6.2. The physical and chemical laboratory data

Due to nitrogen depletion, extremely high C/N ratios are observed in the upper mineral horizons. The critical level is diminishing with depth. A content of 4% organic carbon in the A horizon is high considering the rather sandy texture of this soil. The pH remains acid but stable through the soil, except for a drop in the OH horizon.

Table 8: Analytical data for profile P14 Ravels, Antwerp, Belgium. Profile studied 3/5/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth cm	Total N Modified %	C/N	OC TOC %	Organic matter W&B %	Organic matter LOI %	pH H_2O 1:5	pH $CaCl_2$ 1:5	EC dS/m 1:5	Coarse frag. >2mm %-wght
H1	OL	17-15					88.6	4.5	4.1	0.36	
H2	OFnoz	15-3	1.436	27			77.2	3.8	3.0	0.17	
H3	OHnoz	3-0	1.471	26			75.9	3.4	2.7	0.15	
H4a	Ae/Ap	0-27/32	0.118	34	3.99		6.8	4.1	3.5	0.04	0.04
H4b	E	0-27/32	0.032	33	1.06		1.8	4.4	3.6	0.02	0.02
H5	B(h)s	27/30-40/47	0.049	26	1.28		2.2	4.4	4.0	0.02	0.14
H5b	best developed	27/30-40/47	0.054	22	1.19						0.22
H6	B	40/47-57/85	0.019	12	0.24		0.7	4.5	4.3	0.02	0.03
H7b	Bg1(mottled)	57/85-110					0.6	4.5	4.4	0.02	0.01
H7	Bg1 (bleached)	57/85-110									0.02
H8	Bg2	110-130						4.3	4.1	0.03	0.01
H9	2Cg	130-142/165					0.9	4.2	3.9	0.04	0.00
H10	3Cg	146-154						4.2	4.1	0.03	0.08
H11	3Cr	155/165-					0.3	4.1	4.0	0.05	0.01

Horizon nr.	Particle size distribution (fractions in µm) % 0-2	2-10	10-20	20-50	50-63	63-100	100-125	125-250	250-500	500-1000	1000-2000
H1											
H2											
H3											
H4a	2.3	0.9	1.0	8.1	2.6	11.0	11.0	46.1	14.9	1.7	0.2
H4b	0.7	0.4	1.2	8.9	2.6	12.5	12.1	46.9	13.4	1.2	0.2
H5	1.8	1.0	0.7	11.2	-	13.2	13.2	44.6	12.6	1.4	0.4
H5b											
H6	1.0	0.1	0.2	5.2	2.5	15.4	16.0	47.5	10.9	1.1	0.2
H7b	1.5	0.2	0.2	3.0	1.2	11.3	13.5	54.5	13.5	0.7	0.2
H7											
H8											
H9	6.8	2.6	5.5	58.8	5.8	10.0	3.0	6.1	1.2	0.1	0.0
H10											
H11	2.9	0.0	0.3	5.7	4.2	22.1	14.8	40.5	9.0	0.3	0.1

Horizon nr.	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	Al^{+++}	Fe^{+++}	Mn^{++}	Free H^{+}	CEC sum	CEC measured	BS by CEC-m
	by $MgSO_4$ (compulsive method) cmol(+)/kg soil								cmol(+)/kg		%
H1											
H2											
H3											
H4a	<0.3	<0.05	<0.03	<0.06	7.94	0.09	<0.006	0.69	8.7	9.0	<2
H4b	<0.19	<0.03	<0.02	<0.03	0.95	0.02	<0.004	0.31	1.3	2.0	<6
H5	<0.13	<0.02	<0.01	<0.02	2.29	0.01	<0.002	<0.10	2.3	2.0	<5
H5b											
H6	<0.12	<0.02	<0.01	<0.02	0.86	0.01	<0.002	0.26	1.1	1.0	<9
H7b											
H7											
H8											
H9	<0.12	<0.02	0.06	<0.02	2.87	0.02	<0.002	<0.10	2.9	<3	~9
H10											
H11											

Horizon nr.	Horizon symbols	Depth cm	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	CEC	BS	CEC/ clay	Acidity sum	Acidity titrated
			by NH_4OAc cmol(+)/kg soil					%		cmol(+)/kg	
H1	OL	17-15									
H2	OFnoz	15-3									
H3	OHnoz	3-0									
H4a	Ae/Ap	0-27/32	0.03	0.02	0.02	0.05	17.0	1		8.7	11.6
H4b	E	0-27/32	0.01	0.01	0.01	0.04	2.3	3		1.3	2.2
H5	B(h)s	27/30-40/47	<0,01	<0,01	0.02	0.04	5.8	1		2.3	3.3
H5b	best developed	27/30-40/47									
H6	B	40/47-57/85	<0,01	<0,01	0.02	0.02	1.9	2		1.1	1.5
H7b	Bg1(mottled)	57/85-110									
H7	Bg1 (bleached)	57/85-110									
H8	Bg2	110-130									
H9	2Cg	130-142/165	0.02	0.01	0.08	0.04	4.1	4	60	2.9	3.9
H10	3Cg	146-154									
H11	3Cr	155/165-									

Table 8 (continued): Analytical data for profile P14 Ravels, Antwerp, Belgium. Profile studied 3/5/2007. Profile analysed 10/2007 - 06/2008. H7 concerns the bleached part of the horizon, H7b concerns the mottled part.

Horizon nr.	Horizon symbols	Depth cm	Al Oxalate %	Fe	K Aqua Regia mg/kg	Ca	Mg	Na	P	S	Lab nr.
H1	OL	17-15									JM224
H2	OFnoz	15-3			793	1789	383	158	528	1861	JM225
H3	OHnoz	3-0			657	1432	323	103	541	2283	JM226
H4a	Ae/Ap	0-27/32	0.235	0.040	227	123	86	62	180	169	JM227
H4b	E	0-27/32	0.024	0.007	88	70	10	36	32	48	JM228
H5	B(h)s	27/30-40/47	0.268	0.024	400	320	234	51	95	82	JM229
H5b	best developed	27/30-40/47	0.203	0.028							JM230
H6	B	40/47-57/85	0.116	0.023	557	357	345	45	57	37	JM231
H7b	Bg1(mottled)	57/85-110	0.089	0.335							JM232
H7	Bg1 (bleached)	57/85-110	0.051	0.009							JM233
H8	Bg2	110-130									JM234
H9	2Cg	130-142/165	0.097	0.157	2065	758	1305	76	85	79	JM235
H10	3Cg	146-154									JM236
H11	3Cr	155/165-									JM237

Horizon nr.	Al Aqua Regia mg/kg	As	Cd	Co	Cr	Cu	Fe	Mn	Pb	Ni	Zn
H1											
H2	1217	1.58	0.85	1.79	3.48	24.31	1264	153	74.6	7.86	80.4
H3	2321	5.12	0.60	4.60	8.03	65.42	3616	61	307.5	12.25	86.1
H4a	3918	<2.50	<0.50	<0.50	4.76	<2.50	761	8	3.4	0.93	5.2
H4b	670	<2.50	<0.50	<0.50	<2.50	<2.50	202	6	1.6	<0.50	<5.0
H5	5924	<2.50	<0.50	0.68	5.42	<2.50	1519	17	2.8	2.10	15.9
H5b											
H6	4857	<2.50	<0.50	0.84	6.71	<2.50	2168	21	1.8	2.59	9.6
H7b											
H7											
H8											
H9	13360	2.70	<0.50	2.34	22.11	3.24	10193	46	5.9	6.43	14.8
H10											
H11											

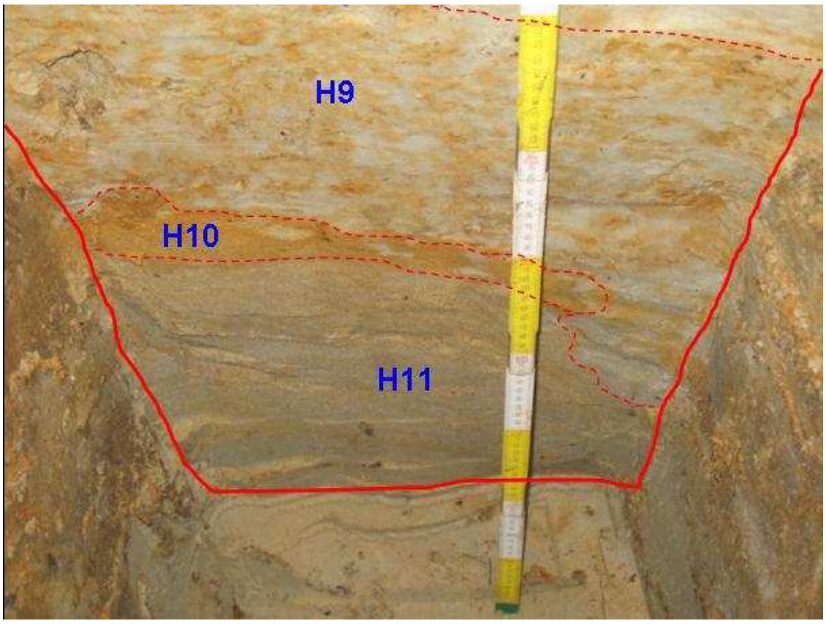

Photo 5: View on the deepest horizons of profile P14 Ravels (Photo JM)

Traces of coarse fragments are found through the soil, the concentrations remain below half a percent. It concerns fine gravels and fragmented gravels. The particle size distribution is extremely homogeneous for H4 to H7 and is characterised by very low contents of clay (0.7-2.3%). The lowest content is found in the E horizon, which may illustrate that right after the soil was decalcified a short period of active clay migration prevailed. Indeed, in H5 the clay content is slightly higher. H9 is different, in the field the horizon was described as clayey (H9 is located deeper than photo 4). The horizon contains 6.8% clay, an important increase considering that in the other soil horizons clay is practically absent. Furthermore, in H9 the bulk of the texture is found in the fraction coarse silt (20-50 µm), where in the horizons above H9, the largest fraction is the fine sand (125-250 µm). H9 may therefore form the water

storage horizon for this soil. Unfortunately, it is located at a depth of 130 cm and is only about 15-18 cm thick. The different texture for H9 dates back to the deposition of the parent material and is not linked to any pedogenetic process.
The content of basic cations is very low: all laboratory results except one are lower than the quantification limit. Only the content of potassium in H9 is above the quantification limit. Obviously, the aluminium saturation is extremely high and never drops below 74%.
The highest content of oxalate iron is found in the mottled part of H7 (H7b), which is not surprising. The content of oxalate extractable aluminium peaks in the B(h)s horizon, indicating that possible some podzolisation is taking place. The content of aqua regia extractable elements is in general very low. Only sulphur and lead of the OH horizon have higher contents than expected. Remarkable is the very low content of iron and aluminium. If the mineral soil material, (outside H9) is composed almost entirely of quartz this may also explain the extremely low values on basic cations.

6.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks
Albic	H4b, H7, H8	Horizon is composed of A + E horizon material
Folic	H1-3	Very thick organic layer
Spodic	-	No Spodic B horizon present
Umbric	-	Colour of H4a+H4b mixed together is too light
Gleyic colour pattern	H7-11	H7-10 Oximorphic colours H11 Reductomorphic colours
Reducing conditions	H7-11	

Simplified classification name
Brunic Albic Arenosol Brunic: H5 has a slightly higher clay content than both the under and overlying horizon Hydrophobic is not tested, but due to the shallow temporarily groundwater table it is assumed that the soil is not hydrophobic.

Full classification name without specifiers
Endogleyic Folic Brunic Albic Arenosol (Dystric)

BioSoil classification name (WRB 2006), with specifiers
Endogleyic Hyperfolic Hypobrunic Albic Arenosol (Hyperdystric) • Hyperfolic because of the extensive thickness • Hypobrunic because it is weakly developed • Hyperdystric: base saturation is less than 5% trough the profile

This soil most probably qualified for a Podzol prior to the single event ploughing, which that is rather clear from H4. The ploughing was sufficiently deep to include not only the Podzol A and E horizon but also the Podzol B(h)s horizon. Below the plough layer only the lower part of the Spodic B horizon is still in situ. In this horizon, the chemical characteristics are not strong enough to qualify for a Spodic horizon.

6.4. Discussion

Morphologically this is a typical soil with a schoolbook example of single time ploughing, resting on top of the remains of a B(h)s horizon and a subsoil under influence of oxido-reduction. Chemically this soil is extremely poor, with low pH, practically absence of exchangeable basic cations but also very low contents of aqua regia extractable elements. The physical aspects are characterised by an extremely low content of clay, little silt and a dominant fraction of fine sand.
The pH remains relatively stable through the soil except for H3, which is the OH horizon. Why the pH drops to 3.4 in this horizon is interesting. Possible this is due to decomposition of the organic matter, whereby organic acids are released.

During the survey in 1991, the soil of this Level II plot was classified according to FAO (1988) as a Haplic Podzol where parts of the ploughed horizon between 0 and 28 cm and the Bh between 28 and 40 cm qualified for the diagnostic spodic B horizon. This difference is soil reference group might be an immediate consequence of a change in definitions between the spodic-B horizon of FAO in 1988 and the spodic horizon of WRB in 2006 posing higher colour and chemical requirements.

7. Profile P15, De Inslag, Antwerp

7.1. Site and profile description

Profile 15	**De Inslag, Brasschaat (Level II forest plot)**
1.2 Date of description:	7/6/2007
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, Province of Antwerp, Brasschaat municipality On highway E19 direction Breda, take exit 4 and drive along N117 direction Kalmthout (north-west). After 1000 m turn left along the Miksebaan after 1800 m turn right and follow Mikseheide to its end, the experimental level II plot is located to the left.
1.5 Profile coordinates:	*ICP Forests Level II plot nr.:* 1502 *Latitude, longitude:* 50° 57′ 58″ N, 02° 57′ 38″ E
1.6 Elevation:	±16 m a.s.l.
2.1 Atmospheric climate and weather condition:	In the days prior to fieldwork the weather was dry and 20-25°C in daytime and 10-15°C overnight. Before this period was a period dominated by rain.
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	*Macrotopography:* Almost flat landscape with few water streams. *Mesotopography:* - *Landscape position:* Intermediate part of an almost flat terrain *Slope form:* - *Slope gradient:* - *Slope length:* - *Slope orientation:* Very gently dipping towards west (260°)
2.4 Land-use:	Plantation forestry without evidences of recent felling. *Wildlife:* Protected *Grazing:* No grazing, the plot is fenced
2.5 Human influence:	In general, the vegetation is slightly disturbed. Locally strongly disturbed like around the meteorological tower and the small shelter hosting some of the measuring instruments. Elsewhere walking paths with a wooden floor assure a minimum of disturbance. The area is artificially drained, with ditches in the slope direction. Furthermore, the microtopography is too gentle, which suggests that the area has been levelled. Probably the area is old agricultural land, with some kind of plaggen or raised bed cultivation system.
2.6 Vegetation:	Evergreen woodland composed of Scots pine (*Pinus sylvestris*) at the canopy level, and with birch (*Betula pendula*), ash (*Sorbus*), oak (*Quercus rubra*) and Scots pine at the understory level. The ground vegetation is composed of different grasses, brambles (*Rubus sp.*), heather (*Calluna vulgaris*) and different types of mosses.
2.7 Parent material:	Coversand (7220)
2.8 Drainage class:	Somewhat excessively drained *Availability of water:* Insufficient
2.9 Internal drainage:	Never saturated
2.10 External drainage:	Neither receiving nor shedding water
2.12 Groundwater:	The groundwater table was found at 155 cm depth at the time of observation
2.13 Rock outcrop:	None

2.14 Coarse surface frag.:	None
2.15 Erosion, sedimentation:	None
2.17 Surface cracks:	None
Humus classification:	The horizon sequence OLv, OFnoz, OHnoz, Ae was found. *Classification name:* Mor → Hemimor
Remarks:	

No.		**Horizon description**
H1	OLv	-8 till -7 cm; needles; grass, birch leaves
H2	OFnoz	-7 till -0.5 cm; mycelia; spiders observed
H3	OHnoz	-0.5 - 0 cm; very dark brown 7.5YR 2.5/2 (slightly M); discontinuous; abrupt smooth boundary
H4	Apbi/Ae Ap1	0-31 cm; very dark greyish brown 10YR 3/2 (M); moderate positive reaction to α,α-dipyridyl throughout; salt and pepper composed of organic matter and bleached quartz grains; loamy sand; single grain; very friable; high porosity; common very fine to medium roots; charcoal fragments; few filled biogalleries (mole); abrupt smooth boundary
H5	Ap2	31-36/48 cm; horizon formed through a single time deep ploughing; dark greyish brown 10YR 4/2 (mixed, M); moderate positive reaction to α,α-dipyridyl throughout; single grain; loose; high porosity; common very fine to fine and few medium roots, most roots stop at the transition between H5 and H6; abrupt wavy boundary
H6	E	36/48-52/77 cm; very pale brown 10YR 7/3 (M); moderate positive reaction to α,α-dipyridyl throughout; few macro pores with rust lining the surface; sand; single grain; loose; medium porosity; very few very fine roots; abrupt broken boundary
H7	Bg1	40/57-56/83 cm; dark yellowish brown 10YR 4/4 (M); some macro pores with oxido-reduction bleached surfaces; strong positive reaction to α,α-dipyridyl throughout; loamy sand; common subrounded fine gravels, mostly quartz at the contact to H10; massive; very friable; very few, distinct, clay, humus and iron oxide coatings in voids; low porosity; very few very fine to fine roots; abrupt irregular boundary
H8	Bg2	65-100 cm (simplified); light yellowish brown 1.5Y 6/4 (M); moderate positive reaction to α,α-dipyridyl throughout; single grain, no traces of stratification; loose; medium porosity; very few root galleries, no living roots observed; abrupt broken boundary
H9	Bh	Tongues; black to greyish brown depending on content of organic matter and concentration of decaying roots; the horizon is a vertical crack where many generations of roots grew and died; accumulation of iron oxides in upper part, locally to such an extent that cementation has occurred; abrupt vertical boundary
H10	Bg3	65-125 cm (simplified); brown 10YR 4/3 (M); many root galleries, mostly vertical, some associated with orange brown mottles; weak positive reaction to α,α-dipyridyl throughout; sand; very few (±1%) fine (2-5 mm), subrounded to rounded gravels; massive; friable; very few, distinct, clay and iron oxide coatings lining pore walls; low porosity; very few very fine to fine roots; abrupt broken boundary
H11	2Cg	100-… cm (simplified); sand; brown 10YR 4/3 (M), 10YR 5/3 (D); strong positive reaction to α,α-dipyridyl throughout; single grain, some stratification; loose; few root galleries, where several generations of roots have been growing, rust along these galleries; very few very fine roots
H12	2Cr	125-… cm (simplified); light olive brown 2.5YR 5/3 (M); strong positive reaction to α,α-dipyridyl throughout; sand; single grain; loose; medium porosity (packing pores); common decaying roots, with several generations growing along the same galleries, very few very fine roots

Colour measurements: M= Moist; MC= Moist-crushed; D= Dry; DC= Dry-crushed; W= Wet.

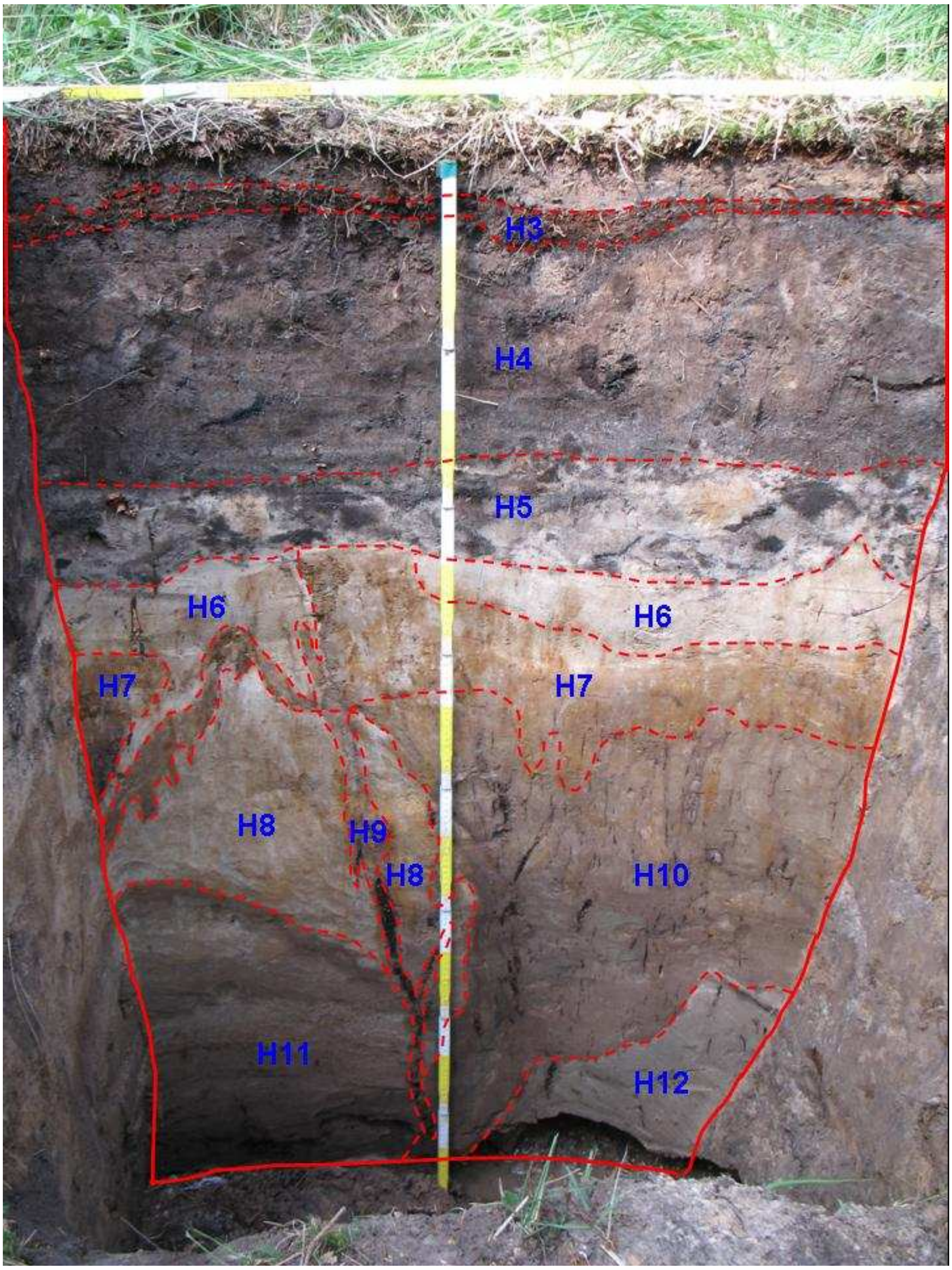

Photo 6: Soil profile P15, De Inslag, Brasschaat, with the horizons indicated. H5 are the remains of a single time deep ploughing (Photo JM).

7.2. The physical and chemical laboratory data

The soil has a C/N ratio ranging from 13 to 19 in the upper horizons. In the E horizon as observed for many of the studied forest soils the C/N ratio appears to be very low (ratio 2). This merely reflects both: a very low content of organic carbon and a relatively high content of nitrogen. The content of organic carbon of only 0.06% is not confirmed by LOI where a content of organic matter of 0.3% was measured. In the A horizon the content of organic carbon is only 1.8% and below the content is 0.6% or lower. The soil has a relatively stable pH(H_2O) ranging from 3.6 to 4.6.

In various horizons, a marginal content of coarse fragments mostly iron cemented quartz grains were seen during sample preparation. The particle size distribution is relatively heterogeneous considering that the parent material is coversand. The A horizon has the best texture for water retention as it contains 4.7% clay, 12.5% silt and 82.7% sand. In the Bg1 horizon and the Br horizon, the clay content is also around 5% but the silt content is only 4%. In the other analysed horizons analysed the sand content makes up more than 95% of the material.

Table 9: Analytical data for profile P15 De Inslag, Brasschaat, Antwerp, Belgium. Profile studied 7/6/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth (cm)	Total N Modified (%)	C/N	OC TOC (%)	Organic matter W&B (%)	Organic matter LOI (%)	pH H_2O 1:5	pH $CaCl_2$ 1:5	EC dS/m 1:5	Coarse frag. >2mm %-wght
1	OLv	8-7					86.5	4.6	4.0	0.16	
2	OFnoz	7-½	1.671	25			84.6	3.8	3.0	0.14	
3	OHnoz	½-0	1.596	22			69.3	3.6	2.8	0.13	
4	Ae/Apbi	0-31	0.093	19	1.78	2.5	2.7	3.8	3.3	0.05	0.7
5	Ap	31-36/48	0.043	14	0.59	1.0		4.0	3.6	0.02	0.5
6	E	36/48-52-77	0.029	2	0.06		0.3	4.3	4.1	0.02	0.1
7	Bg1	40/57-56/83	0.041	6	0.24		0.9	4.0	3.7	0.03	0.6
8	Bg2	65-100						4.1	4.0	0.02	0.0
10	Bg3	65-125	0.031	10	0.31		1.0	3.9	3.6	0.04	0.0
11	2Cg	100-…					0.4	4.1	3.8	0.02	0.0
12	2Cr	125-…					0.2	4.1	3.9	0.02	0.1

Horizon nr.	Particle size distribution (fractions in µm) 0-2	2-10	10-20	20-50	50-63	63-100	100-125	125-250	250-500	500-1000	1000-2000
	%										
1											
2											
3											
4	4.7	3.6	1.5	6.0	1.5	8.0	10.2	48.4	14.4	1.4	0.3
5											
6	0.5	0.1	0.3	2.2	1.3	9.5	13.6	58.8	12.8	0.7	0.1
7	6.5	0.0	0.5	3.4	2.0	14.8	15.4	46.1	10.3	0.8	0.2
8											
10	5.3	0.2	0.2	2.6	1.4	16.6	16.1	41.5	15.0	1.0	0.1
11	0.4	0.2	0.0	0.8	0.2	1.9	3.3	60.7	31.2	1.4	0.1
12	0.8				1.3	1.3	3.0	62.1	30.5	1.0	0.1

Horizon nr.	Mg++	Na+	K+	Ca++	Al+++	Fe+++	Mn++	Free H+	CEC sum	CEC measured	BS by CEC-m
	by $MgSO_4$ (compulsive method)										
	cmol(+)/kg soil								cmol(+)/kg		%
1											
2											
3											
4	<0.23	<0.04	<0.02	<0.04	1.40	0.30	<0.004	1.44	3.1	6.0	<3
5	<0.23	<0.04	<0.02	<0.04	1.19	0.03	<0.004	0.09	1.3	1.0	<17
6	<0.12	<0.02	<0.01	<0.02	0.35	0.04	<0.002	<0.10	0.4	1.0	<9
7	<0.21	<0.03	0.02	<0.04	2.22	0.09	<0.004	<0.10	2.3	3.0	<5
8											
10											
11											
12											

Horizon nr.	Horizon symbols	Depth	Mg++	Na+	K+	Ca++	CEC	BS	CEC/ clay	Acidity sum	Acidity titrated
			by NH_4OAc								
		cm	cmol(+)/kg soil					%		cmol(+)/kg	
1	OLv	8-7									
2	OFnoz	7-½									
3	OHnoz	½-0									
4	Ae/Apbi	0-31	0.02	0.02	0.04	0.08	6.2	3	2	3.1	3.9
5	Ap	31-36/48	0.01	0.01	0.02	0.06	2.1	5		1.3	1.4
6	E	36/48-52-77	<0,01	0.01	<0,01	0.06	0.4	18	43	0.4	0.3
7	Bg1	40/57-56/83	0.01	0.02	0.04	0.06	2.9	4	33	2.3	2.9
8	Bg2	65-100									
10	Bg3	65-125									
11	2Cg	100-…									
12	2Cr	125-…									

Table 9 (continued): Analytical data for profile P15 De Inslag, Brasschaat, Antwerp, Belgium. Profile studied 7/6/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth	Al	Fe	K	Ca	Mg	Na	P	S	Lab nr.
			Oxalate		Aqua Regia						
		cm	%		mg/kg						
1	OLv	8-7									JM238
2	OFnoz	7-½									JM239
3	OHnoz	½-0									JM240
4	Ae/Apbi	0-31	0.032	0.230	263	270	185	45	104	152	JM241
5	Ap	31-36/48									JM242
6	E	36/48-52-77									JM243
7	Bg1	40/57-56/83	0.044	0.137	320	287	145	30	25	86	JM244
8	Bg2	65-100									JM245
10	Bg3	65-125	0.043	0.091	1278	175	544	87	32	101	JM246
11	2Cg	100-…									JM247
12	2Cr	125-…									JM248

Horizon nr.	Al	As	Cd	Co	Cr	Cu	Fe	Mn	Pb	Ni	Zn
	Aqua Regia										
	mg/kg										
1											
2											
3											
4	3519	4.20	<0.50	<0.50	6	<2.50	4429	11.72	23.4	1.5	8
5											
6											
7	3407	<2.50	<0.50	<0.50	4	<2.50	4447	3.22	2.1	0.8	9
8											
10	8156	<2.50	<0.50	0.84	11	<2.50	4761	11.44	2.8	1.9	7
11											
12											

As to be expected with such a sandy texture, the content of basic cations remains below detection limit for all analysed horizons. In the A horizon the Al saturation is only 45% but only because the content of hydrogen cations is rather high. In the subsoil, aluminium saturation increases to values of 90-95%, which is a major problem for plant growth. If the previous profile P14 was described as having low values of aqua regia extractable elements, profile P15 has even lower values. These very low values confirm that this soil has a very poor fertility, and probably the mineralogy is composed nearly entirely of quartz, a mineral that if weathered releases very little nutrients.

7.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks
Albic	H6	
Umbric	-	Colour of H5 has a too high value
Gleyic colour pattern	H8+ H10-12	H8+ H10-11: Oximorphic colours H12: Reductomorphic colours
Reducing conditions	H4-12	

Simplified classification name

Albic Hypoluvic Arenosol

Hypoluvic: having an absolute clay increase of 3% or more within 100 cm from the mineral surface. The clay content in the E horizon is 0.5% and in the underlying Bg1 horizon it is 6.5%

Full classification name without specifiers

Endogleyic Brunic Albic Hypoluvic Arenosol (Dystric)

- Brunic: H7 has a higher chroma than the overlying E horizon, the texture is loamy sand
- Hydrophobic: no information available on hydrophobism, but the soil is regularly influenced by a high groundwater table so most probably the soil can take water
- Dystric: Base saturation remains below 20%

BioSoil classification name (WRB 2006), with specifiers
Endogleyic Hypobrunic Albic Hypoluvic Arenosol (Hyperdystric) • Hypobrunic because of the rather weak Cambic expressions

7.4. Discussion

This soil is chemically and physically extremely poor. The water holding capacity is determined by the content of clay, silt and organic matter but the soil is practically depleted for these elements. The content of basic cations is so low that it could not be measured and the contents of aqua regia extracted elements also illustrates a soil with very little elements except quartz.
The classification name Gleyic Brunic Albic Hypoluvic Arenosol (Dystric) does not express sufficiently the extremely low potential of this soil for plant growth. Why are for Arenosols the qualifiers Dystric and Eutric listed but not Alumic? That the soil is Hyperdystric is important but that it is Hyperalumic is information that is even more important!
The Hypoluvic qualifier applies because an absolute clay increase of 3% has been measured. This provides the illusion that the soil is not that bad after all. In fact, the content of clay in some horizons does not even reach 1% and in one horizon, the content of soil material below 50 µm could not be detected not even after a repetition in the lab with 20 g of soil instead of the usual 10 g.

In 1991, the profile was classified as an Umbric Regosol (FAO, 1988). In contrast to the present profile description, the colour requirements for an Umbric horizon were fulfilled in the profile description of 1991. This might be an indication of subjectivity in the colour judgement by the different field surveyors. Since an Arenosol in the FAO (1988) system could not have a diagnostic horizon other than an ochric A or albic E horizon, even if all texture requirements were fulfilled, this profile ended up in the group of the Regosols.

8. Profile P16, Gontrode, East Flanders

8.1. Site and profile description

Profile 16	**Gontrode (Level II forest plot)**
1.2 Date of description:	22/6/2007
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, East Flanders, Melle municipality, "Aelmoeseneie" forest On highway E40 take exit 17 direction Zottegem. After 500 m, follow Schoolstraat. In Gijzenzele village change to Brielstraat and to Potaardestraat. At the junction with Geraardsbergsesteenweg, turn left (south). After about 300 m, the experimental forest Level II plot is located on the right side. The soil profile is situated about 50-60 m from the road.
1.5 Profile coordinates:	*ICP Forests Level II plot nr.:* 1602 *Latitude, longitude:* 50° 58′ 35″ N, 04° 48′ 19″ E
1.6 Elevation:	±22 m a.s.l.
2.1 Atmospheric climate and weather condition:	In the past weeks prior to the fieldwork the weather was unstable with occasionally (heavy) rain showers. The maximum temperatures were 20-25°C. At the day of fieldwork, it was around 18°C and overcast. It was anticipated that little rain had fallen within the past 24 hours.
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	*Macrotopography:* Gently rolling landscape incised by small tributaries draining into the Schelde river *Mesotopography: -* *Landscape position:* Middle slope *Slope form:* convex, straight (VS) *Slope gradient:* 1.17° *Slope length:* The slope length is from the road upslope to the water stream downslope, which is about 150-180 m. *Slope orientation:* The slope is dipping towards 240° SW
2.4 Land-use:	Plantation forestry without felling. The forest is fenced by a 2 m tall fence with on top barbed wire. This is because the plot is under intensive monitoring, which includes a meteorological tower. *Wildlife:* Protected *Grazing:* No grazing
2.5 Human influence:	Vegetation moderately disturbed due to the intensive monitoring and other research activities. Traces of raised beds with a ditch system still visible on the microtopography.
2.6 Vegetation:	Mixed deciduous forest with deciduous shrubs, dwarf shrub and herbs. The canopy is composed for 10-15% by beech (*Fagus sylvatica*), oak (*Quercus robur*) (10-50%), larch (*Larix decidua*) and sweet chestnut (*Castanea sativa*). In the shrub layer ash (*Sorbus*), black cherry (*Prunus serotina*), maple (*Acer pseudoplatanus*) and beech was recognised, the dwarf shrub layer is composed of oak seedlings and brambles, ferns and black cherry were present in the herb layer.
2.7 Parent material:	The geology is composed of sandy loamy quaternary deposits (code 7120) overlying clayey, clayey sandy and sandy deposits (code 7000) of tertiary age (Paniselian deposits of Middle Eocene age (about 41-49 million yr)
2.8 Drainage class:	Moderately well drained

	Availability of water: sufficient
2.9 Internal drainage:	Probably saturated for short periods in most years
2.10 External drainage:	Slow run-off. Drainage channels are present in the forest, interdistance of 6 m.
2.12 Groundwater:	No information
2.13 Rock outcrop:	None
2.14 Coarse surface frag.:	None
2.15 Erosion, sedimentation:	Locally slight erosion along the many pathways leading around to the different experimental installations. Area affected 0-5% and the erosion is active today.
2.17 Surface cracks:	None
Humus classification:	The horizon sequence observed is OL, OFz, OHz, Aze *Classification name:* Moder → Dysmoder
Remarks:	IN H4-7, the (visible) porosity is relatively low, but due to the many cracks and fissures, roots can easily grow.

No.		**Horizon description**
H1	OL	-13 till - 9 cm; woodlice
H2	OFz	-9 till -3 cm; spiders; woodlice; snails
H3	OHz	-3-0 cm; very dark brown 10YR 2/2 (M); continuously present; crumbly; common very fine to fine and few medium to coarse roots; gravel at contact to the mineral soil surface; smooth abrupt boundary
H4	A/Aze	0-2 cm; 10YR 2/1 (M); massive (compacted); friable; low porosity; few very fine and fine roots; humus accumulation mainly due to infiltration except along cracks where roots grow; smooth clear boundary
H5	Bbi	2-7/27 cm; brown 10YR 4/3 (M); positive reaction to α,α-dipyridyl throughout; silty clay; few, rounded, fresh, fine and medium gravels; well developed, fine (2-10 mm), subangular blocky; friable; low porosity; few very fine to medium roots; open and closed burrows, possible from mole or mice; smooth clear boundary
H6	2B	7/27-33 cm; light yellowish brown 1.5Y 6/4 (M); positive reaction to α,α-dipyridyl throughout; silt loam; few, rounded, fresh fine gravels; massive; friable; low porosity; few very fine to coarse roots; smooth clear boundary
H7	2Bg	33-54 cm; horizon is composed of: many (40-50%), medium, prominent, diffuse, light yellowish brown 2.5Y 6/3 (M), bleached mottles, many (40-50%), medium, prominent, diffuse, yellowish brown 10YR 5/6 (M) rusty mottles, and 10-20% light yellowish brown 1.5Y 6/4 (M) matrix; positive reaction to α,α-dipyridyl throughout; silt loam; massive; friable; low porosity; few very fine to coarse roots; smooth clear boundary
H8	3Bgbi	54-75/100 cm; light yellowish brown 2.5Y 5/3 (M); many (20-30%), medium, prominent, diffuse, brownish yellow 10YR 6/6 (M) mottles; positive reaction to α,α-dipyridyl throughout, oxidation inside peds; clay; common, rounded, fresh, medium to coarse gravels; well developed, fine to medium angular blocky; common pressure faces, with roots growing along and through; friable; no clay coatings observed; low porosity; common very fine to medium roots; wavy diffuse boundary
H9	3Cg	75/100-… cm; olive 5Y 5/3 (M); common, coarse, prominent, diffuse orange brown mottles; no stones; positive reaction to α,α-dipyridyl throughout; clay; no stones; massive, with many well developed, 1-2 cm, shiny pressure faces, few larger ones slickensides-like formed, but dull; friable; no clay coatings; low porosity; roots commonly growing along surface of pressure faces;

Colour measurements: M= Moist; MC= Moist-crushed; D= Dry; DC= Dry-crushed; W= Wet.

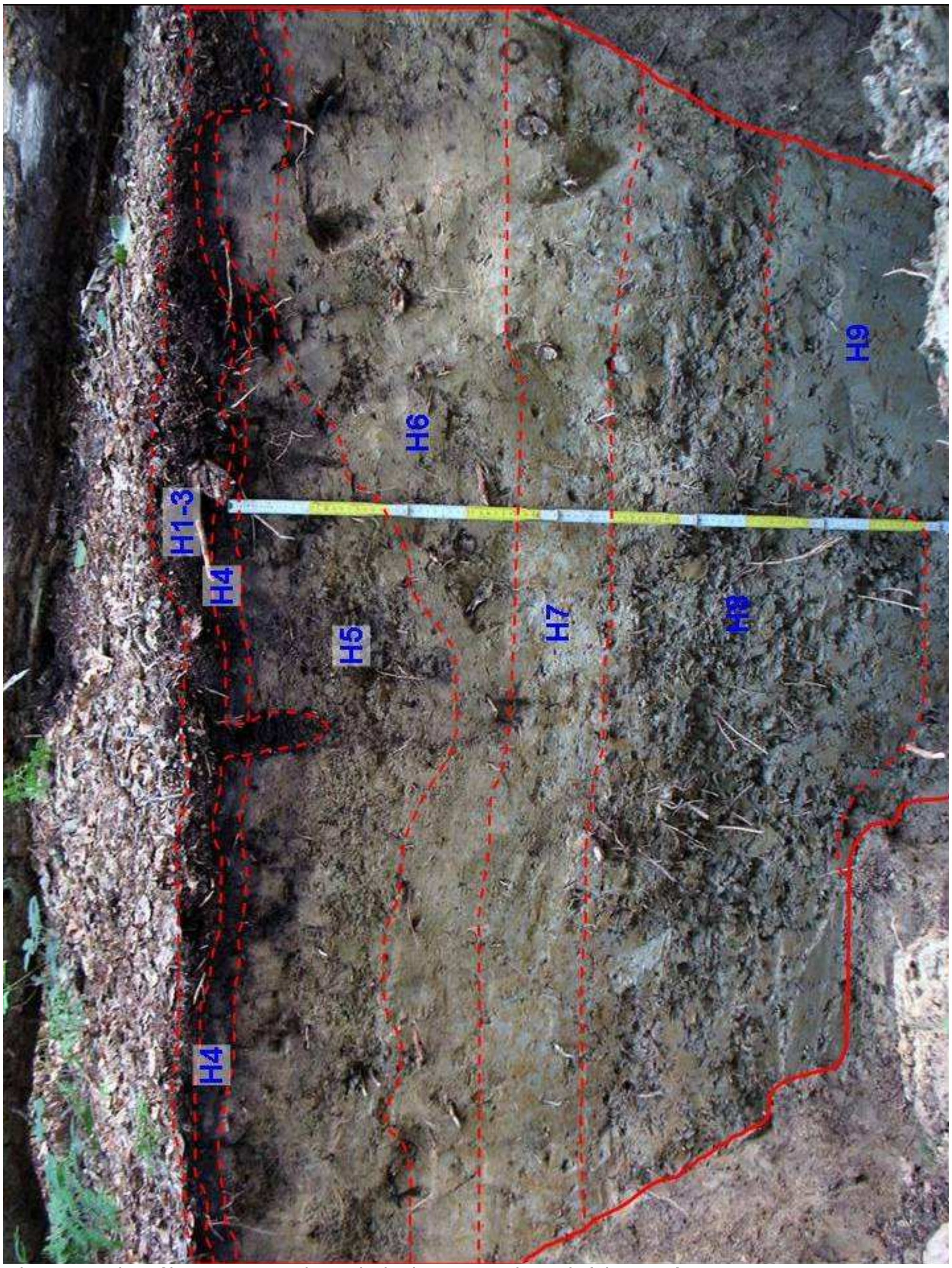

Photo 7: Soil profile P16, Gontrode, with the horizons indicated. (Photo JM).

8.2. The physical and chemical laboratory data

Table 10 shows that the content of nitrogen and organic carbon is relatively high and remains high throughout the soil profile. The C/N ratio is moderate in the upper half of the soil and drops to values below 10 in the subsoil. A strong discrepancy between the values on OC measured by the method of TOC and the organic matter measured by LOI is clear.

Table 10: Analytical data for profile P16 Gontrode, East Flanders, Belgium. Profile studied 22/6/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth cm	Total N Modified %	C/N	OC TOC %	Organic matter W&B %	Organic matter LOI %	pH H_2O 1:5	pH $CaCl_2$ 1:5	EC dS/m 1:5	Coarse frag. >2mm %-wght
1	OL	13-9	1.600	26			84.7	5.0	4.5	0.33	
2	OFz	9-3	2.216	18			80.3	4.0	3.5	0.22	
3	OHz	3-0	1.670	18			58.8	3.5	2.9	0.15	
4	Aze/A	0-2	0.345	18	6.14			3.3	2.8	0.15	1.6
5	Bbi	2-7/27	0.114	13	1.49		4.3	3.5	2.9	0.12	1.2
6	2B	2/27-33	0.050	16	0.78		2.0	3.9	3.3	0.06	2.3
7	2Bg	33-54	0.053	8	0.45		2.2	4.1	3.4	0.05	4.6
8	3Bgbi	54-75/100	0.071	8	0.58		4.5	4.0	2.9	0.09	0.0
9	3Cg	75/100-…	0.049	6	0.32		7.5	4.0	2.9	0.09	0.0

Horizon nr.	Particle size distribution (fractions in µm) % 0-2	2-10	10-20	20-50	50-63	63-100	100-125	125-250	250-500	500-1000	1000-2000
1											
2											
3											
4											
5	40.2	11.1	4.2	27.0	1.2	5.9	3.1	6.5	0.5	0.2	0.1
6	12.0	4.6	4.3	39.5	5.6	13.5	6.5	12.7	0.9	0.2	0.1
7	19.2	4.7	5.8	36.8	5.1	11.0	5.5	10.7	0.8	0.2	0.2
8	71.6	16.5	4.8	4.9	0.3	0.5	0.4	1.0	0.1	0.0	0.0
9	68.6	19.0	5.6	6.6	0.1	0.02	0.03	0.03	<	0.0	0.0

Horizon nr.	Mg++	Na+	K+	Ca++	Al+++	Fe+++	Mn++	Free H+	CEC sum	CEC measured	BS by CEC-m
	by $MgSO_4$ (compulsive method) cmol(+)/kg soil								cmol(+)/kg		%
1											
2											
3											
4	<0.48	<0.07	0.39	1.07	11.56	1.37	0.010	6.06	20.5	18.0	<10
5	<0.23	<0.04	0.42	0.46	16.16	1.43	0.004	2.93	21.4	17.0	<6
6	<0.12	<0.02	0.13	0.18	5.62	0.56	0.002	1.07	7.6	7.0	<5
7	<0.12	0.03	0.20	0.33	9.72	0.27	<0.002	0.20	10.7	8.0	<8
8	6.19	0.38	0.58	12.13	18.86	0.16	<0.003	1.96	40.3	38.0	51
9	0.89	1.68	21.80	9.78	5.09	0.04	<0.009	1.09	40.4	40.0	85

Horizon nr.	Horizon symbols	Depth cm	Mg++	Na+	K+	Ca++	CEC	BS %	CEC/ clay	Acidity sum	Acidity titrated
			by NH_4OAc cmol(+)/kg soil							cmol(+)/kg	
1	OL	13-9									
2	OFz	9-3									
3	OHz	3-0									
4	Aze/A	0-2	0.55	0.08	0.46	1.13	28.1	8		19.0	20.5
5	Bbi	2-7/27	0.43	0.08	0.57	0.70	23.8	7	46	20.5	20.6
6	2B	2/27-33	0.13	0.03	0.16	0.28	8.6	7	50	7.3	7.6
7	2Bg	33-54	0.32	0.06	0.24	0.42	10.6	10	47	10.2	8.4
8	3Bgbi	54-75/100	8.28	0.43	1.63	11.88	41.6	53	55	21.0	19.4
9	3Cg	75/100-…	13.24	1.17	1.92	22.83	42.6	92	60	6.2	7.1

Horizon nr.	Horizon symbols	Depth cm	Al Oxalate %	Fe Oxalate %	K	Ca	Mg	Na	P	S	Lab nr.
					Aqua Regia mg/kg						
1	OL	13-9									JM286
2	OFz	9-3			975	6214	774	112	769	2207	JM287
3	OHz	3-0			1330	2972	1015	131	536	2232	JM288
4	Aze/A	0-2									JM289
5	Bbi	2-7/27	0.193	0.428	5676	524	3812	304	130	123	JM290
6	2B	2/27-33	0.104	0.341							JM291
7	2Bg	33-54	0.123	0.406	3330	737	2149	173	69	61	JM292
8	3Bgbi	54-75/100	0.334	0.552	9512	1922	8171	466	118	99	JM293
9	3Cg	75/100-…			4519	3837	4225	282	72	75	JM294

Horizon nr.	Al	As	Cd	Co	Cr	Cu	Fe	Mn	Pb	Ni	Zn
	Aqua Regia mg/kg										
1											
2	1530	1.03	0.49	1.33	5	21.3	2217	383	41.9	9.1	71
3	6647	4.98	0.51	3.19	14	28.7	7598	100	181.3	14.1	70
4											
5	31246	6.70	<0.50	5.28	45	4.5	25595	53	15.2	8.2	42
6											
7	18528	3.82	<0.50	3.84	31	2.6	16260	50	8.5	5.7	30
8	54699	9.02	<0.50	13.39	74	8.6	47742	66	16.2	18.0	72
9	16094	5.82	<0.50	11.11	29	9.1	24997	38	19.2	15.1	48

As an example in H9 the content of OC-TOC is 0.32% and according to OC-LOI 4.4% (applying the formula OM= OCx1.72). Loss of chemically bound water in the clay is the most reasonable explanation for the high loss on ignition values (De Vos et al., 2005).
The pH is highest in the OL layer and drops to rather acid values in the A-horizon. Only a slight increase in the pH is found in the deeper subsoil.
In the upper part of the mineral soil (H4-7) up to 5% of fine gravel was found both during the fieldwork and confirmed by laboratory results. In H9, no gravel was found. According to the particle, size distribution the soil is composed of at least three parent materials, divided by lithological discontinuities. H5 is composed of 40% clay, 44% silt and 16% sand, H6-7 contains 12-19% clay, 52-54% silt and 28-34% sand and the third group is made up by H8-9 with 68-72% clay, 26-31% silt and less than 2% sand. Especially H8-9 shows a very clayey texture. With sand practically absent, these horizons must slow down any leaching of water. Fortunately, the horizons have some structure, mostly pressure faces, which implies that drainage is enhanced as water can drain along fractures and ped faces. Nevertheless, even if water is able to escape the extremely heavy subsoil, leaching will considerably slow down. Hereby water will stagnate on top for shorter or longer periods depending on the rain intensity and frequency and depending on the lateral surface and subsurface flow.
In H4-7, the content of basic cations is small leading to aluminium saturations between 56% and 90%. In H8 and H9 the CEC is very high due to the high clay content. Therefore in H8 high contents of magnesium and calcium cations are observed but as the aluminium cations are also strongly present the aluminium saturation is still 47%. In H9, the aluminium saturation has dropped to 13%. Instead, an extremely high level of potassium cations has been measured with more than 50% of the cations being potassium. This extremely high content must be formed in an extraordinary situation but this demands further research.
Despite the high clay content oxalate extractable iron and aluminium is not that high. Among the aqua regia extractable elements a relatively high content of sulphur is found in the OF and the OH horizon but also a higher content of lead is found in the OH horizon. Considering that H8 and 9 are very similar the high difference with more than the double aluminium and iron aqua regia elements in H8 compared with H9 is surprising. Most probably, this difference reflects a higher degree of weathering in H8 of the clay minerals whereby iron and aluminium are released. We suspect that in H9 weathering of the clays is much less progressed.

8.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks:
Albic	H8	Dry colour is missing
Argic	H7	Two lithological discontinuities are found. One between H5-H6 and one between H7-H8. In absence of illuvial evidences such as clay coatings an Argic cannot be present in H6 and H8. From H6 to H7, both horizons are part of the second parent material a clay increase is recorded from 12% to 19.2%, which is sufficient.
Cambic	H5	The horizon has both a higher value and chroma than the overlying horizon
Folic	H1-3	Total thickness is 13 cm
Abrupt textural change	H7→H8	Increase in clay content from 19.2% to 71.6%
Gleyic colour pattern	not present	Despite the morphological characteristics this soil is not under influence of a high groundwater table, but is facing a very slow permeability due to a very high clay content. Hereby is rainwater occasionally staying for sufficiently long periods so that the soil develops reduced colours. The high frequency of roots in the bottom of the profile (H9) is an argument that the reduced

		conditions are for short periods only. In H8 the oxidation was observed inside the peds.
Lithological discontinuity	H5→ H6 H7→ H8	
Reducing conditions	H5-9	
Vertic properties		H8-9 have common pressure faces, but it should be slickensides to qualify
Stagnic colour pattern	H7-9	H7-8: Oximorphic colour pattern H9: Reductomorphic colour pattern

Simplified classification name
Luvic Folic Stagnosol

Full classification name without specifiers
Luvic Folic Stagnosol (Albic, Ruptic, Dystric, Siltic, Clayic)

BioSoil classification name (WRB 2006), with specifiers

Luvic Folic Stagnosol (Endoalbic, Hyperruptic, Epidystric, Siltic, Clayic)

- Hyperruptic: with a clay increase from 19% to 72%, applying the “Hyper” seems appropriate
- Epidystric: In H4-7 the base saturation is measured to be 7-10%, which covers the depth 0-54 cm (measured from the mineral soil surface). The specifier epi applies, but not Hyper because the base saturation increases to values above 50% within the upper 100 cm from the soil surface.
- Alumic: the soil has very high contents of aluminium cations but only in the upper 50 cm and Alumic specifically refers to the depth 50-100 cm
- Eutric: the soil is Endoeutric but that is already part of the definition of Luvic, so it should be omitted from the classification name

Discussion

For plant growth this soil has a number of advantages, first the high clay content in the deeper subsoil with a less clayey upper subsoil, which enhances lateral subsurface flow and hereby reducing the negative effects of water stagnating for too long periods. That the water stagnation is a minor problem is best illustrated by the high density of roots growing in H8, which is the most clayey horizon in the soil, but also a source of nutrients and water. The quality of this soil for plant growth is linked with its position on a mid-slope whereby water is enabled to drain laterally downslope. More towards the tributary valley the water will stagnate for extensive periods whereby anaerobic conditions may prevail for too long periods for most roots to survive.
The most important characteristics of this soil are included in the classification name. The Stagnic properties due to a clayey subsoil is included in the reference soil group Stagnosol and the suffix qualifier Clayic.
The profile has a very strong chemical change between H7 and H8. Above, the soil has a base saturation of less than 10% and aluminium saturation above 85%. From H8 on, the base saturation is 51-85% and the aluminium saturation becomes less dominant. This contrast is included in the classification name. The base saturation above 50% is part of the diagnostic criteria for Luvic and the low base saturation in the upper 50 cm of the mineral soil is indicated with the qualifier Epidystric. Only the very high aluminium saturation is excluded from the classification name. The qualifier Alumic is listed but concerns by definition the depth 50-100 cm only. Most probably that is because in the upper more weathered and leached horizons a high content of aluminium cations is to be expected in many soils throughout the world.

In 1991 this soil was classified as Dystric Podzoluvisol (FAO, 1988). Note firstly that in the FAO (1988) system no equivalent major soil grouping existed for the Stagnosols, although stagnic properties were recognised. At present it is not clear why this strongly gleyic profile (as written in the profile description of 1991) received the 'dystric' qualifier in stead of the 'gleyic' or 'stagnic' qualifier.

9. Profile P17, Buggenhout, East Flanders

9.1. Site and profile description

Profile 17	**Buggenhout Forest (Level II forest plot)**
1.2 Date of description:	8/6/2007
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, East Flanders, Buggenhout municipality From the church of Buggenhout follow the Kasteelstraat in southern direction. After 2000 m take turn right along Kapelbaan. After 350 m the profile is located on the right side about 150 m into the forest.
1.5 Profile coordinates:	*ICP Forests Level II plot nr.:* 1702 *Latitude, longitude:* 50° 59′ 47″ N, 04° 12′ 19″ E The new profile is located 18 m from the old profile in southeastern (150°) direction. It is positioned 6.5 m from tree number 3, 4 m from tree number 9 and 7 m from tree number 4.
1.6 Elevation:	20-25 m a.s.l.
2.1 Atmospheric climate and weather condition:	In the days just before fieldwork it was dry. In the weeks prior to fieldwork it was mostly overcast with maximum temperatures of 18-25°C and with common periods of rain.
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	*Macrotopography:* - *Mesotopography:* - *Landscape position:* - *Slope form:* convex, straight (VS) *Slope gradient:* 1.33° *Slope length:* >200 m *Slope orientation:* Dipping towards N (north facing slope)
2.4 Land-use:	Plantation forestry with selective felling *Wildlife:* not known if the wildlife is protected *Grazing:* No grazing
2.5 Human influence:	Vegetation slightly disturbed About 75 m from the profile are some facilities for education of children. Locally the vegetation show strong evidences of playing children. Between the location of the original profile (studied in 1991) and the new one is a micro-depression. Considering its position versus the slope and its wideness (about 2 m) it could very well be the remains of a slightly hollow forest road rather than a drainage ditch.
2.6 Vegetation:	Deciduous woodland composed for 100% of beech (*Fagus sylvatica*) around the pit. From 20 m southwards (uphill) oak (*Quercus robur*) dominates for 100%. The beech and oak trees are very large and form a relatively open canopy. The original profile was located on the transition between oak and beech. Shrub layer: oak, black cherry (*Prunus serotina*) Dwarf shrub: ferns
2.7 Parent material:	Loamy loess (7110)
2.8 Drainage class:	Well drained *Availability of water:* Sufficient
2.9 Internal drainage:	Rarely saturated
2.10 External drainage:	Slow run-off

2.12 Groundwater:	Extremely deep (>2 m)
2.13 Rock outcrop:	None
2.14 Coarse surface frag.:	None
2.15 Erosion, sedimentation:	None, except locally associated with the playing facilities for children
2.17 Surface cracks:	None
Humus classification:	Horizon sequence: OLn+v – Ofnoz – Ohnoz – Aze *Classification name:* Moder → Dysmoder
Remarks:	The original profile location was moved because of the high degree of disturbance around it. An earthen wall was made around the profile and it had been filled by branches, wood debris and leaves. No reaction to α,α-dipyridyl throughout the profile and no rock fragments observed.

No.		**Horizon description**
H1	OLnv	-9.5 till -5 cm; leaves from oak and beech; beechnuts
H2	OFnoz	-5 till -0.5 cm; dark brown 7.5YR 3/4 (M); woodlouses; spiders; mycelia; many very fine and fine roots
H3	OHnoz	-0.5-0 cm; granular; smooth clear boundary
H4	A/Aze	0-2/8 cm; black 10YR 2/1 (M), very dark greyish brown to dark greyish brown 10YR 3.5/2 (D); weak developed granular; friable; common very fine to medium roots; wavy abrupt boundary
H5	Eg	4/8-10 cm; light yellowish brown 1.5Y 6/4 (slightly M); porous massive; few very fine roots; broken abrupt boundary
H6	Bbi1	2/10-15/22 cm; brown 10YR 4.5/3 (M), light yellowish brown 10YR 6/4 (D); coarse angular blocky; very friable; few fine to coarse roots; charcoals; clear smooth boundary
H7	Bbi2	15/22-55 cm; brown to olive brown 1.5Y 4/3 (M), light yellowish brown 1.5Y 6/4 (D); silt loam; fine subangular blocky; very friable; common fine to coarse roots, many roots grow horizontally at contact with H8-9, is it a lithological discontinuity and/or a discontinuous pore system; many crotovinas; charcoals, few in matrix, many in biogalleries; biogalleries filled with A horizon material; abrupt smooth boundary
H8	Br1	55-67/88 cm; yellowish brown 10YR 5/4 (M), pale brown to very pale brown 10YR 6.5/3 (D); very few (1-2%), black, very fine, distinct sharp mottles (Mn stains); silt loam; locally angular blocky, elsewhere massive; friable; medium porosity; no roots; broken abrupt boundary
H9	Br2	55-85/104 cm; pale yellow 2.5Y 7/3 (M); few (2-3%) rusty orange brown, medium, distinct, diffuse mottles; silt loam; angular blocky; firm; very few, prominent, Fe/Mn coatings on ped faces and fractures; iron accumulation around pores, no evidences of clay coatings; very low porosity; very few fine to medium roots; abrupt wavy boundary
H10	B	85/104-130 cm; dark yellowish brown to yellowish brown 10YR 4.5/6 (M); sandy loam; locally angular blocky, locally thick (5-10 mm) platy; very friable; very few clay coatings in pores; coating of sand grains by iron; iron concentration highest along voids; low porosity; very few fine roots; clear smooth boundary
H11	Bg	130-151 cm; bleached part: pale yellow 2.5Y 7/3 (M), orange part: yellowish brown 10YR 5/4 (M); many (30-40%) coarse distinct diffuse oxido-reduction mottles (Oximorphic colour pattern); silt loam; incomplete angular blocky; friable; very few, prominent, clay and iron oxides coatings in voids; very few very fine roots; clear smooth boundary
H12	C	151-178 cm; light yellowish brown 2.5YR 6/4 (M); single grain; very friable; medium porosity; no roots; smooth gradual boundary
H13	Cg	178-… cm; dark yellowish brown 10YR 4/4 (m); massive; friable; no clay coatings; medium porosity

Colour measurements: M= Moist; MC= Moist-crushed; D= Dry; DC= Dry-crushed; W= Wet.

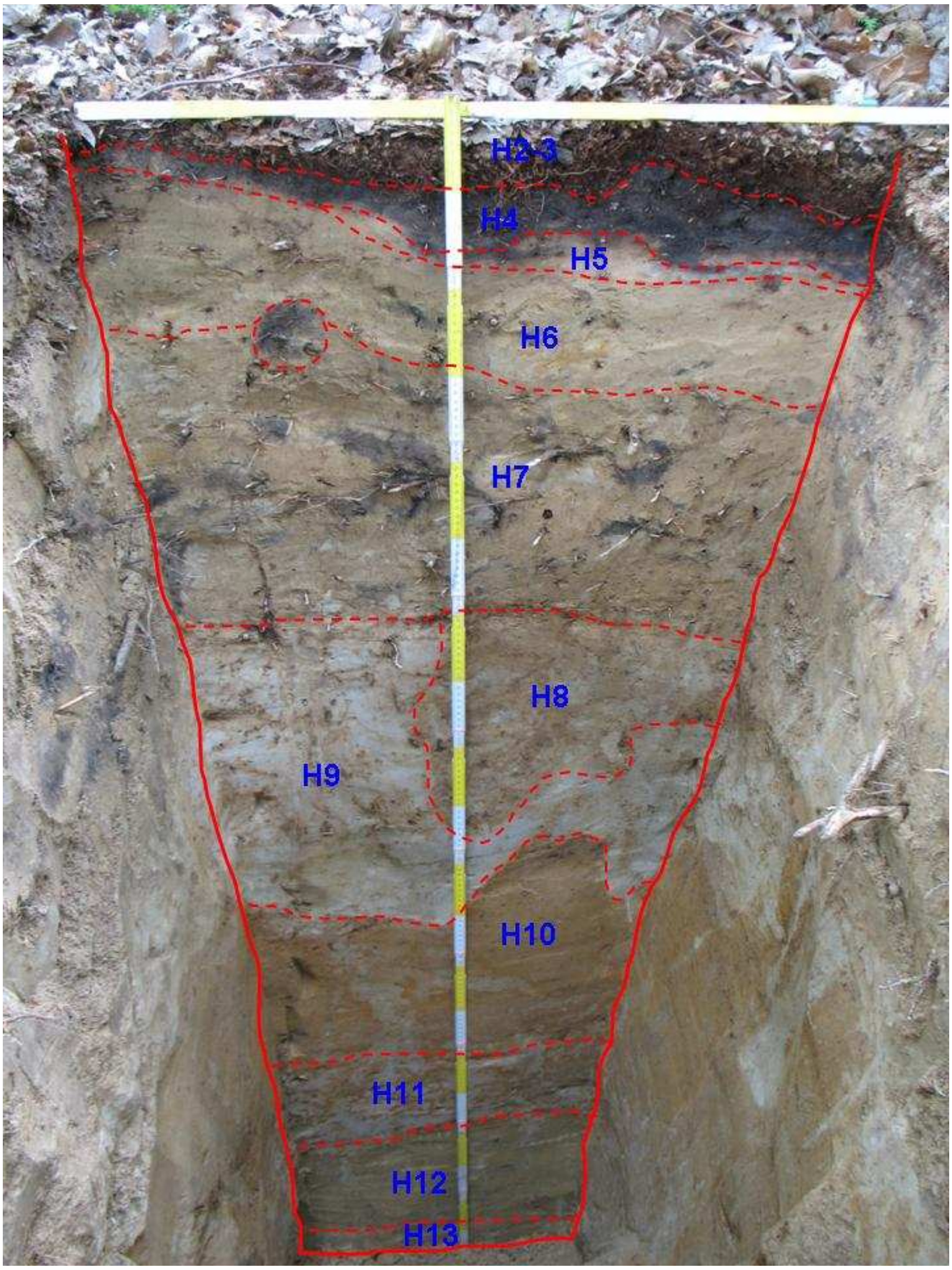

Photo 8: Soil profile P17, Buggenhout, with the horizons indicated. (Photo JM).

9.2. The physical and chemical laboratory data

The C/N ratio becomes smaller through the organic layers and increases in the mineral horizons. An increase in the content of organic matter by the LOI method in H10-11 may simply reflect a higher clay content (see discussion of profile P13) The pH is, like for most forest soils, highest in the OL layers and drops fast with the lowest values found in the OH and the A horizon. A slight increase in pH has been measured towards the bottom of the soil profile.

Table 11: Analytical data for profile P17 Buggenhout, East Flanders, Belgium. Profile studied 8/6/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth cm	Total N Modified %	C/N	OC TOC %	Organic matter W&B %	Organic matter LOI %	pH H_2O 1:5	pH $CaCl_2$ 1:5	EC dS/m 1:5	Coarse frag. >2mm %-wght
1	OLn+OLv	9½-5	1.270	33			84.7	5.2	4.6	0.22	
2	OFnoz	5-½	2.093	19			80.3	4.2	3.2	0.17	
3	OHnoz	½-0	1.859	18			65.2	3.7	2.7	0.11	
4	Aze/A	0-2/8			6.64			3.5	2.8	0.11	0.8
5	Eg	4/8-10									
6	Bbi1	2/10-15/22						4.0	3.7	0.03	0.1
7	Bbi2	15/22-55	0.040	23	0.91		2.1	4.1	4.0	0.03	0.1
8	Br1	55-67/88			0.05		0.7	4.0	3.9	0.05	0.0
9	Br2	55-85/104					0.8	4.1	3.9	0.05	0.0
10	B	85/104-130					1.0	4.2	3.7	0.04	0.0
11	Bg	130-151					1.4	4.0	3.6	0.07	0.0
12	C	151-178						4.4	3.7	0.04	0.0
13	Cg	178-…						4.7	3.8	0.03	0.0

Horizon nr.	Particle size distribution (fractions in µm) 0-2 %	2-10	10-20	20-50	50-63	63-100	100-125	125-250	250-500	500-1000	1000-2000
1											
2											
3											
4											
5											
6											
7	5.7	4.9	5.5	41.8	6.0	14.6	8.5	12.4	0.5	0.0	0.0
8	6.1	4.5	6.3	43.4	5.6	14.6	7.6	11.4	0.4	0.0	0.0
9	5.4	4.7	7.9	48.2	5.5	12.8	6.1	9.0	0.4	0.0	0.0
10	13.9	0.3	0.5	8.0	3.5	24.5	18.1	30.0	1.1	0.0	0.0
11	12.6	3.0	3.1	48.2	5.7	12.2	5.6	9.2	0.4	0.0	0.0
12											
13											

Horizon nr.	Mg++ (by $MgSO_4$ (compulsive method), cmol(+)/kg soil)	Na+	K+	Ca++	Al+++	Fe+++	Mn++	Free H+	CEC sum cmol(+)/kg	CEC measured cmol(+)/kg	BS by CEC-m %
1											
2											
3											
4	<0.48	0.13	0.13	0.23	4.08	0.68	0.019	4.19	9.5	10.0	<7
5											
6											
7	<0.23	<0.04	<0.02	<0.04	2.00	0.02	0.020	<0.10	2.0	2.0	<8
8	<0.22	<0.03	0.04	<0.04	2.30	0.02	0.032	<0.10	2.4	3.0	<6
9	<0.20	<0.03	0.03	<0.04	2.31	0.02	0.037	<0.10	2.4	3.0	<6
10											
11											
12											
13											

Horizon nr.	Horizon symbols	Depth cm	Mg++ (by NH_4OAc, cmol(+)/kg soil)	Na+	K+	Ca++	CEC	BS %	CEC/ clay	Acidity sum cmol(+)/kg	Acidity titrated cmol(+)/kg
1	OLn+OLv	9½-5									
2	OFnoz	5-½									
3	OHnoz	½-0									
4	Aze/A	0-2/8	0.23	0.09	0.17	0.25	20.0	4		9.0	9.4
5	Eg	4/8-10									
6	Bbi1	2/10-15/22									
7	Bbi2	15/22-55	0.02	0.02	0.03	0.05	4.2	3	18	2.0	2.0
8	Br1	55-67/88	0.04	0.03	0.06	0.06	3.4	6	53	2.4	2.3
9	Br2	55-85/104	0.03	0.04	0.05	0.04	3.0	5	55	2.4	2.5
10	B	85/104-130									
11	Bg	130-151									
12	C	151-178									
13	Cg	178-…									

Table 11 (continued): Analytical data (2/2) for profile P17 Buggenhout, East Flanders, Belgium. Profile studied 8/6/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth (cm)	Al (Oxalate, %)	Fe (Oxalate, %)	K (Aqua Regia, mg/kg)	Ca	Mg	Na	P	S	Lab nr.
1	OLn+OLv	9½-5									JM249
2	OFnoz	5-½			1003	2933	596	174	713	2417	JM250
3	OHnoz	½-0			693	1149	557	167	537	2549	JM251
4	Aze/A	0-2/8	0.070	0.222	1414	870	705	94	289	524	JM252
5	Eg	4/8-10									
6	Bbi1	2/10-15/22									JM253
7	Bbi2	15/22-55	0.136	0.251	1257	772	748	86	181	101	JM254
8	Br1	55-67/88	0.073	0.180	1780	736	1251	77	191	93	JM255
9	Br2	55-85/104	0.065	0.158	1750	789	1223	77	157	88	JM256
10	B	85/104-130									JM257
11	Bg	130-151									JM258
12	C	151-178									JM259
13	Cg	178-…									JM260

Horizon nr.	Al (Aqua Regia, mg/kg)	As	Cd	Co	Cr	Cu	Fe	Mn	Pb	Ni	Zn
1											
2	1141	0.94	0.67	1.27	4	18.0	1914	612	48.3	9.4	61
3	3522	4.37	0.89	3.15	10	25.9	4714	101	211.2	19.8	67
4	7715	10.18	<0.50	2.73	19	10.3	8938	62	70.0	7.2	29
5											
6											
7	9083	<2.50	<0.50	2.84	16	<2.50	8145	260	7.4	3.0	18
8	9316	3.03	<0.50	5.28	16	<2.50	9936	424	4.8	6.0	21
9	9130	2.68	<0.50	3.85	17	<2.50	9143	227	4.4	5.5	19
10											
11											
12											
13											

Small contents of coarse fragments in H4-7 concern coarse organic material and charcoal fragments. A very similar particle size distribution is found between H7-9, with about 5-6% clay and with the bulk in the fraction coarse silt. In H10-11 the clay content is 12-14%. H10 contains relatively high amounts of very fine sand (63-100 µm) and fine sand (125-250 µm), this on expense of the coarse silt fraction. H10 has despite higher clay content a silt and sand distribution more like H7-9. Apparently the parent material was composed of silty and fine sandy layers reflecting different deposition environments.

In H4 the content of basic cations is higher than the detection limit although the aluminium saturation with 43% is relatively high too. In the deeper horizons the content of basic cations is very marginal leading to aluminium saturations above 95%, which is such a high level that it will have a strong negative influence on the plant growth.
The content of oxalate extractable aluminium and iron remains low through the analysed horizons. Among the aqua regia extractable elements a relatively high content of sulphur and lead is found in the OF-OH and the OH horizons respectively.

9.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks
Albic	H9	Dry colours missing
Argic	H10-11	Very few clay coatings observed in both horizons.
Cambic	H6, H8	Both horizons have a redder hue than the horizon above and below
Folic	-	H1-3 are 9.5 cm thick, should be 10 cm to qualify
Abrupt textural change	H9→ H10	Increase in clay from 5.4 to 13.9%
Lithological discontinuity	H9→ H10 H10→ H11	Fro H9 to H10 the coarse silt fraction drops from 48% to 8% and increases again to 48% in H11. In fact H10 has a very different particle size distribution than all other analysed horizons from this profile. Additional chemical

		analyses of the H10 and H11 (Fe content) could possibly help us in understanding the origin of these horizons.

Simplified classification name
Haplic Cambisol • The soil is not a Planosol because the Abrupt textural change is located deeper than 100 cm from the soil surface furthermore the reduced conditions, although morphological visible, is not active today • The soil is not an Alisol because the Argic horizon is located deeper than 100 cm from the soil surface • The soil keys out in Cambisol because H6 is located less than 50 cm from the soil surface, the base is located between 25 and 30 cm from the soil surface

Full classification name without specifiers
Haplic Cambisol (Ruptic, Alumic, Dystric, Siltic) • Ruptic: the lithological discontinuities are located deeper than 100 cm from the soil surface • Alumic: the Al saturation is based on CEC-$BaCl_2$ • Dystric: The base saturation is 3-6%

BioSoil classification name (WRB 2006), with specifiers
Haplic Cambisol (Ruptic, Hyperalumic, Hyperdystric, Siltic) • Hyperdystric: the base saturation for the analysed horizons remains below 6%

9.4. Discussion

This appears to be a complex profile. The upper 55 cm is the biological active zone (H1-7). H8-9 are two horizons with colours and morphology as if the horizons have been compacted and experienced oxido-reduction in function of this compaction. Further downwards are two horizons with evidences of clay migration. H10 has a very different particle size distribution than any of the other horizons analysed. Despite its lithological difference, it makes part of the Argic horizon because its illuvial character is evidenced by the presence of clay coatings. If H8-9 are compacted e.g. due to traffic, the horizons must at some time have been closer to the surface, in that case H4-7 are formed in colluvial material of younger age. The very high similarity between the particle size distribution of H7 and H8 is an argument against the colluvial theory. Stagnating water on top of the Argic horizon is another possibility to explain the oxido-reduction features of particular H8.
The soil has a weakly developed Argic horizon and little accumulation of organic matter despite in the very thin A-horizon. With its silty nature a classification as a Cambisol is correct especially because the qualifiers Hyperalumic and Hyperdystric can be applied to illustrate the extremely poor chemical qualities of this soil.

In 1991 the soil profile description defined the start of a Bt horizon with very few fine clay cutans at 96 cm below the mineral soil surface. The thickness of the litter layer was 6 cm. The FAO (1988) required that the diagnostic argic B horizon had to start within 125 cm from the soil surface. Since the soil classification was done without the laboratory measurement of the exchangeable cations and CEC on the horizon samples, ,the soil was erroneously classified as an Haplic Acrisol.

10. Profile P18, Houthulstbos, West Flanders

10.1. Site and profile description

Profile 18	**Houthulst (Level II forest plot)**
1.2 Date of description:	1/6/2007
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, West Flanders, Houthulst municipality From Houthulst city centre follow the road Stadenstraat in eastern direction, after about 1500 m follow Vossendreef on the right side (towards west). Inside the forest park the car at the first side road on the right and walk for about 400 m. The profile is located to the left.
1.5 Profile coordinates:	*ICP Forests Level II plot nr.:* 1802 *Latitude, longitude:* 51° 18′ 33″ N, 04° 31′ 14″ E
1.6 Elevation:	±25 m a.s.l.
2.1 Atmospheric climate and weather condition:	Frequent rain in the weeks prior to the fieldwork. Maximum temperatures around 15-20°C and mostly overcast.
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	*Macrotopography:* - *Mesotopography:* - *Landscape position:* Higher part of flat terrain *Slope form:* - *Slope gradient:* - *Slope length:* - *Slope orientation:* -
2.4 Land-use:	Plantation forestry with selective felling *Wildlife:* Probably protected *Grazing:* No grazing
2.5 Human influence:	Vegetation strongly disturbed in following ways: 1) Recent felling and removal of wood with heavy machinery 2) Several generations of drainage ditches a. Parallel ditches with interdistance of 12-14m, inactive today b. Fully functional ditches with interdistance of 16 m, are crossing the first generation ditches. Water was standing in these ones during fieldwork. 3) Gentle depressions in the surface topography, which does not appear natural. Considering the location in West Flanders with its past war history and keeping in mind that nearby military domain, the topographical deformation might be related to some kind of military activity.
2.6 Vegetation:	Deciduous woodland with deciduous shrub. The forest stand is composed of 60-70% pedunculate oak (*Quercus robur*), 10-20% European beech, (*Fagus sylvatica*) less than 10% sweet chestnut (*Castanea sativa*) and less than 10% other species. Oak is dominant with respect to the canopy, beech and chestnut are co-dominant.
2.7 Parent material:	Coversand (7220)
2.8 Drainage class:	Originally somewhat poorly drained, today well drained due to artificial drainage. *Availability of water:* sufficient
2.9 Internal drainage:	Rarely saturated (a few days in some years)
2.10 External drainage:	Neither receiving nor shedding water
2.12 Groundwater:	During the profile description water was standing in the profile

	from a depth of 130 cm, but that might be stagnation of rainwater due to a more clayey horizon below.
2.13 Rock outcrop:	None
2.14 Coarse surface frag.:	None
2.15 Erosion, sedimentation:	None
2.17 Surface cracks:	None
Humus classification:	The humus type was studied in a mini pit at 6 m distance from the soil profile. The humus layers found are OLv, OFz, OHz. *Classification name:* Moder; subdivision: Hemimoder, bordering Lignomoder
Remarks:	At the level of the soil profile below the forest floor there is about 15 cm of mineral soil material, which is rubbish from digging the profile the first time. Below this rubbish the original forest floor is still present. No rock fragments throughout the profile. H7 turns redder on ignition.

No.		**Horizon description**
H1	OLv	-9 till - 6 cm;
H2	OFz	-6 till -0.5 cm; spiders, millipedes and other insects present
H3	OHz	-0.5 -0 cm; granular; discontinuous gradual change to Aje
H4	Ah/Aje	0-6/10 cm; organic rich horizon; very dark brown 10YR 2/2 (M), dark brown 10YR 3/3 (D); granular; friable; common very fine to fine and few medium roots; abrupt smooth boundary
H5	Ap/E	6/10-33/35 cm; matrix: very dark greyish brown to dark greyish brown 10YR 3.5/2 (M), black pocket 10YR 2/1 (M), very dark greyish brown 10YR 3/2 (MC), greyish brown 10YR 5/2 (DC); common, leopard-like, light brownish grey mottles, 10YR 6/2 (M); weak, positive reaction to α,α-dipyridyl; silt loam; single grain; friable; common very fine to fine, few medium roots; abrupt smooth boundary
H6	2Bcs	Pocket on top of H7; dark yellowish brown 10YR 4/4 (M); weak positive reaction to α,α-dipyridyl; single grain; friable; few very fine to fine and coarse roots; abrupt broken boundary
H7	2Bchms	33/38-42/53 cm; dark brown 7.5YR 3/2 (M); weak positive reaction to α,α-dipyridyl; sandy loam; single grain; very firm; broken, nodular, iron-organic matter, weakly cementation; many (±25%), soft segregated, coarse, irregular, hard, iron-manganese oxide, yellowish red to strong brown nodules 6.5YR 4/6 (M); few very fine and very few fine roots; gradual smooth boundary
H8	2Bcgs	42/53-79/85 cm; horizon influenced by a fluctuating water table; light olive brown 2.5Y 5/3 (M), yellowish brown to light yellowish brown 1.5Y 5.5/4 (D); yellowish brown mottles 10YR 5/8 (M); weak positive reaction to α,α-dipyridyl; sandy loam; single grain; very friable; few very fine to coarse roots; gradual smooth boundary
H9	2Cg1	79/85-102 cm; light olive brown to light yellowish brown 2.5Y 5.5/3 (M), pale brown to light yellowish brown 1.5Y 6/3 (D); yellowish brown mottles 10YR 5/6 (M); moderate positive reaction to α,α-dipyridyl; single grain; very friable; very few fine to medium roots; gradual smooth boundary
H10	2Cg2	102-130 cm; light olive brown 2.5Y 5/3 (M), light yellowish brown 2.5Y 6/4 (D); weak positive reaction to α,α-dipyridyl; loamy sand; single grain; very friable; very few medium to coarse roots; diffuse smooth boundary
H11	2Cg3	130-158 cm; water stagnates on top of H12; light olive brown to light yellowish brown 2.5Y 5.5/3 (W), light yellowish brown 2.5Y 6/4 (D); sandy loam; single grain; very friable; no roots; abrupt smooth boundary
H12	3Cr	158-… cm; greenish grey 5/5GY (W); weak positive reaction to α,α-dipyridyl; massive; non sticky, slightly plastic; iron lining pores; some clay coatings;

		medium porosity; no roots

Colour measurements: M= Moist; MC= Moist-crushed; D= Dry; DC= Dry-crushed; W= Wet.

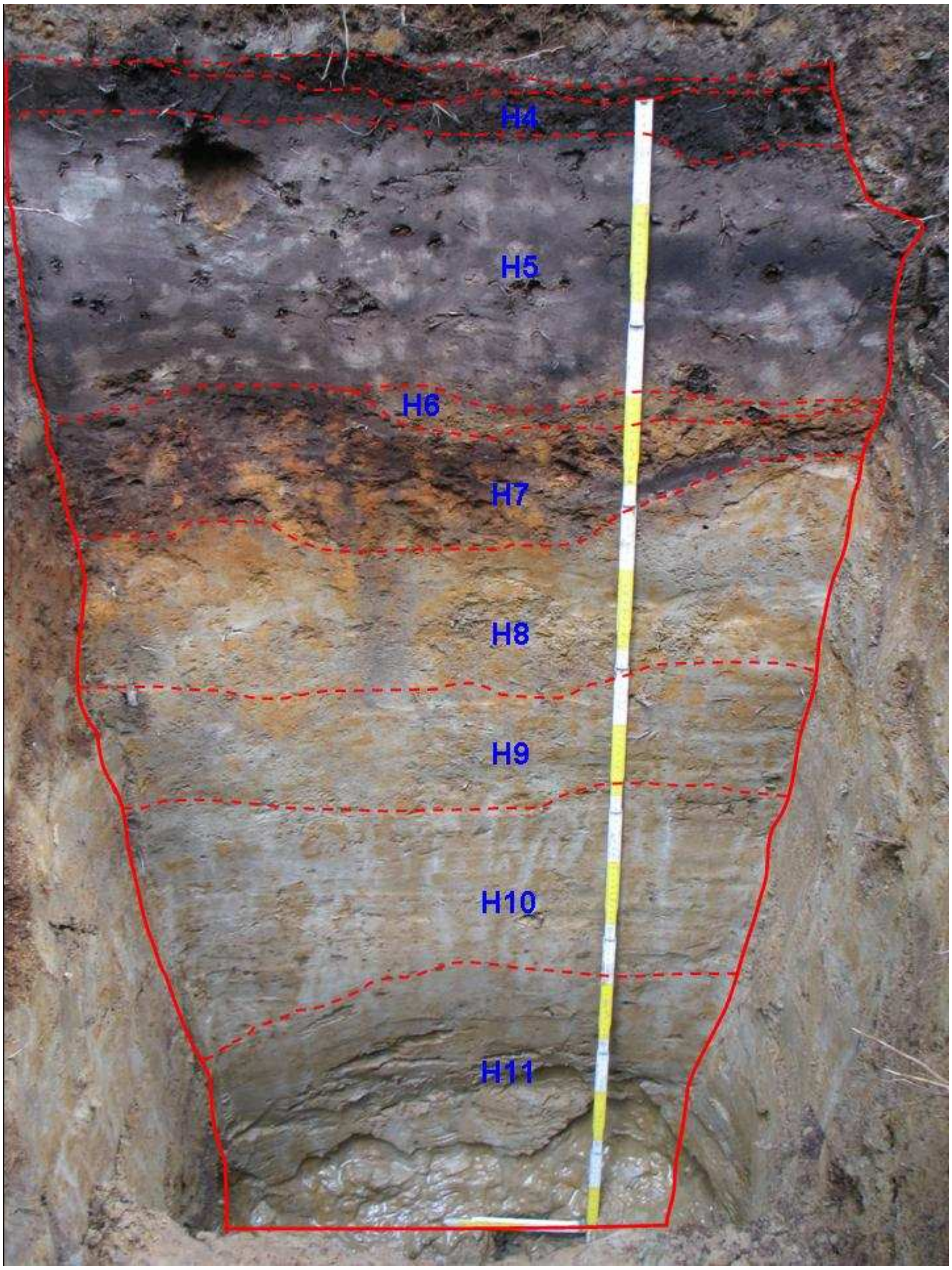

Photo 9: Soil profile P18, Houthulstbos, with the horizons indicated. (Photo JM).

10.2. The physical and chemical laboratory data

In the organic layers the C/N ratio remains below 20. In the A horizon it is 16 and increases to 34 in H7 (2Bchms). The many symbols for this horizon is unusual and has follow meaning: "2" is because the horizon belongs to the second type of parent material found in the soil (observed from the surface and downwards); "B" means it is a subsurface horizon that makes up part of the pedon; "c" concretions are present in the horizon and they are composed mainly by iron ("s") and possible some manganese. The accumulation of iron concretions are so extensive that they cause some cementation of the horizon ("m"); finally, also humus accumulation was noticed during the fieldwork. In H4-7 the content of organic carbon remains high with values ranging from 1.9-5.2%. The pH(H_2O) starts at 5.2 drops to 3.6 in the mineral surface horizon and slowly increases towards the bottom of the profile.

The coarse fraction is composed entirely out of cementations and concretions. During the process of dry sieving on a 2 mm sieve, some mechanical destruction of weakly cemented concretions unavoidable, otherwise the content of coarse material would have been considerable higher that the measured 0.1-0.4%. H7-11 have the same general trend in the particle size distribution with 8-11% clay, 10-24% silt and 66-78% sand. Above these horizons H5 shows a different pattern with 56% silt and 40% sand. Remarkable is that the fraction coarse silt makes up almost 40% of the particle size distribution.

Table 12: Analytical data for profile P18 Houthulstbos, West Flanders, Belgium. Profile studied 1/6/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth cm	Total N Modified %	C/N	OC TOC %	Organic matter W&B %	Organic matter LOI %	pH H_2O 1:5	pH $CaCl_2$ 1:5	EC dS/m 1:5	Coarse frag. >2mm %-wght
1	OLv	9-6	1.790	23			83.6	5.2	4.6	0.38	
2	OFz	6-½	2.186	19			83.1	4.2	3.6	0.25	
3	OHz	½-0	1.368	18			49.3	3.7	2.9	0.12	
4	Ajz/Ah	0-6/10	0.334	16	5.24			3.6	3.0	0.10	0.1
5	Ap/E	6/10-33/35	0.078	24	1.86		3.3	4.0	3.3	0.06	0.1
6	2Bcs	pocket	0.112	26	2.89			4.3	3.8	0.06	0.4
7	2Bchms	33/38-42/53	0.088	34	3.01		6.5	4.4	3.9	0.03	0.1
8	2Bcgs	42/53-79/85	0.029	11	0.33		1.6	4.6	3.8	0.04	0.0
9	2Cg1	79/85-102						4.6	3.7	0.04	0.0
10	2Cg2	102-130					0.6	4.4	3.7	0.06	0.0
11	2Cg3	130-158					0.6	5.0	3.9	0.04	0.0
12	3Cr	158-…									

Horizon nr.	Particle size distribution (fractions in μm) 0-2	2-10	10-20	20-50	50-63	63-100	100-125	125-250	250-500	500-1000	1000-2000
	%										
1											
2											
3											
4											
5	4.3	4.2	5.7	39.7	6.4	14.5	6.3	17.5	1.3	0.0	0.0
6											
7	9.7	2.8	2.0	14.9	4.7	19.8	10.9	30.4	2.7	0.8	1.3
8	11.3	2.0	0.9	6.1	3.6	22.5	13.8	36.9	2.8	0.1	0.0
9											
10	8.2	0.4	0.4	4.9	4.0	25.5	14.5	37.9	4.1	0.1	0.0
11	9.2	0.5	0.6	6.8	4.6	26.9	14.1	33.5	3.6	0.2	0.0
12											

Horizon nr.	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	Al^{+++}	Fe^{+++}	Mn^{++}	Free H^{+}	CEC sum	CEC measured	BS by CEC-m
	by $MgSO_4$ (compulsive method) cmol(+)/kg soil								cmol(+)/kg		%
1											
2											
3											
4	<0.58	<0.09	0.14	0.21	5.66	0.65	<0.011	4.50	11.2	11.0	<6
5	<0.24	<0.04	0.03	0.14	3.53	0.18	<0.004	0.43	4.3	4.0	<8
6											
7	<0.24	<0.04	<0.02	0.08	5.44	0.28	<0.004	<0.10	5.8	5.0	<5
8	<0.16	<0.02	0.10	0.06	6.24	0.09	<0.003	<0.10	6.5	7.0	<4
9											
10											
11											
12											

Horizon nr.	Horizon symbols	Depth cm	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	CEC	BS %	CEC/ clay	Acidity sum cmol(+)/kg	Acidity titrated cmol(+)/kg
			by NH_4OAc cmol(+)/kg soil								
1	OLv	9-6									
2	OFz	6-½									
3	OHz	½-0									
4	Ajz/Ah	0-6/10	0.12	0.04	0.17	0.25	18.3	3		10.8	8.8
5	Ap/E	6/10-33/35	0.04	0.03	0.05	0.24	6.3	6		4.1	4.3
6	2Bcs	pocket									
7	2Bchms	33/38-42/53	0.02	0.02	0.04	0.12	21.3	1	113	5.7	5.5
8	2Bcgs	42/53-79/85	0.05	0.03	0.14	0.14	10.1	4	79	6.3	7.8
9	2Cg1	79/85-102									
10	2Cg2	102-130									
11	2Cg3	130-158									
12	3Cr	158-…									

Table 12 (continued): Analytical data for profile P18 Houthulstbos, West Flanders, Belgium. Profile studied 1/6/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth	Al	Fe	K	Ca	Mg	Na	P	S	Lab nr.
			Oxalate		Aqua Regia						
		cm	%		mg/kg						
1	OLv	9-6									JM261
2	OFz	6-½			1007	5554	993	146	759	2437	JM262
3	OHz	½-0			810	2065	801	89	545	1889	JM263
4	Ajz/Ah	0-6/10	0.092	0.209		964			247	446	JM264
5	Ap/E	6/10-33/35	0.062	0.088	1538	427	461	91	81	114	JM265
6	2Bcs	pocket									JM266
7	2Bchms	33/38-42/53	0.664	0.880	2189	678	1260	76	125	230	JM267
8	2Bcgs	42/53-79/85	0.184	0.217	3322	562	1964	84	80	51	JM268
9	2Cg1	79/85-102									JM269
10	2Cg2	102-130			2612	615	1556	98	126	54	JM270
11	2Cg3	130-158									JM271
12	3Cr	158-…									JM272

Horizon nr.	Al	As	Cd	Co	Cr	Cu	Fe	Mn	Pb	Ni	Zn
	Aqua Regia										
	mg/kg										
1											
2	661	0.85	0.38	0.71	3	15.3	2256	637	21.0	5.1	38
3	3430	7.64	0.18	2.31	11	14.9	10543	166	159.6	8.9	31
4											
5	8237	<2.50	<0.50	0.60	15	<2.50	2610	27	9.3	1.2	8
6											
7	16453	7.91	<0.50	3.49	33	<2.50	31566	120	10.7	5.0	19
8	17481	3.63	<0.50	3.65	32	2.6	18000	48	5.1	7.6	24
9											
10	10711	3.05	<0.50	6.07	29	3.5	12636	96	3.8	9.0	26
11											
12											

The content of basic cations is low to extremely low, although calcium cations are present throughout the soil but in low quantities. The aluminium saturation increases from 51% in H4 to 96% in H8. One of the highest levels of oxalate extractable iron and aluminium among the studied forest soils is found in H6 of this profile with 0.88% oxalate iron and 0.66% oxalate aluminium. These values are comfortable above the required 0.5% for half of the iron content plus the aluminium content.
The content of sulphur as extracted by aqua regia is on the higher side of what can be expected, the other aqua regia elements are within the expected range.

10.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks
Albic	-	Dry colours have too high chroma
Argic	-	Although a clay increase is found from H7, it is linked with a lithological discontinuity. The illuvial nature of this horizon could not be proven (e.g. by clay coatings)
Cambic	H6-7	H6 has both a higher chroma and value than the horizon above and below. H7 has a redder hue than the underlying or overlying horizon. Texture is ok for H7 no data for H6. The required thickness is exactly reached.
Folic	-	Too thin, lacking 1 cm
Spodic	H7	In absence of an Albic horizon above H7, the horizon qualifies because it has cementation and the oxalate extractable Al plus ½Fe is with 1.104% comfortable above the required 0.5%. The horizon turns redder on ignition (Rustic)
Umbric	H4-5	Colours are just exactly good
Abrupt textural change	H5→H7	
Gleyic colour pattern	H8-H12	H8-9 Oximorphic colour pattern H10-12 Reductomorphic colour pattern
Lithological discontinuity	H5→H7	Abrupt change in particle size distribution
Reducing conditions	H5-H12	Positive reaction to α,α-dipyridyl

Simplified classification name
Umbric Spodic Gleysol From H8 the soil is composed of Oximorphic mottles embedded in a Reductomorphic coloured matrix, the soil shows positive reaction to ɑ,ɑ-dipyridyl. The Gleyic colour pattern begins on average at 47.5 cm below the mineral soil surface.

Full classification name without specifiers
Umbric Spodic Gleysol (Abruptic, Humic, Alumic, Dystric) • Humic, the weighted average exceeds 2.6% organic carbon • Alumic, H8 has an aluminium saturation of 96%, based on CEC by $BaCl_2$ • Dystric, BS is 1-6%

BioSoil classification name (WRB 2006), with specifiers
Hypoumbric Spodic Gleysol (Abruptic, Humic, Hyperalumic, Hyperdystric) Hypoumbric because the colour requirement is just exactly met

10.4. Discussion

That this soil is keyed out in Gleysols is by no means a surprise. The upper seven horizons appear to be well drained and are lacking mottles, although concretions are present. From H8 on, positive reactions to the ɑ,ɑ-dipyridyl test is registered and as the upper limit of H8 is a few cm above the 50 cm depth measured form the mineral surface, the soil keys out in Gleysols. That the soil gets the qualifier Umbric is due to the plaggen like topsoil. The Spodic horizon is based on the high content of oxalate extractable iron and aluminium, as the original Podzol E horizon is present as fragments only embedded in the Ap horizon. The poor chemical potential of the soil is accurately expressed by the qualifiers Dystric and Alumic. Only the cementation of H7, which also is a serious limitation for plant growth in the soil is not accounted for in the classification name.

In 1991 this profile was classified originally in the field as a Haplic Podzol, later revised as a Stagnic Podzoluvisiol according to FAO (1988). The first name identified the presence of the spodic horizon. The second soil classification name shows that later the pedologists were not happy with this classification and that there was a need to express the wet character of the profile. It also indicates that the differences between 'stagnic' and 'gleyic' properties are not easy to define uniformly. The gleyic colour pattern at that time was observed from 32 cm onwards (measured from the mineral soil surface) so it is somehow strange that the profile was not classified as a Gleysol. This might directly be related to the key of FAO (1988) which excluded soil with Spodic horizons from the Gleysols. So this profile is an example where WRB-2006 provides us with a more accurate and satisfactory soil classification name compared to the FAO system of 1988.

11. Profile P19, Pijnven, Limburg

11.1. Site and profile description

Profile 2	**Pijnven** (Level II plot, nr. 1902)
1.2 Date of description:	4/11/2005
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, Province of Limburg, Hechtel-Eksel municipality. On motorway E314 take exit 29 direction Houthalen along N715. Follow this road, after about 15.5 km the road leads through the Pijnven forest. Drive for another 2750 m and take the gravel road on the left side leading deeper into the forest. After about 800 m along this road, follow the road to the right just before the forest hut for about 900 m then the road turns left follow this road for about 1400 m. The forest plot is located on the right side of the road.
1.5 Profile coordinates:	E 5°20'03", N 51°10'35"
1.6 Elevation:	50-55 m a.s.l.
2.1 Atmospheric climate and weather condition:	±800 mm annual rainfall
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	Smooth slope dipping in WNW direction (300°) with 1°; at the level of the soil profile the surface is considered too flat, probably it has been levelled or ploughed. On further distance the relief is much more pronounced
2.4 Land-use:	Tree cropping
2.5 Human influence:	Vegetation slightly disturbed. Partly due to a single time.
2.6 Vegetation:	The profile is located in a Corsican pine (*Pinus nigra subsp. laricio*) plantation of about 40 yr age; the ground vegetation is composed of fern with small Pinus saplings less than 100 cm tall, *Prunus serotina* is scattered through the plot. Mosses grow between the ground vegetation.
2.7 Parent material:	Cover sand (7220)
2.8 Drainage class:	Somewhat excessively drained *Availability of water:* insufficient
2.9 Internal drainage:	Never saturated
2.10 External drainage:	Slow run-off
2.12 Groundwater:	Extremely deep (>200 cm)
2.13 Rock outcrop:	None
2.14 Coarse surface frag.:	None
2.15 Erosion, sedimentation:	-
2.17 Surface cracks:	None
Humus classification:	Not executed
Remarks:	

No.		**Horizon description**
H1	OL	-9 till -7 cm; Litter layer; many very fine roots; smooth abrupt (1-2 cm) boundary
H2	OF+H	-7-0 cm; black to dark reddish brown 5YR 2.5/1.5 (M); fragmented litter and a very thin humified litter layer (<1 cm); very high porosity; many very fine roots; smooth abrupt (0.5-1 cm) boundary
H3	A/Ep	0-18 cm; very clear furrows, ploughed once whereby the original O+A horizon has been ploughed into the eluvial horizon; A: very dark grey 7.5YR 2.5/1 (M), dark grey 10YR 4/1 (D); E: 10YR 4/1 (M), grey 10YR 5/1 (D); sand; single

		grain; loose; high porosity; common very fine, few fine and medium roots; smooth abrupt (<0.5 cm) boundary
H4	Bh1	18-25 cm; black 10YR 2/1 (M&D); loamy sand; massive; friable; medium porosity; common very fine and few fine roots; smooth abrupt (<0.5 cm) boundary
H5	Bhs	25-36 cm; very dark greyish brown 7.5YR 3/3 (M&D); reddish brown (rusty) to beige, common (± 10% studied part of the profile), to abundant (± 80% on the eastern wall) coarse (2-7 cm), prominent, sharp Leopard-like microbio[1] mottles; to some iron cementation in the upper few cm; dark colour due to humus mainly, but where humus is consumed reddish brown rusty colours appears from iron accumulation; sand; single grain; very friable; medium porosity; upper part of horizon is discontinuous weakly cemented by iron-organic matter lacking visible structure, where strongest developed (eastern wall) it locally restrict root growth; very few very fine to medium roots; smooth abrupt (<0.5 cm) boundary
H6	Bh2	36-37 cm; black 5YR 2.5/1 (M), black 10YR 2/1 (D); the entire horizon is an thick black humus illuviation band, on the western and the central wall H6 is continuous, on the eastern wall most of H6 has disappeared, where H6 is gone or where its black colour is reduced in intensity rusty to beige, few to abundant, coarse, prominent, sharp microbio[1] mottles are crossing through the horizon; sand; massive; friable; very few very fine to medium roots; smooth abrupt (<0.5 cm) boundary
H7	Bw	37-76 cm; yellowish brown 10YR 5/4 (moist), light yellowish brown 1.5Y 6/4 (dry); light orange- yellowish brown common to abundant (10-20% on western wall, 60-80% on eastern wall), coarse (4-9 cm), prominent sharp microbio[1] mottles; slight greyish brown colour due to humus accumulation, where the humus is not consumed; very few, rounded to sub rounded, fresh, quartz-rich gravels (<3 cm); loamy sand; single grain; loose; high porosity; could this horizon (at least the lower half) be a buried surface horizon (interglacial) associated with the E/Bt (H8) horizon below?; common very fine to medium and few coarse roots; smooth abrupt (<0.5 cm) boundary
H8a	Bt	76-100 cm; brownish yellow 10YR 6/6 (M&D); sandy loam; massive; friable; brittle; medium porosity; Mn staining locally; locally root gley with iron enriched cortex and a bleached core; no roots
H8b	Eg	76-100 cm; pale yellow to light yellowish brown 2.5Y 6.5/4 (moist), pale yellow 2.5Y 7/4 (dry); bleached irregular polygons; sandy loam; single grain; very friable; medium to high porosity; where roots and water goes; very few very fine and fine roots;

[1] Leopard-like mottles= due to bacterial consumption of the organic material present in the soil matrix, rounded mottles are formed. Such mottles are commonly found in well-drained Podzol like soils although it is also found in other sandy soil types.

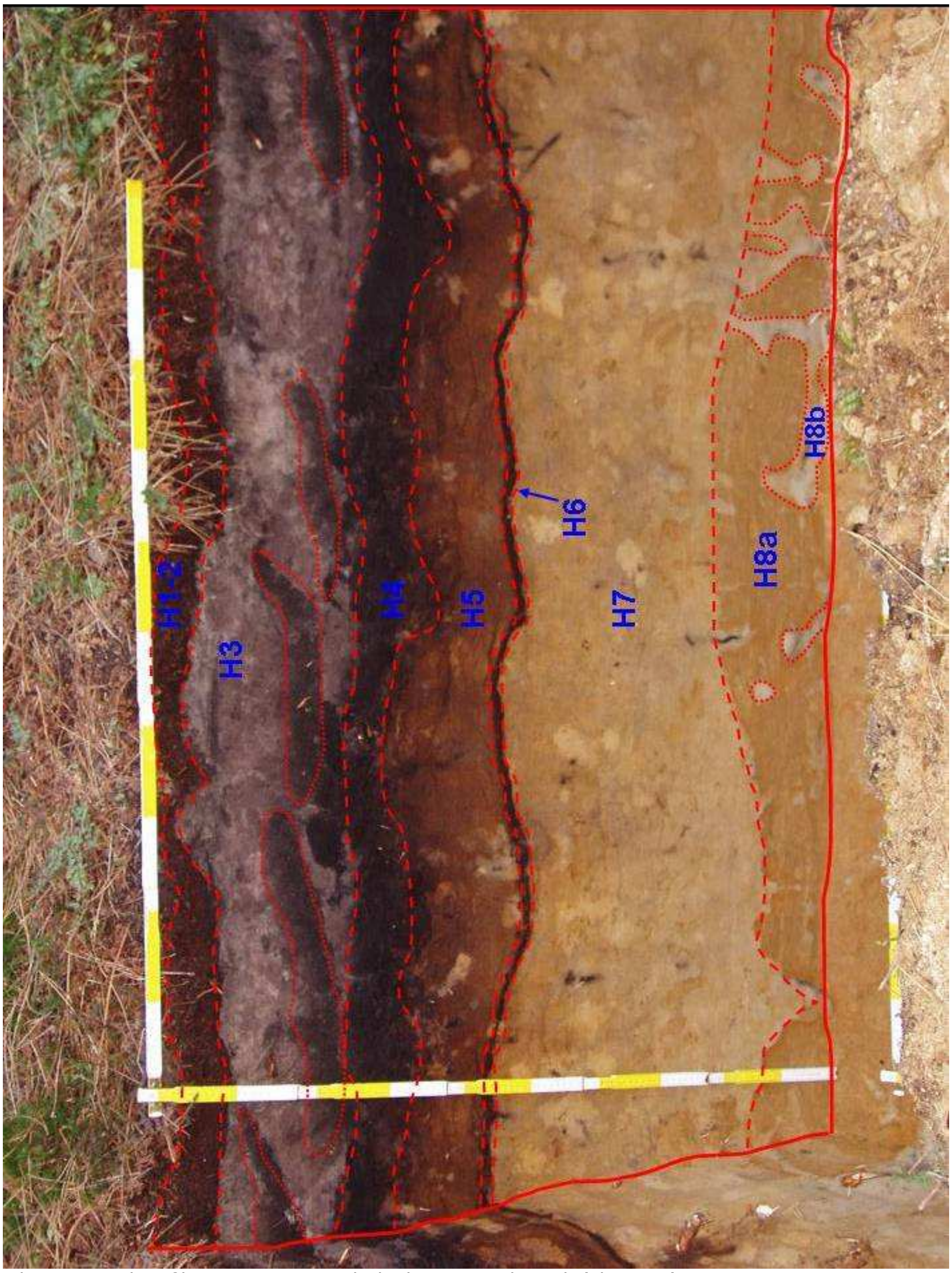

Photo 10: Soil profile P19, Pijnven, with the horizons indicated. (Photo JM).

11.2. The physical and chemical laboratory data

Although the C/N ratio shows some fluctuation through the soil the general trend is that the ratio is very high, which has a negative influence on the decomposition rate of the litter. A minor peak in the nitrogen content in H4 (Bh1) is associated with a major peak in the content of organic carbon. The pH remains stable through the pedon. A peak in the content of extractable iron has been measured in the Bs horizon, but as the oxalate aluminium content peaks in the horizon above and below, the combined concentration is insufficient to qualify for Spodic.

Table 13: Analytical data for profile P19 Pijnven, Limburg, Belgium. Profile studied 1/6/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth (cm)	Total N Modified (%)	C/N	Org. Carbon TOC (%)	Org. Carbon W&B (%)	pH H_2O 1:5	pH $CaCl_2$ 1:5	Al Oxalate (%)	Fe Oxalate (%)	Lab nr.
H1	OL	9-7	1.184	42	49.64						JM1
H2	OF+H	7-0	1.482	33	48.18						JM2
H3	A/Ep	0-18	0.068	19	1.30		4.3	3.2	0.016	0.023	JM3
H4	Bh1	18-25	0.269	26	7.03		3.9	2.8	0.259	0.096	JM4
H5	Bhs	25-36	0.069	15	1.05		4.3	3.7	0.114	0.298	JM5
H5b	Bhs	25-28			1.30				0.225	1.133	
H6	Bh2	36-37	0.074	26	1.92		4.3	3.6	0.164	0.155	JM6
H7	Bw	37-76	0.067	5	0.34		4.6	4.3	0.103	0.073	JM7
H8a	Bt	76-100			0.07		4.4	4.0	0.095	0.110	JM8
H8b	Eg	pockets			0.13		4.6	4.3	0.077	0.022	JM9

Horizon nr.	Particle size distribution (fractions in µm) 0-2 (%)	2-10	10-20	20-50	50-100	100-200	200-300	300-500	500-1000	1000-2000	Coarse frag. >2mm (%-wght)
H1											
H2											
H3	0.7	0.5	0.3	4.2	7.3	55.6	17.5	7.5	4.0	2.4	
H4	1.5	1.4	1.3	3.6	8.1	54.8	15.7	7.4	4.6	1.6	
H5	1.4	0.3	0.2	3.1	4.0	52.1	20.6	10.3	6.5	1.5	
H5b											
H6	0.9	0.6	0.3	3.7	6.6	51.0	17.8	9.6	7.4	2.1	
H7	0.4	0.1	1.7	12.8	9.6	48.0	14.1	6.6	5.1	1.7	
H8a	4.1	1.9	1.6	21.1	13.8	40.9	9.3	4.0	2.1	1.2	
H8b	1.3	2.0	2.2	19.1	15.0	45.6	10.0	3.4	1.2	0.3	

Horizon nr.	Mg++	Na+	K+	Ca++	Al+++	Fe+++	Mn++	Free H+	CEC sum	CEC measured	BS by CEC-m (%)
	by $MgSO_4$ (compulsive method), cmol(+)/kg soil								cmol(+)/kg		
H1											
H2											
H3	<0.22	<0.03	0.11	0.07	0.63	0.04	<0.004	0.87	1.7	<6	~10
H4	<0.12	<0.02	<0.01	0.33	8.95	0.07	<0.002	0.90	10.2	14.3	~3
H5	<0.12	<0.02	<0.01	<0.02	1.63	0.04	<0.002	0.22	1.9	<4	~4
H5b											
H6											
H7	<0.12	<0.02	0.06	<0.02	0.75	<0.01	<0.002	0.01	0.8	<4	~7
H8a	<0.12	<0.02	0.06	<0.02	1.79	<0.01	<0.002	0.18	2.0	<4	~7
H8b	<0.21	<0.03	0.04	<0.04	0.61	<0.01	<0.004	0.01	0.6	<6	~6

Horizon nr.	Horizon symbols	Depth (cm)	Mg++	Na+	K+	Ca++	CEC	BS (%)	CEC/clay	Acidity sum	Acidity titrated
			by NH_4OAc, cmol(+)/kg soil							cmol(+)/kg	
H1	OL	9-7									
H2	OF+H	7-0									
H3	A/Ep	0-18					4.0			2.1	
H4	Bh1	18-25					33.4			4.4	
H5	Bhs	25-36	0.05	0.00	0.01	0.11	3.7	5	5	2.4	
H5b	Bhs	25-28					11.5				
H6	Bh2	36-37									
H7	Bw	37-76	0.05	0.00	0.03	0.02	1.8	6		2.4	
H8a	Bt	76-100	0.06	<	0.04	0.01	2.8	4	63	1.7	
H8b	Eg	pockets					2.5			1.1	

The soil is characterised by a rather sandy texture with clay contents not exceeding 5%, not even in the subsoil. A change in parent material is clear from the particle size distribution. In H3-6 the sand content is about 85-90% and the silt content 8-15%. In the transition horizon H7, the sand content is 76% and the silt 24%. In H8 the sand content has further been reduced and is now about 60%. The silt content has increased to 38%.

A very marginal content of potassium could be measured in the mineral soil, the content of most other basic cations remains below the detection limit. The data on CEC by ammonium acetate confirms the extreme low contents of basic cations with a base saturation of 4-6%. Below the OH horizon the aluminium saturation exceeds 85% throughout.

11.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks
Albic	H3	Qualifying colours are taken where the E horizon is best developed.
Cambic	-	The texture of H8 is fine enough, but the horizon is too thin (should be 15 cm or more thick, and it only appears as bands in the depth 76-100 cm)
Folic	-	The OL, OF, OH horizons are together 9 cm thick, they should have been 10 cm to qualify.
Spodic	H5	Where the colours of the Albic horizon are sufficient bleached, H4-6 qualifies for a Spodic. Where not, the Spodic horizon needs the chemistry e.g. by a sufficient accumulation of oxalate extractable Al and Fe. The general samples for H4-6 do not have high enough values. If the upper 3 cm of H5 is separated as being the best developed part of the horizon, the concentration of Al and Fe is more than sufficient enough to qualify (see analytical data: H5b). This illustrates that sampling correctly is extremely important.
Stagnic colour pattern	H8a-8b	An irregular polygonal pattern with E tongues and Bt matrix prevails from 76 cm depth.
Reducing conditions	?	Testing with α,α-dipyridyl was not executed during the fieldwork and no other evidences of reductomorphic features were observed.

Simplified classification name

Albic Rustic Podzol

- Rustic: Upon ignition a sample changed colour from dark brown to pinkish red (tested on 3/8/2007)

Full classification name without specifiers

Stagnic Albic Rustic Podzol

- Stagnic: α,α-dipyridyl test is missing, it is most likely, considering the depth and the colour pattern of H8 that this horizon experiences reducing conditions for some time during the year. The probability that a Stagnic horizon is present is 70% (expert judgement).

BioSoil classification name (WRB 2006), with specifiers

Endostagnic Hypoalbic Rustic Podzol

11.4. Discussion

This is a nice example of a Podzol where due to ploughing the E horizon largely has been destroyed. At first, a composite sample was taken of H5 at 25-36 cm depth. Unfortunately the content of oxalate extractable iron plus aluminium was too low to qualify for Spodic. As the soil was revisited, a second sample was taken of the upper 3 cm of H5 where the accumulation of iron was most expressed. In this sample (H5b) the chemical requirements are fulfilled. This case study illustrates on one hand how important it is to correctly execute the fieldwork and particular the sampling but it illustrates also how fragile the classification system is. In this case the profile would be re-sampled, it is perfectly possible that more horizons are defined. In the field one pedologist would for a given soil maybe define 10 horizons and another 7 due to further subdivisions of some major horizons. For many diagnostic horizons, criteria and materials a minimum thickness is required; as it is for Spodic too. Here the minimum thickness is 2.5 cm that is why a composite sample of the upper 3 cm was taken for analyses. During the first visit to the profile no predefined opinions about the classification outcome was made and the soil was described and sampled according to the existing field guidelines. During the second visit the classification issue was clear and additional samples could be taken. For this reason it can strongly be recommended that if soils are to be classified in the field, the checklist for classifying forest soil profiles according to the World Reference Base for soil resources (WRB-2006) (Mikkelsen and Cools, 2007), should be consulted.

The FAO (1988) system put this profile in the group of the Haplic Podzols which corresponds well to the present soil classification since each of the qualifiers indentified in WRB-2006 did not exist in the FAO (1988) system.

12. Profile 20, Heiwijk, Limburg

12.1. Site and profile description

Profile 20	**Heiwijk (Level II forest plot)**
1.2 Date of description:	17/7/2007
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, Limburg, Maasmechelen (Opgrimbie) Municipality On E314 take exit 33 direction Lanaken. After about 800 m follow 'Weg naar Zutendaal' in western direction. Follow this road for about 6650 m. On the left side appears a very long red and white fence closing off the road (mostly it is unlocked). Enter the forest here. Drive nearly to the end and turn left along one of the side roads.
1.5 Profile coordinates:	*ICP Forests Level II plot nr.:* 2002 *Latitude, longitude:* 50° 56' 25" N, 05° 36' 30" E
1.6 Elevation:	±98 m a.s.l.
2.1 Atmospheric climate and weather condition:	Blue sky during fieldwork, at night heavy rain showers. In the 6 weeks prior to fieldwork the precipitation has been far above average
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	*Macrotopography:* The profile is located on a plateau position in an almost flat landscape position even on a regional scale. The level I profile Gellik is located only 5500 m to the south-south west at the foot of this plateau. *Mesotopography: -* *Landscape position:* Intermediate part of an almost flat terrain *Slope form:* straight, straight (SS) *Slope gradient: -* *Slope length: -* *Slope orientation:* dipping towards west (locally) and towards south a bit further into the forest
2.4 Land-use:	Plantation forestry with selective felling *Wildlife:* probably protected *Grazing:* no grazing
2.5 Human influence:	Vegetation strongly disturbed by timber jacks. Artificial drainage ditches with mutual distance of 6 m. The ditches are relatively deep, about 40 cm.
2.6 Vegetation:	• Scots pine (*Pinus sylvestris*), dominant canopy position, >90% frequency • Silver birch (*Betula pendula*), dominant canopy position, <10% frequency • Black cherry (*Prunus serotina*), suppressed, >50% frequency • Silver birch, Rowan (*Fraxinus excelsior*), Pedunculate oak (*Quercus robur*), co-dominant and suppressed, <50% frequency
2.7 Parent material:	River terrace gravel (5312)
2.8 Drainage class:	Somewhat excessively drained *Availability of water:* insufficient at times
2.9 Internal drainage:	Never saturated
2.10 External drainage:	Neither receiving nor shedding water
2.12 Groundwater:	Probably extremely deep (>200 cm)
2.13 Rock outcrop:	None

2.14 Coarse surface frag.:	Very few (0-2%), fine to medium gravels, visible on the surface where due to forest exploitation the vegetation cover has been damaged hereby exposing the stones.
2.15 Erosion, sedimentation:	Human induced erosion, 0-5% of the area affected, slight degree of erosion, erosion active today
2.17 Surface cracks:	None
Humus classification:	Horizon sequence: OL-OFnoz-OHnoz-E *Classification name:* Mor → Eumor
Remarks:	H7 does not turn redder upon ignition

No.		**Horizon description**
H1	OL	-5.7 till -5.5 cm; discontinuous layer of leaves and needles found on top of the moss layer; the moss layer is 2 cm thick
H2	OF	-5.5 till -1.0 cm; in the upper 1 cm a large proportion is composed of decaying bark, below mixture of needles, mosses, roots etc. with mycelia, spiders and beetles
H3	OH	-1.0-0 cm; continuous; black 10YR 2/0 (M); crumbles; abrupt smooth boundary
H4	A1	0-4/26 cm; is composed of waste soil material and disturbed soil material related to historical and recent human activities; very dark grey 10YR 3/1 (M); no reaction to α,α-dipyridyl; sand; common gravels; single grain; loose; high porosity; few very fine to fine and very few medium to coarse roots; abrupt complex boundary
H5	A2	4/8-17-22 cm; very dark grey to dark grey 10YR 3-4/1 (M); no microbiological mottles; salt and pepper; no reaction to α,α-dipyridyl; sand; very few gravels; single grain; loose; medium porosity; few very fine and fine roots; single biogallery extending from H5 into H6; smooth clear boundary
H6	E	17-27 cm; light brownish grey 10YR 6/2 (M); no reaction to α,α-dipyridyl; sand; common gravels; single grain; loose; low porosity; very few very fine roots; abrupt smooth boundary
H7	Bh	27-33 cm; black 10YR 2/1 (M), salt and pepper; no reaction to α,α-dipyridyl; common gravels; massive; friable; very low porosity; very few very fine and fine roots; abrupt smooth boundary
H8	Bhs	33-35 cm; dark yellowish brown 10YR 4/4 (M); moderate positive reaction to α,α-dipyridyl throughout; common gravels; single grain; very friable; low porosity; very few very fine and fine roots; abrupt smooth boundary
H9	Bs	35-40 cm; yellowish brown to brownish yellow 10YR 5.5/6 (M); faint positive reaction to α,α-dipyridyl throughout; common gravels; single grain; loose; low porosity; very few fine roots; clear smooth boundary
H10	B	40-73 cm; yellowish brown 10YR 5/6 (M); many (20-25%), medium to coarse, faint, diffuse orange brown mottles, slightly cemented by iron oxides; no reaction to α,α-dipyridyl; many gravels and stones, pendants on stones; loamy sand; single grain; loose; low porosity; very few fine roots; clear smooth boundary
H10b	pockets	Pockets embedded in H10; very dark brown to very dark greyish brown 10YR 2.5/2 (M);
H11	2Bg	73-97/104 cm; strong brown to yellowish brown 8.5YR 5/6 (M); many (40-50%), coarse, prominent, diffuse, pale yellow 2.5Y 7/3 (M) mottles, probably formed by stagnating water; no reaction to α,α-dipyridyl; sandy loam; abundant gravels and stones, pendants on stones; massive; very friable; low porosity; no evidences of clay coatings; no roots observed; gradual smooth boundary
H12	2B	97/104 cm; strong brown to dark yellowish brown 8.5YR 4/6 (M); no reaction to α,α-dipyridyl; sandy loam; many gravels and stones, pendants on stones; massive; very friable; low porosity; no evidences of clay coatings; no roots observed

Colour measurements: M= Moist; MC= Moist-crushed; D= Dry; DC= Dry-crushed; W= Wet.

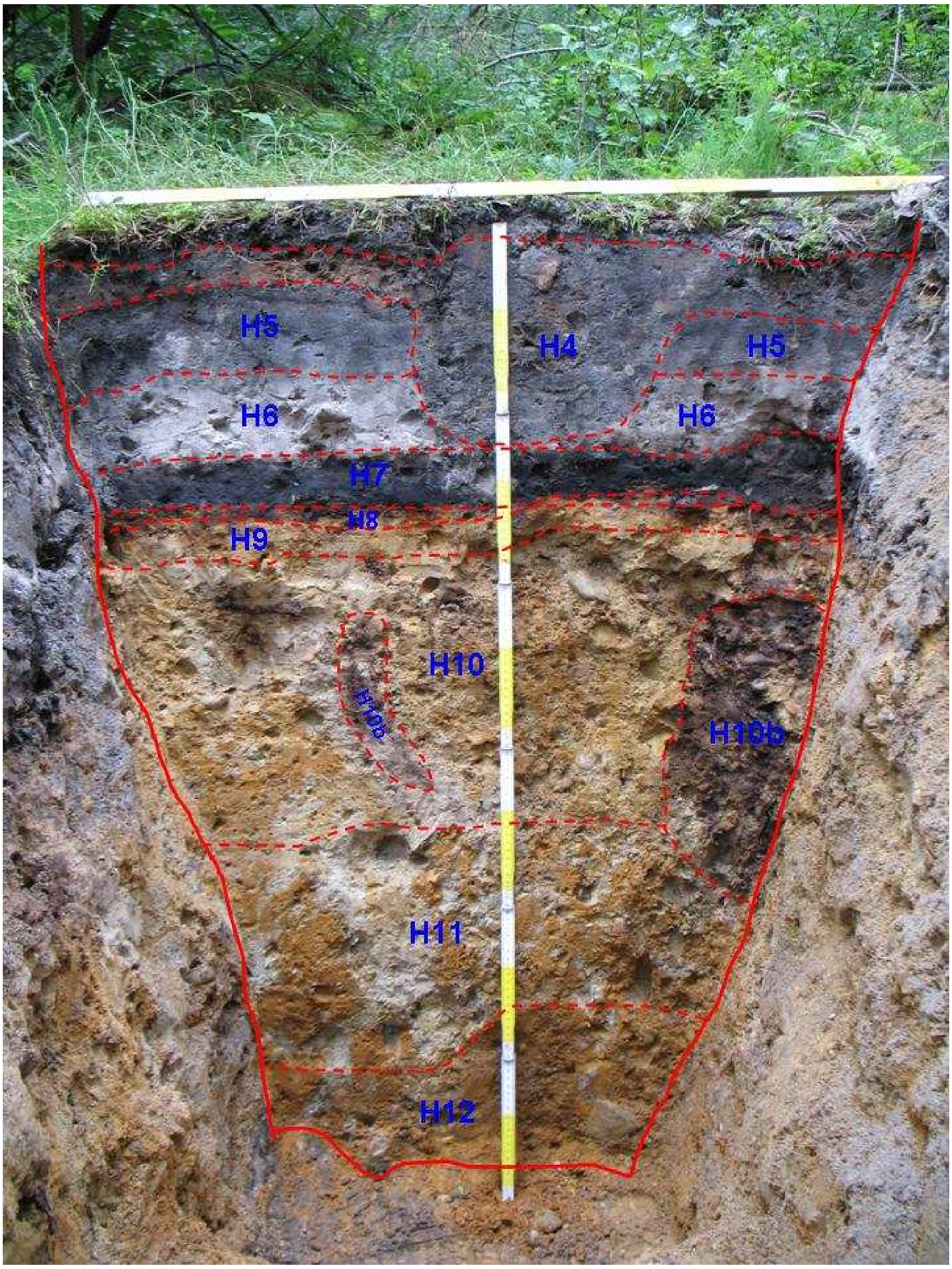

Photo 11: Soil profile P20, Heiwijk, with the horizons indicated. (Photo JM).

12.2. The physical and chemical laboratory data

High C/N ratios characterise this soil although in H5 the ratio is 12. A peak in the content of organic carbon is found in H4-5, the A horizons, and a second strong peak is found in H7, the Bh horizon, but also in H8, the Bhs horizon, the content of organic carbon is relatively high. The pH is rather stable through the soil and remains between 3.6 and 4.6.
The soil contains coarse fragments throughout with up to 65% by weight. The parent material is interpreted to be river terrace gravel, which is best illustrated by the very high difference in gravel content from horizon to horizon. In the upper horizons until H10 the content of clay is

very low and remains less than 4%. In H11-12 the content is 15-18%. The presence of a lithological discontinuity is evident. The content of basic cations remains below detection limit except for potassium, although the content of this cation is very low as well. The aluminium saturation is 72-75% in the upper mineral horizons and increases to 97% in H11.
The content of oxalate extractable iron is moderate in H7 (Bh) and peaks in H8 (Bhs) with more than 1%. In H8 (Bs) the content is nearly 0.5%. The distribution of oxalate aluminium peaks in H7. Together the chemical requirement for Spodic is fulfilled in H7 mainly due to aluminium and in H8 mainly due to iron. A relatively high content of lead has been found in the OH horizon 350 mg/kg.

Table 14: Analytical data for profile P20 Heiwijk, Limburg, Belgium. Profile studied 17/7/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth cm	Total N Modified %	C/N	OC TOC %	Organic matter W&B %	Organic matter LOI %	pH H_2O 1:5	pH $CaCl_2$ 1:5	EC dS/m 1:5	Coarse frag. >2mm %-wght
1	OL	4.7-4.5									
2	OF	4.5-1	1.869	22			81.6	4.0	3.2	0.10	
3	OH	1-0	1.465	23			68.2	3.6	2.8	0.09	
4	A1	0-4/26	0.103	23	2.35		4.8	4.1	3.4	0.04	13.7
5	A2	4/8-17/22	0.046	12	1.66		2.6	4.4	3.7	0.02	0.9
6	E	17-27	0.015	36	0.18		0.4	4.6	4.1	0.01	13.3
7	Bh	27-33	0.168	28	4.72			4.1	3.6	0.03	7.6
8	Bhs	33-35	0.059	29	1.72			4.3	3.8	0.03	7.9
9	Bs	35-40	0.033		0.41		1.4	4.3	4.0	0.02	15.8
10	B	40-73					2.3	4.5	4.3	0.02	45.7
11	2Bg	73-97/104					2.3	4.1	3.8	0.04	65.6
12	2B	97/104-…						4.0	3.8	0.05	37.3

Horizon nr.	Particle size distribution (fractions in µm) 0-2	2-10	10-20	20-50	50-63	63-100	100-125	125-250	250-500	500-1000	1000-2000
	-%										
1											
2											
3											
4	1.5	0.6	1.4	8.4	1.5	11.4	17.0	45.3	10.7	1.8	0.4
5	1.0	0.9	0.9	7.0	1.6	11.7	17.3	47.5	10.4	1.4	0.2
6	0.7	0.8	1.8	6.2	1.9	12.4	17.6	45.5	10.6	2.0	0.6
7											
8											
9											
10	3.4	3.4	2.1	9.9	1.5	6.0	8.0	32.8	21.0	6.3	5.6
11	18.2	4.6	2.5	7.5	1.0	3.0	3.1	23.5	24.7	8.1	3.9
12	15.8	3.5	2.2	8.7	0.9	3.0	3.0	27.8	25.8	6.6	2.7

Horizon nr.	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	Al^{+++}	Fe^{+++}	Mn^{++}	Free H^{+}	CEC sum	CEC measured	BS by CEC-m
	by $MgSO_4$ (compulsive method) cmol(+)/kg soil								cmol(+)/kg		%
1											
2											
3											
4	<0.17	<0.03	0.04	<0.03	1.96	0.20	<0.003	0.51	2.7	3.0	<5
5	<0.16	<0.02	<0.02	<0.03	1.06	0.03	<0.003	0.32	1.4	1.0	<12
6	<0.12	<0.02	<0.01	<0.02	0.10	0.01	<0.002	<0.10	0.1	<1	~17
7	<0.52	<0.08	<0.05	<0.10	11.31	0.20	<0.01	1.14	12.6	11.0	<3
8	<0.23	<0.03	0.03	<0.04	3.09	0.25	<0.004	0.16	3.5	3.0	<6
9											
10											
11	<0.12	<0.02	0.08	<0.02	4.86	0.05	<0.002	<0.10	5.0	5.0	<3
12											

Horizon nr.	Horizon symbols	Depth cm	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	CEC	BS %	CEC/ clay	Acidity sum	Acidity titrated
			by NH_4OAc cmol(+)/kg soil							cmol(+)/kg	
1	OL	4.7-4.5									
2	OF	4.5-1									
3	OH	1-0									
4	A1	0-4/26	0.02	0.01	0.05	0.07	6.2	2		2.7	2.8
5	A2	4/8-17/22	<0.015	<0.015	0.02	0.03	3.2	2		1.4	1.5
6	E	17-27	<0.015	<0.015	0.01	0.04	0.4	15		0.1	0.3
7	Bh	27-33	<0.015	0.02	0.06	0.06	24.9	1		12.6	11.7
8	Bhs	33-35	<0.015	<0,01	0.04	0.04	10.4	1		3.5	4.1
9	Bs	35-40									
10	B	40-73									
11	2Bg	73-97/104	0.02	0.02	0.10	0.04	7.8	2	43	4.9	5.7
12	2B	97/104-…									

Table 14 (continued): Analytical data for profile P20 Heiwijk, Limburg, Belgium. Profile studied 17/7/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth	Al	Fe	K	Ca	Mg	Na	P	S	Lab nr.
			Oxalate		----------Aqua Regia----------						
		cm	%		----------mg/kg----------						
1	OL	4.7-4.5									JM307
2	OF	4.5-1			418	4001	332	47	531	1802	JM308
3	OH	1-0			528	1902	464	76	699	2282	JM309
4	A1	0-4/26	0.075	0.154		183			92		JM310
5	A2	4/8-17/22			128	287	5	46	42	65	JM311
6	E	17-27	0.005	0.003							JM312
7	Bh	27-33	0.412	0.162	473	317	84	59	167	232	JM313
8	Bhs	33-35	0.271	1.055							JM314
9	Bs	35-40	0.130	0.448							JM315
10	B	40-73	0.200	0.130	1130	325	538	61	87	61	JM316
11	2Bg	73-97/104	0.189	0.630	3584	294	1480	157	194	130	JM317
12	2B	97/104-…									JM318

Horizon nr.	Al	As	Cd	Co	Cr	Cu	Fe	Mn	Pb	Ni	Zn
	----------Aqua Regia----------										
	----------mg/kg----------										
1											
2	1144	1.66	1.41	0.95	9	11.2	1824	99	57.0	11.8	89
3	3861	12.00	1.40	3.90	18	29.0	7551	76	357.6	20.4	135
4											
5	708	<2.50	<0.50	<0.50	3	<2.50	240	5	5.1	0.7	6
6											
7	6110	<2.50	0.59	<0.50	8	<2.50	2793	9	8.8	1.8	10
8											
9											
10	9159	4.87	<0.50	1.88	16	4.4	10606	38	4.7	6.4	16
11	26224	13.36	<0.50	4.01	39	22.1	32104	43	10.3	13.8	33
12											

12.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks:
Albic	H6	Dry colour is missing but the moist colour is sufficient for both the dry and moist requirements
Argic	H11-12	No clay coatings were observed in the Argic horizon but in absence of a lithological discontinuity the illuvial character of the horizon is not diagnostic
Spodic	H7	Does not turn redder upon ignition
Umbric	-	Too shallow en too light colour
Reducing conditions	H8-9	No reaction above and below
Stagnic colour pattern	H11-12	

Simplified classification name

Albic Carbic Podzol

Full classification name without specifiers

Stagnic Albic Carbic Podzol

- Stagnic: although the horizons with a Stagnic colour pattern showed no reaction to α,α-dipyridyl, it is most likely that a positive reaction appears sometime during the year. The profile was studied in the full summer of 2007.
- Skeletic: the weighted average of the gravel content (by weight) is 37%, required is 40%

BioSoil classification name (WRB 2006), with specifiers
Endostagnic Albic Carbic Podzol The presence of an Argic horizon is ignored following the classification key

12.4. Discussion

This is one of the best-developed Podzols among the profiles described in this report and in the report on the level I profiles (Mikkelsen et al., 2008). Firstly the E horizon remains mostly intact despite obvious human activities. The Bh horizon is particular well developed with 4.6% organic carbon, but also the Bhs horizon has a high content of organic carbon and a high content of oxalate extractable iron. This makes that this soil qualifies for the Spodic both due to the morphological criteria (colours) but also due to the chemical criteria (oxalate extractable iron and aluminium). In the subsoil the presence of oxido reduction mottles is expressed in the Endostagnic qualifier, as water is slowed down due to the higher clay content in the deepest analysed horizons. The presence of stones is insufficient for the qualifier Skeletic. Considering that this is one of the more stony soils in Flanders it is a pity the stoniness is not expressed in the classification name. On a world scale where the classification system is handled the stoniness in this profile is not really a problem. Still introducing a qualifier for lower contents of stones than 40% weighted average from 0-100 cm depth is recommended, e.g. Hyposkeletic for contents between 20 and 40% weighted average 0-100 cm.

The FAO (1988) system put this profile in the group of the Haplic Podzols which corresponds reasonably well to the present soil classification although the carbic qualifiers did already exist in the FAO (1988) system. Probably the ignition test was not performed in 1991 to check for the carbic qualifier.

13. Profile P21, Zevenster, Flemish Brabant

13.1. Site and profile description

Profile 21	**Groenendaal/Zevenster (Level II forest plot)**
1.2 Date of description:	21/6/2007
1.3 Author:	Jari Hinsch Mikkelsen
1.4 Location:	Belgium, Flemish Brabant, Hoeilaart municipality. On the inner ring around Brussels (R0) direction Waterloo take exit 29 (Groenendaal). Follow the Duboislaan. Take at the pond Ganzepootvijver, the Sint Corneliusdreef direction Waterloo. After 1.8 km the 7-star junction and the forest reserve Kesselaersplein. The plot is located directly north of the Schone Beukweg east of a horse track running in north-south direction (340°)
1.5 Profile coordinates:	*ICP Forests Level II plot nr.:* 2102 *Latitude, longitude:* 50° 44′ 50″ N, 04° 24′ 53″ E
1.6 Elevation:	120-125 m a.s.l.
2.1 Atmospheric climate and weather condition:	Overcast, past week's regular rain showers. The day before fieldwork it was 25-30°C
2.2 Soil climate:	*STR:* Mesic *SMR:* Udic
2.3 Topography:	*Macrotopography:* The profile is located within a region characterised by a gently rolling loess landscape *Mesotopography:* - *Landscape position:* On the transition between the upper slope and the middle slope. With microtopography created by generations of wind throws. *Slope form:* convex, straight (VS) *Slope gradient:* No information *Slope length:* About 200 m *Slope orientation:* 320° North
2.4 Land-use:	Plantation forestry with selective felling *Wildlife:* protected *Grazing:* No grazing
2.5 Human influence:	Vegetation slightly disturbed. Locally more intensive disturbed, especially related to horse tracks, forest exploitation tracks, level II intensive monitoring with bimonthly activities.
2.6 Vegetation:	Deciduous woodland, with deciduous shrubs and herbs. European Beech (*Fagus sylvatica*), dominant in canopy, >90% frequency Pine (*Pinus*), co-dominant in canopy, <10% frequency
2.7 Parent material:	Loamy loess (7110)
2.8 Drainage class:	Well drained *Availability of water:* sufficient
2.9 Internal drainage:	Rarely saturated
2.10 External drainage:	Slow run-off
2.12 Groundwater:	No traces of a groundwater table observed
2.13 Rock outcrop:	None
2.14 Coarse surface frag.:	None
2.15 Erosion, sedimentation:	None
2.17 Surface cracks:	None
Humus classification:	Humus classification studies 4 m to the north of the soil profile. Horizon sequence OL-OFz-OHz-Aze. OH is more than 1 cm

	thick. *Classification name:* Moder → Dysmoder, locally Lignomoder
Remarks:	Few biogalleries (burrows) from mice or mol? Diameters 3-5 cm, oriented vertically. No reaction to α,α-dipyridyl.

No.		**Horizon description**
H1	OL	-9 till - 6 cm; wood louse observed
H2	OFz	-6 till -5 cm; mycelia present
H3	OHz	-5-0 cm; very dark brown 8.5YR 2/2 (M); well developed granules; many roots, mostly horizontally, vertical roots grow mostly into the mineral soil along a polygonal surface cracking system; earthworms present; irregular boundary
H4	A/Aze	0-2/13 cm; very dark greyish brown 10YR 3/2 (slightly M); weakly developed medium platy; friable; few very fine and fine roots; smooth abrupt boundary
H5	Bh	2/9-5/12 cm; brown 10YR 4/3 (slightly M); moderately developed medium platy; friable; few very fine and fine roots; smooth abrupt boundary
H6	E	5/12-18/27 cm; light yellowish brown 1.5Y 6/4 (M), very pale brown to pale yellow 1.5Y 7/4 (D); few coarse distinct diffuse orange brown mottles, along edges of tongues where iron has accumulated; faint positive reaction to α,α-dipyridyl throughout; silt; strong developed medium platy; friable; low porosity; common very fine, soft, manganese oxide (positive reaction to hydrogen peroxide) black nodules; few very fine to fine and very few medium roots; abrupt irregular boundary
H7	Btbi	18/27-39 cm; yellowish brown 10YR 5/4 (slightly M); colour on pedfaces is brown 10YR 4/3 (slightly M); silt loam, bleached silt accumulations 2-5 mm diameter; strong developed coarse (2-4 cm) angular blocky; high porosity; many very fine to medium and common coarse roots; smooth gradual boundary
H8	Eg/E	Tongues; most bleached part pale brown 10YR 6/3 (M), light grey 10YR 7/2 (D); silt loam; few very fine to medium and common coarse roots; abrupt irregular boundary
H9	Btmx1	39-65 cm; yellowish brown 10YR 5/4 (M); silt loam; well developed coarse angular blocky; firm; clay-humus coatings in pores and mainly on pedfaces, common siltans and bleached silt accumulations of 2-5 mm diameter; high porosity; few very fine to medium and very few coarse roots; smooth diffuse boundary
H10	Btmx2	65-97 cm; yellowish brown 10YR 5/4; silt loam; prisms breaking to moderate developed conchoidal shaped structures (not slickensides); friable; few clay coatings in pores; high porosity; common very fine to fine and few medium to coarse roots; smooth diffuse boundary
H11	Bt	97-134 cm; yellowish brown 10YR 5/4 (M); silt loam; massive; friable; few clay coatings in pores; high porosity; very few very fine and fine roots; smooth diffuse boundary
H12	Bw	134-183 cm; yellowish brown 10YR 5/4 (M); silt loam; massive; friable; brown clay coatings in pores; medium porosity; very few very fine and fine roots; smooth diffuse boundary
H13	BC	183-… cm; bleached parts light yellowish brown 1.5Y 6/4 (M), brown parts yellowish brown 10YR 5/4 (M); silt loam; massive; friable; few reddish brown clay coatings in pores; medium porosity; very few very fine and fine roots;

Colour measurements: M= Moist; MC= Moist-crushed; D= Dry; DC= Dry-crushed; W= Wet.

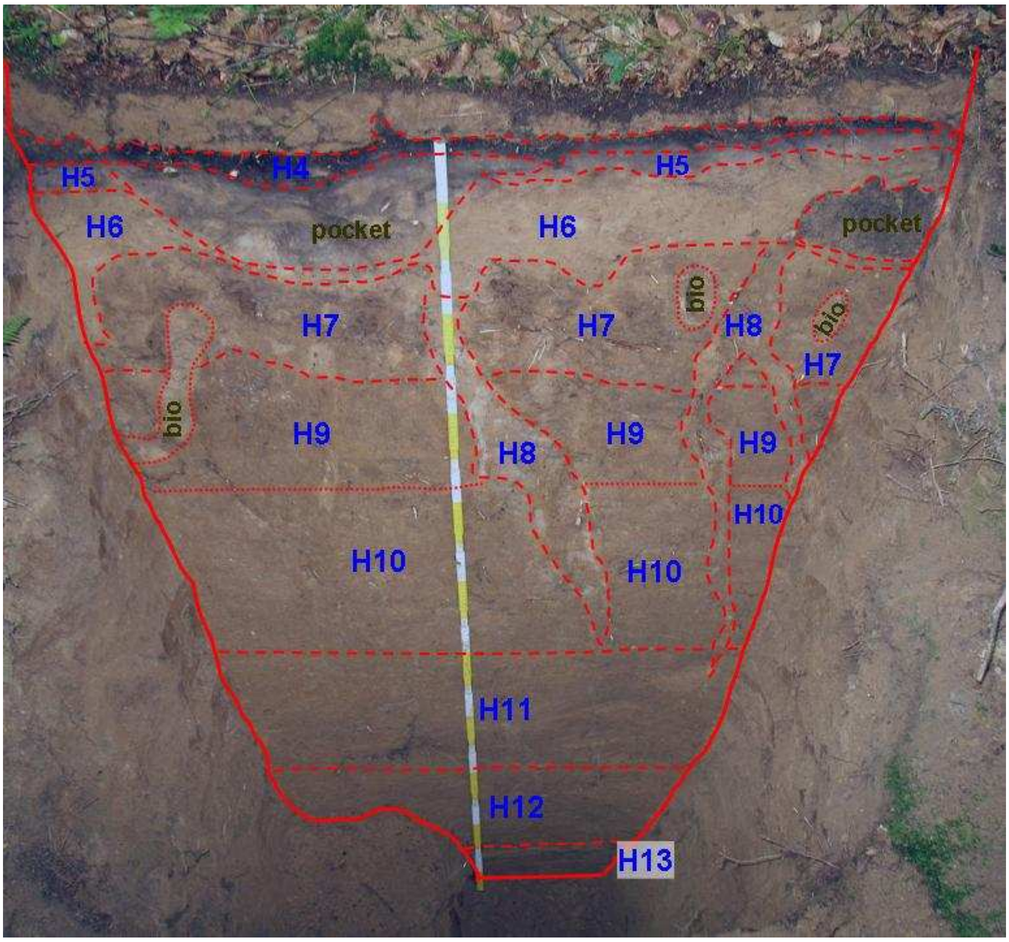

Photo 12: Soil profile P21, Zevenster, Groenendaal, with the horizons indicated. (Photo JM).

13.2. The physical and chemical laboratory data

This loess soil has better C/N ratios than what has been observed in the previous sandy soils. Most horizons have a ratio between 12 and 20. The lowest ratios are as in most soils observed in the deeper horizons where the content of organic carbon is rather low. That the forest floor is classified as a Moder fits with the moderate C/N ratio meaning better relationship between the content of nitrogen and organic carbon. A high content of organic carbon is found in H4 and in particular in H4b, which is H4 but sampled in the mini profile where the organic layers were described and sampled. The mean depth of H4 is 3 cm, which explains the high concentration of organic carbon, there is simply very little vertical mixing of the soil by faunal activity in this soil. The pH of the litter layer shows the trend found in most analysed soils that the pH is highest in the OL and drops through the OF, OH and into the uppermost mineral horizon, which usual has (one of) the lowest pH of the entire profile. Towards the depth the pH increases slowly again. In H4b the content of coarse fragments is 1.2% but it is entirely composed of coarse fragmented organic material. The particle size distribution shows a soil with very high silt contents and with sand never exceeding 3%. The very low content of sand compared to what normally is explained about Belgian loess soils is because the fraction 50-63 µm is included in the fraction coarse silt. Previously when the Belgian soil map booklets were elaborated this fraction was included in the fraction very fine sand. The lowest clay content of the horizons analysed is found in H6 and H8, both horizons were described in the field as eluvial horizon and the symbol E was applied. The highest clay content has been measured in H10 (21.5%) but around 20% of clay were measured in H7, H9 and H11 as well due to clay illuviation.

Table 15: Analytical data for profile P21 Zevenster, Groenendaal, Flemish Brabant, Belgium. Profile studied 21/6/2007. Profile analysed 10/2007 - 06/2008.

Opmerking [NC2]: de horizontnamen in deze table komen niet overeen met de horizontnamen in de profielbeschrijving

Horizon nr.	Horizon symbols	Depth cm	Total N Modified %	C/N	OC TOC %	Organic matter W&B %	Organic matter LOI %	pH H_2O 1:5	pH $CaCl_2$ 1:5	EC dS/m 1:5	Coarse frag. >2mm %-wght
1	OL	9-6	1.647	25			83.5	5.7	5.1	0.45	
2	OFz	6-5	1.433	24			70.1	5.0	4.3	0.24	
3	OHz	5-0	1.193	16			37.9	4.4	3.5	0.12	
4	Aze/A	0-2/13	0.251	18	4.56			4.0	3.3	0.07	0.0
4b	A	Special sample	0.630	22	14.10			3.8	2.9	0.15	1.2
5	Bh	2/9-5-12	0.138	17	2.41			4.1	3.4	0.05	0.1
6	E	5/12-18/27	0.068	14	0.96		2.7	4.4	3.8	0.04	0.0
6b	E	Special sample	0.058	12	0.70			4.4	3.9	0.03	0.0
7	Btbi	18/27-39	0.051	7	0.37		2.0	4.4	3.7	0.05	0.0
8	Eg/E	tongues	0.041	5	0.20		1.7	4.5	3.7	0.05	0.0
9	Bdtx1	39-65	0.041	4	0.19		2.0	4.7	3.7	0.04	0.0
10	Bdtx2	65-97					1.9	4.9	4.0	0.04	0.0
11	Bt	97-134					1.9	5.2	4.2	0.03	0.0
12	Bw	134-183					2.0	5.2	4.2	0.04	0.0
13	BC	183-…					1.9	5.4	4.4	0.03	0.0

Horizon nr.	Particle size distribution (fractions in µm) % 0-2	2-10	10-20	20-50	50-63	63-100	100-125	125-250	250-500	500-1000	1000-2000
1											
2											
3											
4											
4b											
5											
6	8.8	8.3	11.8	66.5	2.6	1.4	0.1	0.2	0.1	0.1	0.1
6b											
7	19.8	7.2	11.9	57.1	2.3	1.4	0.1	0.1	0.0	0.0	0.0
8	16.6	6.5	8.7	63.5	3.1	1.3	0.1	0.1	0.0	0.0	0.0
9	19.6	6.9	11.2	58.9	2.2	1.1	0.1	0.0	0.0	0.0	0.0
10	21.5	8.0	11.0	56.1	2.1	1.1	0.1	0.0	0.0	0.0	0.0
11	20.0	8.3	8.1	58.7	3.2	1.5	0.1	0.1	0.0	0.0	0.0
12	17.3	9.7	13.9	55.7	2.0	1.1	0.1	0.1	0.0	0.0	0.0
13	18.6	6.0	9.7	59.4	4.0	2.0	0.2	0.1	0.0	0.0	0.0

Horizon nr.	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	Al^{+++}	Fe^{+++}	Mn^{++}	Free H^{+}	CEC sum	CEC measured	BS by CEC-m
	by $MgSO_4$ (compulsive method) cmol(+)/kg soil								cmol(+)/kg	cmol(+)/kg	%
1											
2											
3											
4	<0.23	<0.04	0.06	0.14	5.18	0.52	0.006	1.63	7.5	7	<5
4b	<0.57	<0.09	0.37	0.99	6.64	1.18	0.038	5.86	15.1	14	<12
5	<0.24	<0.04	0.04	0.20	4.74	0.39	0.012	0.38	5.8	5	<8
6	<0.17	<0.03	0.03	<0.03	3.10	0.02	0.089	<0.10	3.2	4	<4
6b	<0.17	<0.03	0.04	<0.03	2.68	0.06	0.036	<0.10	2.8	3	<5
7	<0.17	<0.03	0.16	0.08	6.23	0.01	0.045	<0.10	6.5	7	<5
8	<0.18	0.03	0.15	0.16	5.46	0.01	0.020	1.75	7.6	6	<7
9	0.35	0.07	0.20	0.96	5.25	0.01	0.072	<0.10	6.9	8	20
10											
11											
12											
13											

Table 15 (continued): Analytical data for profile P21 Zevenster, Groenendaal, Flemish Brabant, Belgium. Profile studied 21/6/2007. Profile analysed 10/2007 - 06/2008.

Horizon nr.	Horizon symbols	Depth	Mg++	Na+	K+	Ca++	CEC	BS	CEC/ clay	Acidity sum	Acidity titrated
			by NH_4OAc								
		cm	cmol(+)/kg soil					%		cmol(+)/kg	
1	OL	9-6									
2	OFz	6-5									
3	OHz	5-0									
4	Aze/A	0-2/13	0.24	0.06	0.09	0.20	15.4	4		7.3	8.2
4b	A	Special sample	0.60	0.13	0.39	0.67	33.0	5		13.7	16.0
5	Bh	2/9-5-12	0.16	0.05	0.07	0.25	10.3	5		5.5	7.2
6	E	5/12-18/27	0.06	0.03	0.06	0.12	6.6	4	38	3.2	4.2
6b	E	Special sample	0.03	0.02	0.07	0.10	5.8	4		2.8	3.7
7	Btbi	18/27-39	0.19	0.06	0.22	0.13	10.7	5	48	6.3	7.9
8	Eg/E	tongues	0.23	0.06	0.19	0.27	8.9	9	49	7.2	7.0
9	Bdtx1	39-65	0.63	0.09	0.26	1.17	10.9	20	52	5.3	6.7
10	Bdtx2	65-97									
11	Bt	97-134									
12	Bw	134-183									
13	BC	183-…									

Horizon nr.	Horizon symbols	Depth	Al	Fe	K	Ca	Mg	Na	P	S	Lab nr.
			Oxalate		Aqua Regia						
		cm	%		mg/kg						
1	OL	9-6									JM273
2	OFz	6-5			1354	6907	1019	107	920	1445	JM274
3	OHz	5-0			1195	3027	988	104	823	1394	JM275
4	Aze/A	0-2/13	0.117	0.383							JM276
4b	A	Special sample	0.120	0.353	1452	882	893	87	600	894	JM276b
5	Bh	2/9-5-12	0.116	0.457							JM277
6	E	5/12-18/27	0.118	0.363							JM278
6b	E	Special sample	0.124	0.382	1086	484	1284	41	155	88	JM278b
7	Btbi	18/27-39	0.190	0.316	4987	967	3507	181	332	95	JM279
8	Eg/E	tongues			4493	971	3189	169	201	69	JM280
9	Bdtx1	39-65	0.151	0.227	5141	1225	3707	191	357	70	JM281
10	Bdtx2	65-97									JM282
11	Bt	97-134			5710	2070	4561	241	399	47	JM283
12	Bw	134-183									JM284
13	BC	183-…			5299	2664	4471	226	452	40	JM285

Horizon nr.	Al	As	Cd	Co	Cr	Cu	Fe	Mn	Pb	Ni	Zn
	Aqua Regia										
	mg/kg										
1											
2	2089	2.42	0.43	1.32	6	15.07	2852	985	56.9	7.4	66
3	6096	7.16	0.33	3.06	14	18.96	8309	179	147.2	11.4	67
4											
4b	8196	10.34	<0.50	3.30	17	15.68	11306	108	145.8	9.8	50
5											
6											
6b	9541	3.83	<0.50	3.28	15	<2.50	11037	116	9.7	6.4	24
7	25400	8.35	<0.50	8.83	38	9.62	25392	365	10.8	17.4	61
8	22991	5.39	<0.50	5.07	38	6.55	17913	120	8.6	14.0	42
9	25625	8.98	<0.50	9.05	40	10.52	25932	376	11.1	19.5	55
10											
11	27343	10.00	<0.50	9.65	45	13.24	28456	441	11.7	25.6	51
12											
13	24623	9.33	<0.50	8.82	45	11.12	26353	412	10.3	25.3	49

In nearly all horizons the content of exchangeable potassium and calcium cations exceeds the quantification limits but the contents remain very low. For the same reason the aluminium saturation reaches concentrations as high as 95-96% and remains above 40% in all analysed horizons.

The oxalate extractable content of iron is around 0.35% with a minor peak in H5 the Bh horizon. The content of oxalate extractable aluminium remains rather low. The content of aqua regia extractable elements is as expected although the content of Arsenic remains above the detection limit through the profile.

13.3. Classification according to World Reference Base (2006)

Diagnostic horizon, properties, material	Present in horizon	Remarks
Albic	H8	H6 has a too high chroma
Argic	H7-13	H8-13 show evidences of clay migration
Fragic	H9	No information on the penetration resistance at field capacity. The horizon is described as firm
Abrupt textural change	H6→H7	
Lithological discontinuity	-	The abrupt textural change is partly due to clay migration
Albeluvic tonguing	-	The texture of H8 does not resemble that of the overlying coarser textured E horizon. A drop in clay content in the Albic tongues is evidenced but insufficient for the classification.

Simplified classification name:

Albic Cutanic Alisol

- Alisol: the CEC of the clay remains above the required 24 cmol(+)/kg clay for the analysed horizons and the base saturation remains below 50%

Full classification name without specifiers:

Albic Cutanic Alisol (Fragic, Abruptic, Alumic, Hyperdystric, Siltic)

- Humic: The weighted average content of organic matter from the mineral surface to a depth of 50 cm is 0.88%. At least 1.00% is required.

BioSoil classification name (WRB 2006), with specifiers:

Glossalbic Hypocutanic Alisol (Fragic, Abruptic, Hyperalumic, Hyperdystric, Siltic)

- Glossalbic: added Gloss because the Albic horizon in question is the Albeluvic tonguing.
- Hypocutanic: added hypo because the quantity of coatings is rather low
- Hyperdystric: Base saturation is 4-20%

13.4. Discussion

The soil is an example of a well-drained soil that has many similarities with Albeluvisols with possibly a fragipan or at least a dense subsurface horizon. Due to its well-drained nature the Albeluvic tonguing is not very well expressed in form of colour contrast with the soil matrix and the soil therefore keys out in Alisols.

The upper 10 cm faces a micropodzolisation with some humus migration from the A into the Bh horizon. The E is compacted as well with Mn nodules where the humus type is studied (micro-low). The E horizon is much more bleached than here (micro-high).

Roots grow until about 40 cm depth (H7), below this depth the roots only grow along fractures. At the bottom (H13), a band of brown clayey and beige silty material makes up the horizon. No calcareous material observed.

The total profile depth is 210 cm. The relatively high content of roots is due to 1) close distance to large beech trees, and 2) the old pit partly filled but with loosened subsoil has promoted root growth.

H5 is what in the field would be described as the B-horizon of a micropodzol because of the morphological characteristics with podzolisation and Podzols. Chemically thought this horizon has been formed by other process than a real Spodic Bh horizon. As an example, in a Spodic Bh the organic matter concentration is due to illuviation, in H5 the organic matter has accumulated rather through mixing of the mineral soil with organic matter. If H5 is tested for a Spodic horizon the requirement for a low pH is fulfilled (pH = 4.1 and should be <5.9). The minimum content of organic carbon is also fulfilled (OC is 2.41% should be >0.5%), but the colour (10YR 4/3) is one unit too high for both value and chroma. Also the content of oxalate extractable iron and aluminium (1/2Fe+Al= 0.35% while it should be >0.5%) is too low mainly due to the rather low content of aluminium. With other words, fortunately the diagnostic criteria for Spodic horizons are defined in such as way that so called micropodzolisation horizons fail to classify for Spodic.

In 1991, this soil was classified as a Dystric Podzoluvisol (FAO, 1988), the equivalent major soil grouping to the major soil reference group of the Albeluvisols of WRB-2006. The difference might here be explained by the less strict diagnostic requirements in the 1988 system to qualify as a Podzoluvisol.

14. Conclusions

Within this survey, the 11 Level II profiles were described and classified for a second time following the present day international guidelines and soil classification key (WRB-2006). On four sites, the WRB soil classification name offered clearly more accurate and detailed information. This was the case for profiles N° 12 in Meerdaal forest, N° 13 in Hallerbos, N° 19 in Pijnven forest and N° 20 in Maasmechelen where the FAO (1988) Haplic Alisols and Haplic Podzols received additional qualifiers.

On other sites, the soils ended up in a different reference soil group compared to the FAO (1988) system. The reasons for this shift are usually due to a change in the definitions (profile N° 21 in Zonien forest or profile N° 14 in Ravels forest) or due to the availability of additional chemical data (profile N° 17 in Buggenhout forest). This makes that all three Podzoluvisols in the FAO (1988) system, do not end up in the expected group of the Albeluvisols in WRB-2006. Profile N° 16 in Gontrode was classified within the new reference soil group of the Stagnosols. Profile N° 18 in Houthulst is now characterised as a Gleysol, which was found to describe better the properties of this profile. Of these three profile, profile N° 21 did show the most similarities with the group of the Albeluvisols though not all requirements were fulfilled.

This relates to an important problem we faced with the classification of the Albeluvisols. Both profiles N° 13 in Haller forest and N° 21 in Zonien forest have eluvial tongues into the Bt horizon but since the colours of the tongues have a too high chroma, the soil keys out as an Alisol. Often in poorly drained soils the same tongues become bleached and then the soil will qualify as an Albeluvisol. This is a weakness in the classification system. The ultimate problem with this kind of soils is the impermeable subsoil for fauna, flora and even for water. Whether the tongues are bleached or not is in this respect irrelevant. It is recommended that soils having a closed box system with Albeluvic tongues (bleached or not) all are included in Albeluvisols. The measurement of the difference in penetration resistance between the fragipan and of Albeluvic tongues can be an additional diagnostic requirement if indeed the tongues are present in a polygonal pattern.

Concerning profile N° 15 in Brasschaat the migration to the major soil reference group of the Arenosol, is due to a combination of different field observations and a change of definitions. In 1991 the colour requirements for the umbric horizon were fulfilled while this was not the case in the filed description in 2007. Since the Arenosols in the FAO (1988) system did not accept other diagnostic horizons than a Orchic A or a Albic E horizon, the soil ended up in the Regosols.

This makes that in most cases, the WRB -2006 is better characterising the properties of the soils on the Level II plots compared to the previous classification efforts. Concerning profile N° 11 in Wijnendale forest however, both field surveys in 1991 and 2007 felt the need to express the human influence and the relatively young nature of this forest soil. This could however not be realised within either the FAO (1988) or the WRB-2006 system.

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17. List of Tables

18. List of Photos