DRIFT SAND-PODZOL HYDROSEQUENCES IN THE MOL-DESSEL AREA, NE BELGIUM

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ABSTRACT
This paper explores the concept of drift sand-Podzol hydrosequences, based on recent observations (exposures and hand augerings) at a small interfluve in the Mol-Dessel area, NE Belgium. It shows that drift sand characteristics and the soil horizon morphology of the buried Podzols covary in a slightly undulating landscape, according to their vertical position with respect to an assumed palaeogroundwater table. Notwithstanding the fact that several issues still need to be resolved, the investigated sequences have great potential as a palaeohydrological archive.

KEYWORDS
soil horizon morphology, Podzol, drift sand facies, palaeohydrology, groundwater table, Holocene

DOI
10.5281/zenodo.3420877

1. Introduction

Podzol horizon morphology is strongly dependent on the hydrological conditions during soil development. The average highest and average lowest groundwater tables have an impact on the distribution of Fe in the soil profile and the morphology, thickness and nature of the transition between the B- and E-horizons (Buurman, 1984; Buurman and Jongmans, 2005; Buurman et al., 2013). De Coninck (1980) distinguishes four types of B-horizons, and thus Podzols. The first, Friable Podzols have loose B-horizons, which are characterised by high biological activity. Drainage conditions may vary from poorly drained to well drained. The second, Cemented Podzols have partially or completely cemented B-horizons which are characterised by less biological activity (e.g. as a result of a shallowing groundwater table or changing vegetation). Again, drainage conditions may vary from poorly drained to well drained. The third, Nodular Podzols have a gley horizon in the shallow subsurface, which is characterised by iron nodules and mottles. The B-horizon then develops around the iron nodules. Finally, Placic Podzols have an orange-red iron pan directly underneath the B-horizon. The iron-pan develops as a result of stagnant conditions on top of a cemented B-horizon.

In general, soil development in the sandy parent material of the Campine area (NE Belgium) started after the stabilisation of the landscape due to vegetation development at the beginning of the Holocene (see references in Beerten et al., 2014). Subsequent land use and socio-economic changes were responsible for increased pressure on the landscape (deforestation, grazing, development of road track networks, heather sodding practices in agriculture) that caused wind deflation of the previously developed Podzols and parts of the parent material. Episodes of decreased landscape stability and sand drifting are known to have occurred during several stages in the Holocene, but it was not until the late Middle Ages (AD 1050-1500) and the Modern Period (from AD 1500) that sand became massively mobilised which led to the development of the characteristic micro-topography in many regions in the European sand belt (Figure 1; Koster, 2009; Tolksdorf and Kaiser, 2012; Küster et al., 2014; Pierik et al., 2018). Gradually, during the course of the 19th century, the landscape became stabilised again. The thus fossilized drift sand landscape shows characteristic alternations of deflation hollows (usually around 1-2 m deep) and shallow (1 m up to several m high) irregularly shaped drift sand dunes. Very often drift sand is found on top of (partially eroded) Podzols, in which case the podzolization process is no longer active and the soil turns into a palaeosoil. Typical features in drift sand landscapes are table-shaped mounds, showing an alternation of elevated areas consisting of buried Podzols, and deflation areas where the Podzol has been completely removed (Castel, 1991). In some regions, sand is still drifting today, such as in the Veluwe area in the central Netherlands (Koster, 2009).

Logically, similar to the Podzols that developed prior to landscape instability, deflation hollows and drift sand deposition patterns are expected to have been influenced (or not influenced) by the contemporaneous groundwater table. For example, a rising groundwater table may cause groundwater to outcrop in a deflation hollow that developed during an earlier episode of deeper groundwater tables. Drift sands that are subsequently caught in a body of standing water or on a saturated surface are expected

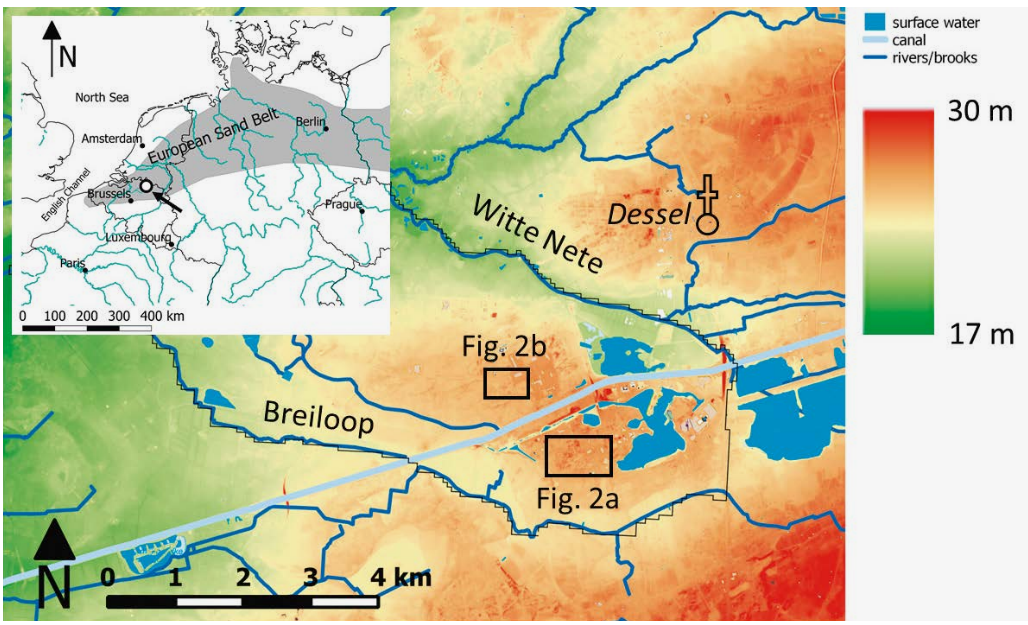


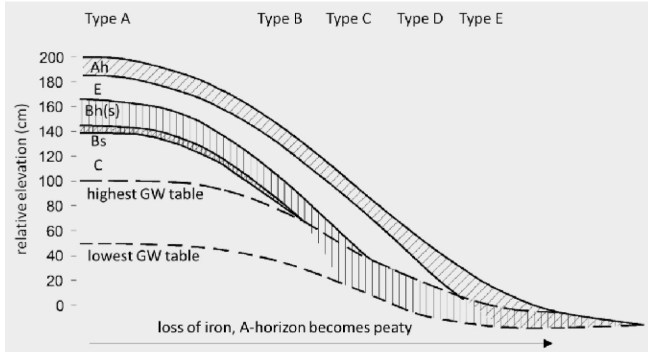
Figure 1. Location of the study area. See Figure 2 for a detailed DTM of the area covered by the two rectangles (AGIV, 2006).

to exhibit distinct sedimentological features compared to their purely aeolian counterparts. Beyond doubt, such sequences, if studied in sufficient detail, may evolve into valuable palaeohydrological archives. Therefore, the aim of this paper is to explore the concept of drift sand-Podzol hydrosequences in the Mol-Dessel area (NE Belgium), based on earlier work in the region (Beerten et al., 2012 and 2014; Beerten and Leterme, 2015) and new field observations (exposures and hand augerings) in view of their palaeohydrological significance.

2. Materials and methods

During the past few years, temporary exposures became available on the interfluve that is bordered by the Breiloop in the south and the Witte Nete and Kleine Nete in the north (Figure 1 and Figure 2). The exposures typically display soil-sediment profiles consisting of a (partially eroded) Podzol buried underneath drift sand deposits. Two soil profiles were previously investigated in detail and serve as the basis for the current work. Profile BP (Figure 2b) was studied in Beerten et al. (2012) and profile GKD (Figure 2a) was studied in Beerten et al. (2014). Additionally, the following characteristics of the newly observed profiles were described in detail: soil colour (Munsell Soil Color Book, 2009), soil horizon morphology, and macroscopic sedimentology. Furthermore, hand augerings were done in the vicinity of profile GKD, in order to map the pre-drift sand landscape (see Figure 2a). Podzol soil morphology was interpreted in terms of (palaeo)hydrological conditions using the concepts developed by Buurman (1984), Buurman and Jongmans (2005), and applied in, e.g. Buurman et al. (2013) and Martinez et al. (2018). The concept is visualized in Figure 3 and summarized in Table 1. Well-drained Podzols, in which the groundwater table never reaches the B-horizon, retain Fe in the profile and usually show clear horizon differentiation (hydrosequence type A). The E-B transition is clear and wavy. A typical feature in these Podzols is the presence of thin bands of organic matter near the transition from the B- to C-horizon. Moderately drained Podzols, in which the groundwater table occasionally would reach the B-horizon, usually show a clear differentiation in horizons and the presence of iron concretions and/or mottles in the B-horizon (type B). Poorly drained Podzols, in which the B-horizon is permanently saturated by groundwater, usually are depleted in Fe and show vague horizon differentiation (type C). The E-horizon in particular becomes very thin (type D) and even disappears (type E) when the groundwater table becomes shallower.

Figure 3. The concept of a Podzol hydrosequence in a slightly undulating landscape (modified from Buurman (1984)). Podzol hydrosequence types A-E are explained in the text.



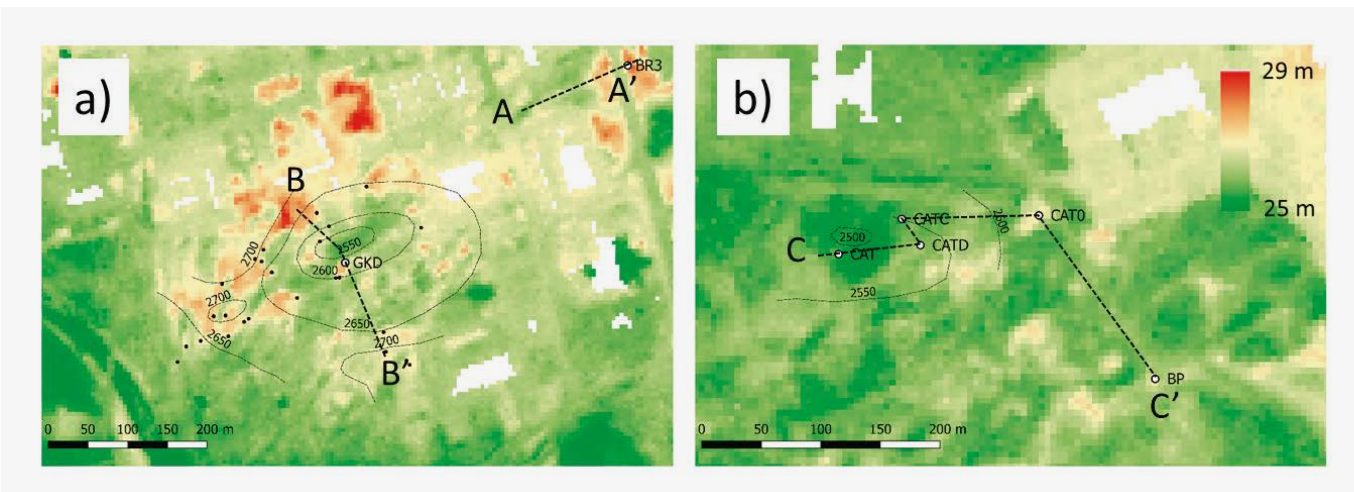


Figure 2. DTM of the study area. Thin black lines are isolines representative of the top of the Podzol soil (i.e. the top of the A-horizon). Numbers give the altitude of the top of the Podzol in cm a.s.l. (TAW). (a) See Figure 7a and b for cross-sections A-A' and B-B'. Black dots indicate hand augering locations. (b) See Figure 7c for cross-section C-C'.

Table 1 Diagnostic criteria to determine the position of the groundwater table with respect to the contemporaneously formed Podzol soil

Podzol morphology	Well-drained (I)	Moderately drained (II)	Poorly drained (III)
Fe distribution	Mottles of Fe oxyhydrates or no Fe in C horizon	Fe concretions/mottles in lower B horizon	Depleted in Fe
B horizon colour and morphology	Thin, black, wavy and well-pronounced with thin humus bands in BC-horizon	Black to dark-brown (sometimes with humus bands)	Less pronounced and black or brownish
E horizon morphology	Thickness depends on time, parent material and speed	Thickness and depth limited by GW table; may be thick	May still be present, usually very thin
E-B transition	Clear and wavy	May still be clear	Diffuse (vertical water movement) to abrupt (lateral water movement)

(based on Buurman et al., 2013). I = GW table permanently saturates C-horizon. II = GW table sporadically saturates B-horizon. III = GW table regularly saturates B- and E-horizon.

Drift sand depositional facies were interpreted using diagnostic criteria to distinguish structures that are produced by aeolian deposition in a dry environment, on a wet (saturated) surface, and/or in standing water (Schwan, 1991; van Huissteden et al., 2001; Koster, 2009; Brookfield and Silvestro, 2010; Van Loon and Pisarska-Jamroży, 2014). In this work, four different facies are distinguished. Facies 1 is an aeolian sand sheet facies and consists of homogeneous massive drift sand deposited in dry conditions from grain fallout. Facies 2 is also an aeolian sand sheet facies, but there is a slight alternation in grain size between cm-dm thick laminae, mainly deposited in dry conditions or a damp surface from grain fallout. Facies 3 is similar to facies 2, but the cm thick laminae contain more organic material as a result of slightly wetter conditions. Finally, facies 4 consists of finely and irregularly laminated sand with traces of wavy and flaserlike bedding, which suggests deposition in a shallow pool.

3. Results and discussion

3.1. DESCRIPTION OF THE INDIVIDUAL SOIL-SEDIMENT PROFILES

The location of the studied profiles is shown in Figure 2 and their main characteristics are summarized in Table 2 and Table 3. Based on colour characteristics, soil-sediment profile BR3 (Figure 4a, green bar) shows a clear differentiation in Ah-, E-, Bh- and Bs-horizons (see Figure 3). The B-horizon is relatively loose and thin humus bands are present in the BC-horizon. It is interpreted as hydrosequence type A. The overlying drift sands (yellow bar) are organised in thick laminae of slightly alternating grain size (facies 2) and are interpreted as grainfall laminae resulting from sustained wind gusts (Brookfield and Silvestro, 2010). They are covered by massive and homogeneous windblown sands which may also be the result of sustained wind patterns (facies 1). The granulometric differentiation in the laminae (facies 2) is very weak, and only accounts for a 5-10% change in grain size, the darker horizons being slightly finer and containing a very small amount of organic carbon. These may reflect very short periods of landscape stabilisation and vegetation development in otherwise dry conditions and/or the final phase of an individual aeolian event (Beerten et al., 2012).

Soil-sediment profile GKD (Figure 4b and c) is a complex profile that shows a clear differentiation in Ah-, E-, Bh- and Bs-horizons. The Bh-horizon is directly underlain by an iron pan, which reflects stagnant conditions above the Bh-horizon. According to De Coninck (1980) this Podzol can be classified as a Placic Podzol. The Fe-content underneath this iron pan is still relatively high, such that it can be qualified as a Bs-horizon (Beerten et al., 2014). Below the Bs-horizon is a C-horizon with abundant oximorphic mottles but without thin humus bands. As these mottles may reflect temporary saturation of the C-horizon, up to the transition to the B-horizon, this soil is interpreted as soil type B (Figure 3). As can be seen in Figure 4b on the left side, the soil is eroded, presumably by aeolian deflation (Beerten et al., 2014). The erosional surface and the Podzol are covered by drift sand facies 1 and 2.

The next profile, BP (Figure 4d), again shows an eroded Podzol. In this Podzol, horizon differentiation is slightly less well expressed, and the typical colour of iron (as observed for BR3 and GKD) is lacking in the profile. The B-horizon is cemented and poorly developed humus bands are present. This Podzol marks the transition from a moderately drained soil to a poorly drained soil (soil type C; Figure 3). The overlying drift sands are again organised in thick laminae of slightly alternating grain size (facies 2) and become massive and homogeneous towards the top (facies 1).

Table 2 Summary of field observations for the various profiles

Profile	Altitude (m a.s.l.)	Alt. of podzol top (m a.s.l.)	Drift sands				A-horizon		E-horizon			Bh(s)-horizon		Bs-horizon		C-horizon	Type
			Thickness (cm)	Type	Colour (facies 1 and 2)	Colour (facies 3)	Thickness (cm)	Colour	Thickness (cm)	Colour	E-B transition	Thickness (cm)	Colour	Thickness (cm)	Colour	Colour	
BR3	28.1	27.5	60	1 and 2	7.5YR8/1 5Y6/1	n/a	5-10	5B4/1	10	N9-N10	Clear	5	N0-N2	5-10	7.5YR4/6	10YR7/2	A
GKD	27.7- 27.3	26.7	60-100	1 and 2	10YR8/1 10YR7/1	n/a	5-10	10BG2/1	10-15	5BG8/1	Rather clear	5-10	N4	>5	10Y8/1 7.5YR5/2	10YR8/1 10YR7/8	B
BP	27.0	25.7	130	1 and 2	10YR8/1 5Y6/1	n/a	Eroded	n/a	>10	5B6/1	Rather vague	5-10	10B3/1	0	n/a	10YR6/7	C
CAT0	26.8- 26.7	26.3	40-50	2	10YR8/1 5YR8/1	n/a	5-10	10BG6/1	10	N9-N10	Very clear	5-10	N0-N2	>10	10YR3/3	10YR7/4	A
CATC	25.6	25.6	0	n/a	n/a	n/a	5	10BG4/1	15	N9-N10	Rather clear	10-15	N0-N2	5-20	10YR5/4 10YR7/6	n/d	B
CATD	26.2	25.4	80	1, 2, 3 and 4	10YR7/1	10GY8/1	5	N0-N1	5-10	10B7/1 5BG6/1	Rather vague	>10	N0-N2	?	n/a	n/a	D
CAT	25.7- 25.2	25.1	10-60	2 and 4	10YR8/1 10YR7/1	10G8/1 10YR8/1 N5	0-5	10B2/1	0-5	10B8/1	Vague	10 upper (h) 15 lower (hs)	5PB2/1 (h) 5YR5/1 (hs)	0	n/a	7.5YR3/2	E

Altitude of the terrain (m a.s.l. *Tweede Algemene Waterpassing*), altitude of the top of the Podzol soil, drift sand thickness, colour and facies (facies 1, 2, 3 or 4), thickness and colour of the Ah-, E-, Bh(s) and Bs-horizons, and hydrosequence type (A-E) are given. n/a = not applicable. n/d = not determined.

Table 3 Summary of field observations

Profile	Alt. of podzol top (m a.s.l.)	Bh-horizon	Humus bands in BC-horizon	Type
BR3	27.5	Weakly cemented	Yes	A
GKD	26.7	Cemented with placic horizon	No	B
BP	25.7	Cemented	Yes	C
CAT0	26.3	Weakly cemented	Yes	A
CATC	25.6	Cemented	No	B
CATD	25.4	Cemented	n/a	D
CAT	25.1	Cemented	Yes	E

Bh-horizon characteristics (according to De Coninck (1980)) and presence or absence humus bands. n/a = not applicable.

Profile CAT0 (Figure 5a) shows a soil with clear horizon differentiation, similar to profile BR3, and is covered by drift sand facies 2. The B-horizon is weakly cemented and there is some accumulation of organic matter in thin humus bands below the B-horizon. The soil is interpreted as belonging to type A. The next profile, CATC (Figure 5b), again shows a soil with clear horizon differentiation. The Bs-horizon is well developed, but thin humus bands are absent. This soil is interpreted as belonging to type B, towards the well drained end-member of the hydrosequence (Figure 3).

Profile CATD (Figure 5c and d) is very different from the previous profiles, both in terms of soil development and drift sand characteristics. Though the C-horizon of the profile could not be observed, it is clear that horizon differentiation in this soil is less well developed. The E-horizon is vaguely defined and shows a vague transition towards the B-horizon underneath. This soil is interpreted as a Podzol with features that typically belong to the poorly drained end-member of the full hydrosequence, type B (Figure 3). The drift sands that overlay the Podzol are very different from what can be observed on top of well drained Podzols. Near the bottom they are organised in very thin laminae (several mm thick) of contrasting grain size (facies 4; Figure 5d). White laminae consist of sand, while the amount of fines and organic matter increases when the colour darkens. The laminae are irregular, i.e. cannot be followed over a large lateral distance and sometimes show wavy bedding (white arrows in Figure 5d) and flaserlike features (black arrows in Figure 5d). Wavy bedding is thought to be the result of waves acting upon the surface of stagnant water. Similarly, flaserlike features develop when slightly finer material fills in shallow troughs that result from weak wave action. The thin irregular laminae may reflect very short wind gusts (Brookfield and Silvestro, 2010) from which the resulting sedimentological product (a thin lamina) would have been blown away during the next event unless it is protected by a wet surface and/or a shallow column of standing water. The laminae are slightly better expressed towards the top and then alternate with mm-cm thick dark layers enriched in organic matter. This layer of drift sand is overlain by drift sands that are interpreted as belonging to facies 3. They mark the transition from the top of facies 4 to facies 2, as the laminae become thicker and the amount of organic matter declines. The top of the profile consists of drift sand facies 1. The full drift sand accumulation can be interpreted as a drying-upward sequence in which the

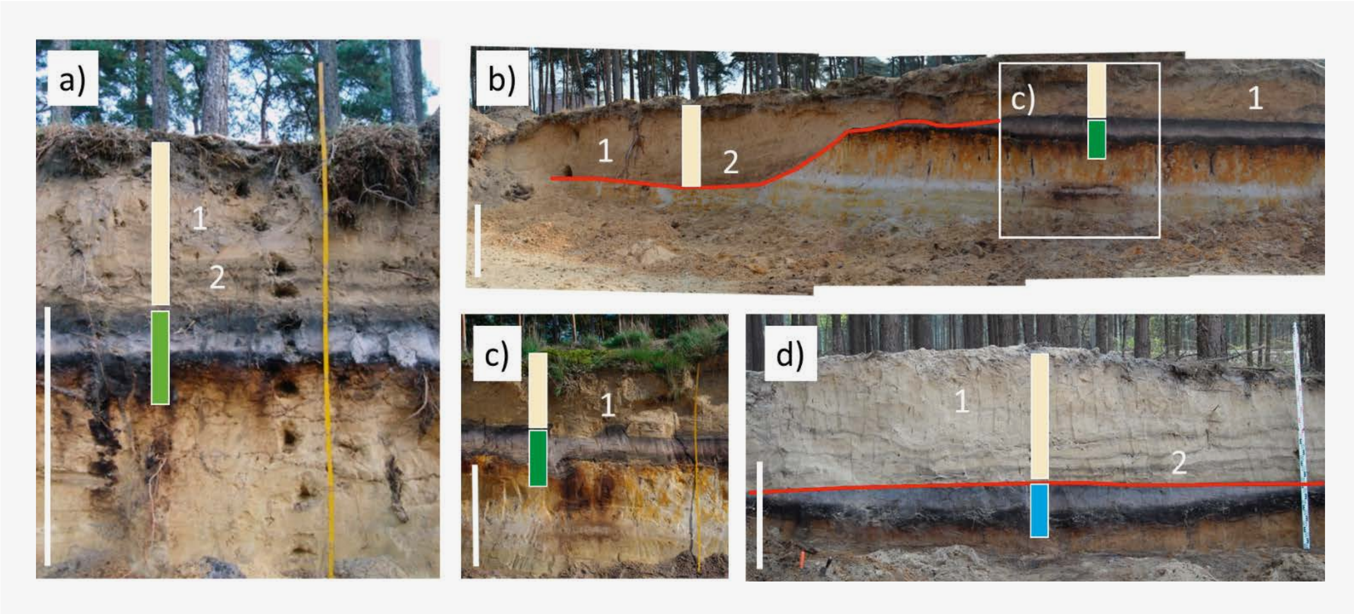


Figure 4. (a) Soil-sediment profile BR3. (b) Soil-sediment profile GKD. (c) Detail of the image shown in Figure 4b. (d) Soil-sediment profile BP. Vertical line = 50 cm. See Figure 7 for colour legend. Green and blue bars refer to the Podzol hydrosequence type, the yellow bars indicate the overlaying drift sands. Red line shows the position of the deflation horizon. Numbers denote the drift sand facies (1 and 2).

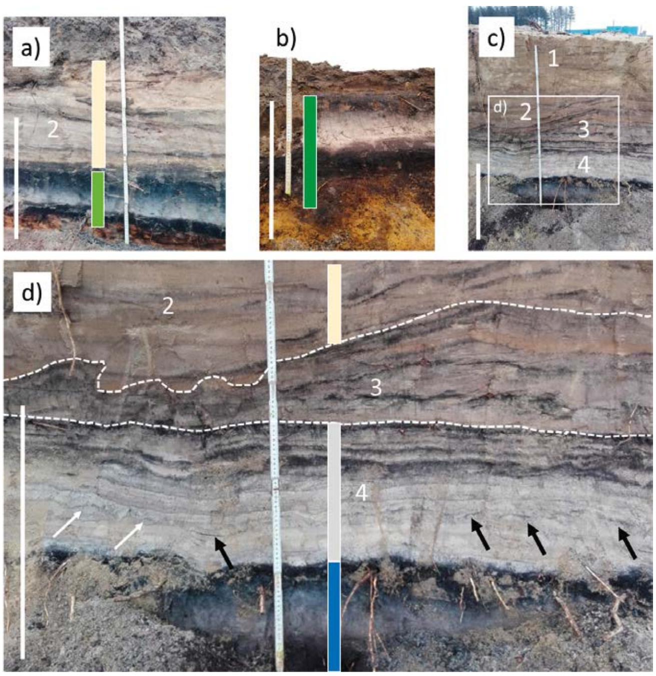


Figure 5. (a) Soil-sediment profile CAT0. (b) Soil-sediment profile CATC. (c) Soil-sediment profile CATD. (d) Detail of the image shown in Figure 5c; wavy bedding is indicated by white arrows and flaser structures are indicated by black arrows. Vertical line = 50 cm. See Figure 7 for colour legend. Green and blue bars refer to the Podzol hydrosequence type, the yellow and grey bars indicate the overlaying drift sands. Numbers denote the drift sand facies (1, 2, 3 and 4).

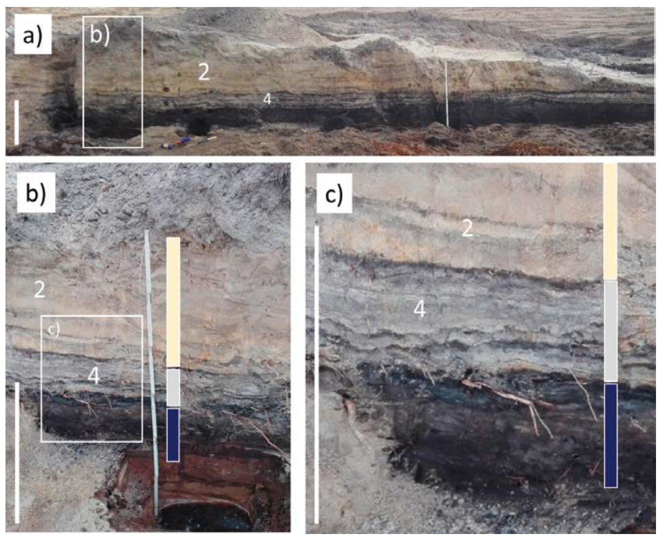


Figure 6. (a) Soil-sediment profile CAT. (b) Detail of the image shown in Figure 6a. (c) Detail of the image shown in Figure 6b; note the wavy lamination in drift sand facies 3. Vertical line = 50 cm. See Figure 7 for colour legend. Blue bars refer to the Podzol hydro-sequence type, the yellow and grey bars indicate the overlaying drift sands. Numbers denote the drift sand facies (2 and 4).

build-up of the groundwater table could not keep pace with the accumulation of drift sand. Profile CAT (Figure 6) shows similar features as the previous one (CATD). Podzol horizon differentiation is even less well expressed, with a peaty A-horizon, a very vague E-horizon and a cemented B-horizon (Figure 6a, b and c). The soil is interpreted as belonging to type E. There is some accumulation of organic matter in thin humus bands in the Bhs-horizon. The palaeosoil is overlain by drift sand facies 4 and 2, similar to profile CATD.

3.2. PODZOL MORPHOLOGY, AEOLIAN DEFLATION AND DRIFT SAND CHARACTERISTICS IN RELATION TO THE PALAEOGROUNDWATER TABLE

Whereas there might be some uncertainty regarding the interpretation of the individual soil-sediment profiles, their relative elevation and their absolute position in the landscape strongly suggest they are genetically related with respect to a first-order long-term groundwater table elevation.

Profile BR3 is schematically positioned in a topographical cross-section in Figure 7a (see Figure 2a for the location of the cross-section). As there were no indications of groundwater table features in this particular soil-sediment profile (hydrosequence type A and drift sand facies 1 and 2), the groundwater table must have been far below the soil forming depth during soil formation and subsequent drift sand deposition, as tentatively illustrated by the sine-wave in Figure 7a. The sine-wave is meant to illustrate the variation of the average highest groundwater table in a given timeframe.

Next, Figure 7b shows the position of soil-sediment profile GKD (see Figure 2b for the location of the cross-section). Here, the position of the groundwater table is assumed to have been permanently below the deflation horizon. Prior to the formation of the latter, the groundwater table may have reached the B-horizon during some episodes (hydrosequence type B). The top of the Podzol soil as reconstructed from hand drillings (see also Figure 2b) gives an indication of the palaeotopography prior to aeolian deflation and sand drifting. Apparently the

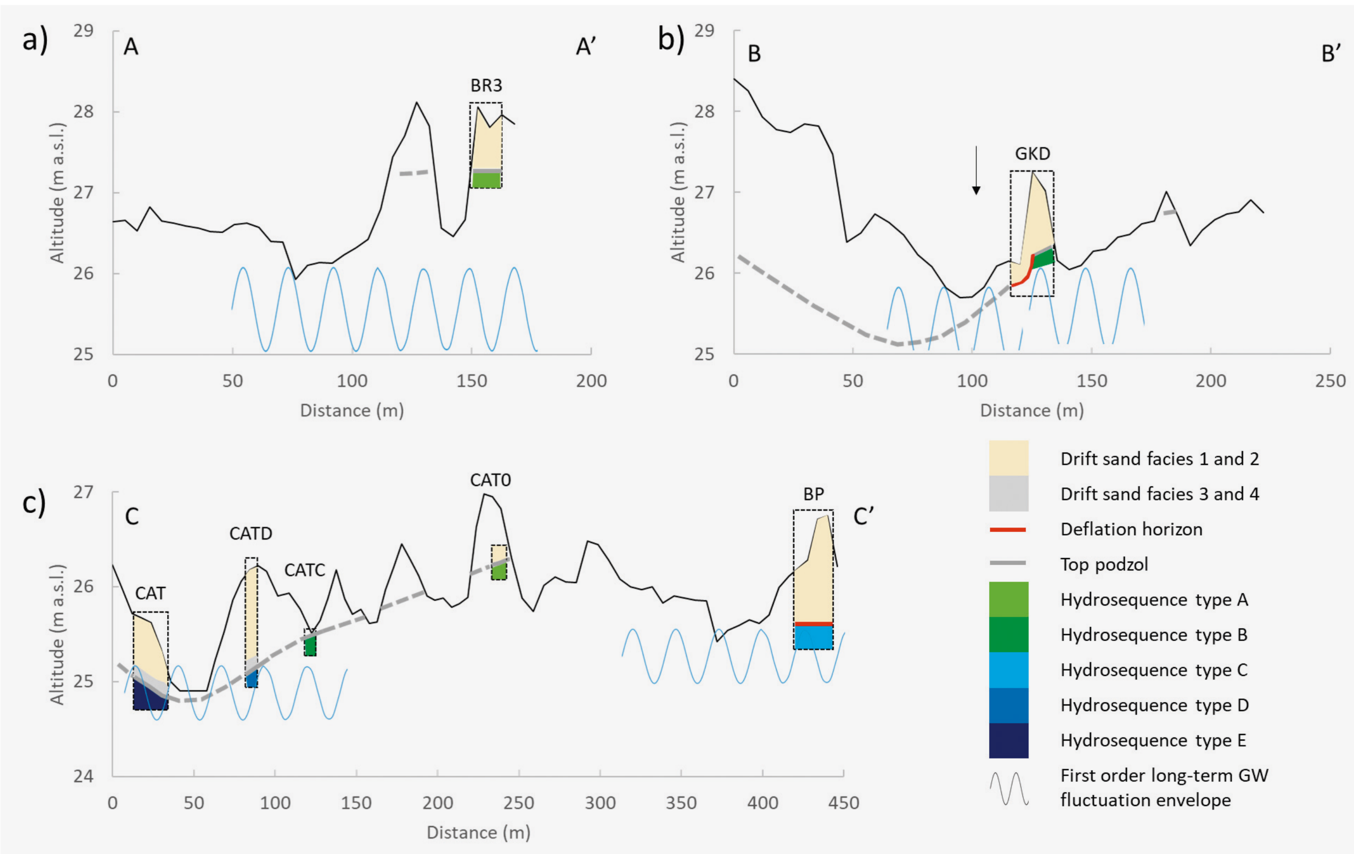


Figure 7. Topographical cross-sections showing the position and interpretation of the studied soil-sediment profiles. (a) Soil-sediment profile BR3. (b) Soil-sediment profile GKD. (c) Soil sediment sequence CAT-CAT0-CATD-CATC-CAT. The sine-wave is meant to illustrate the anticipated variation over longer time periods (decennia, centuries) of the average highest groundwater table around the time of podzolization and drift sand deposition.

area used to be a depression before it partially became overblown by aeolian drift sand. The erosional feature as observed in soil-sediment profile GKD may be related to the existence of a road track which is indicated on the Ferraris map (see arrow in Figure 7b). Possibly, the road track used to run through the center of the depression which became too wet so that the road was shifted laterally towards more drier ground. Note that hoofprints were observed in the basis of the drift sand that overlays the eroded soil (facies 2 in Figure 4b; Beerten et al., 2014). In a previous study, the erosional phase was determined to have taken place around AD 1500-1600 (based on optically stimulated luminescence dating of the drift sands; Beerten et al., 2014), while sand drifting continued until ca. AD 1800. This implies that the inferred groundwater table position for this sequence is valid for at least the period around AD 1500.

The deflation horizon observed in soil-sediment profile BP (Figure 7c) was estimated to have been formed around AD 1500 (Beerten et al., 2012), while drift sands were deposited until ca. AD 1700-1800. The drift sands, belonging to facies 2 and 1, all seem to have been deposited in dry conditions, yet the soil shows some features that may relate to a periodically elevated groundwater table (hydrosequence type C). This leads to a tentative groundwater table reconstruction as illustrated in Figure 7c, which is valid for the period around ca. AD 1500, and a period of unknown duration prior to this age window (since the soil must have been formed prior to deflation and sand drifting).

From profile BP the link can be made to nearby profiles CAT0, CATC, CATD and CAT, which at first sight seem to be toposequences, but in fact can be interpreted as hydrosequences (Figure 7c). Profile CATo shows a well-drained Podzol (type A) overlain by drift sand facies 2 and interpreted to have been formed well above the groundwater table. Profile CATC, without drift sand, shows a Podzol which may have been sporadically influenced by groundwater. Profile CATD shows a Podzol hydrosequence type D that was developed while the groundwater table was very close to the surface, yet sufficiently deep to allow for podzolization. From the drift sand characteristics it can be inferred that the groundwater table was still very shallow (and sporadically even outcropping) during deposition of the latter (see indications of standing water in Figure 5d). Finally, the Podzol from profile CAT developed under similar conditions, with a very shallow contemporaneous groundwater table (since the E-horizon is almost completely absent). The drift sands show similar characteristics to the ones from profile CATD and are deposited in very wet conditions and/or standing water.

It is important to note that some soil profiles bear traces which point to polygenetic development. For example, the thin humus bands in profile CAT suggest different drainage conditions than the E-horizon morphology and drift sand facies do. Similarly, drainage conditions for profile GKD would have been different during development of the oximorphic features in the C-horizon than those during development of the deflation horizon. Again, these polygenetic conditions are captured by the fluctuating average highest palaeogroundwater table in Figure 7.

The poorly drained Podzol hydrosequence in profiles CAT and CATD suggests that during its formation the groundwater table was episodically very shallow. It can reasonably be assumed that during some periods groundwater was outcropping. This tentative interpretation is supported by the drift sand characteristics (facies 4). Even though this interpretation might be straightforward, a standing water column can also be the result of extreme precipitation events and/or the presence of an impermeable horizon in the shallow subsoil. In particular, cemented B-horizons may develop into an impermeable barrier capable of supporting a perched water table. In such conditions an iron pan would develop, as is the case for profile GKD (Figure 4b). However, if the B-C horizon transition is saturated, iron cannot precipitate in the form of a pan. The absence of an iron pan in hydrosequences CAT and CATD indeed demonstrates that the groundwater table was very shallow during their development. Alternatively, extreme precipitation may cause the depression to fill up with water for a very short time, even without a hydraulic barrier in the shallow subsoil. In such case, the observed drift sand features of facies 4 reflect frequent heavy precipitation events rather than outcropping groundwater.

In the absence of age control for the drift sands deposited in profiles CAT0, CATD and CAT, it is assumed for now that they were deposited in approximately the same time period as those observed in profiles GKD and BP. As such, the hydrosequence would reflect the average highest groundwater table conditions for the period around AD 1500 and a period of unknown duration prior to this time window (since the soil must have been formed prior to drift sand deposition).

In an earlier study, an attempt was made to reconstruct the groundwater table in the study area using a combination of Digital Terrain Models (DTM's), historical maps and 20th century soil maps (Beerten and Leterme, 2015). In that study, the DTM of the area was carefully inspected and preserved deflation hollows were mapped, assuming that they all belong to the same deflation period (around AD 1500). For the areas depicted in Figure 2 this resulted in an estimated maximum palaeogroundwater table elevation of ca. 25-26 m a.s.l. (TAW). This value seems to be in accordance with the estimated palaeogroundwater table based on drift sand characteristics and Podzol soil morphology outlined above. The present-day average highest groundwater table is ca. 24.5 m a.s.l. (Rogiers et al., 2016) and seems to be slightly lower than the palaeogroundwater table around AD 1500, even if we allow for some uncertainty in the interpretation, as suggested by the sine-wave in Figure 7.

4. Conclusions

In this study the use of drift sand-Podzol hydrosequences was explored in terms of their palaeohydrological significance for an interfluval area in the Mol-Dessel area, NE Belgium. It shows that drift sand characteristics covary with Podzol soil morphology along a topographical gradient. Together they seem to constitute a hydrosequence in the investigated area and as such are a promising palaeohydrological archive. However, at present there are still some issues that need to be resolved. Firstly, a more detailed soil-sediment analysis is needed (geochemistry, granulometry) in order to e.g. quantify the Fe- and C-concentrations of the various horizons, exactly determine the depth of the E-horizon in profile CAT, and verify the genetic interpretation of drift sand facies 4. Additionally, the palaeohydrological interpretation of the sequences would certainly benefit from palaeobotanical analysis (macrobotanical and pollen analysis) since the presence of certain species may be indicative of shallow eutrophic standing water. Finally, more age control for the various horizons and sediment facies would be welcome in order to confirm or refine the existing age model that is currently applied in the region.

Acknowledgments

Laurent Wouters (ONDRAF/NIRAS) is thanked for arranging access to the profiles north of the canal Bocholt-Herentals.

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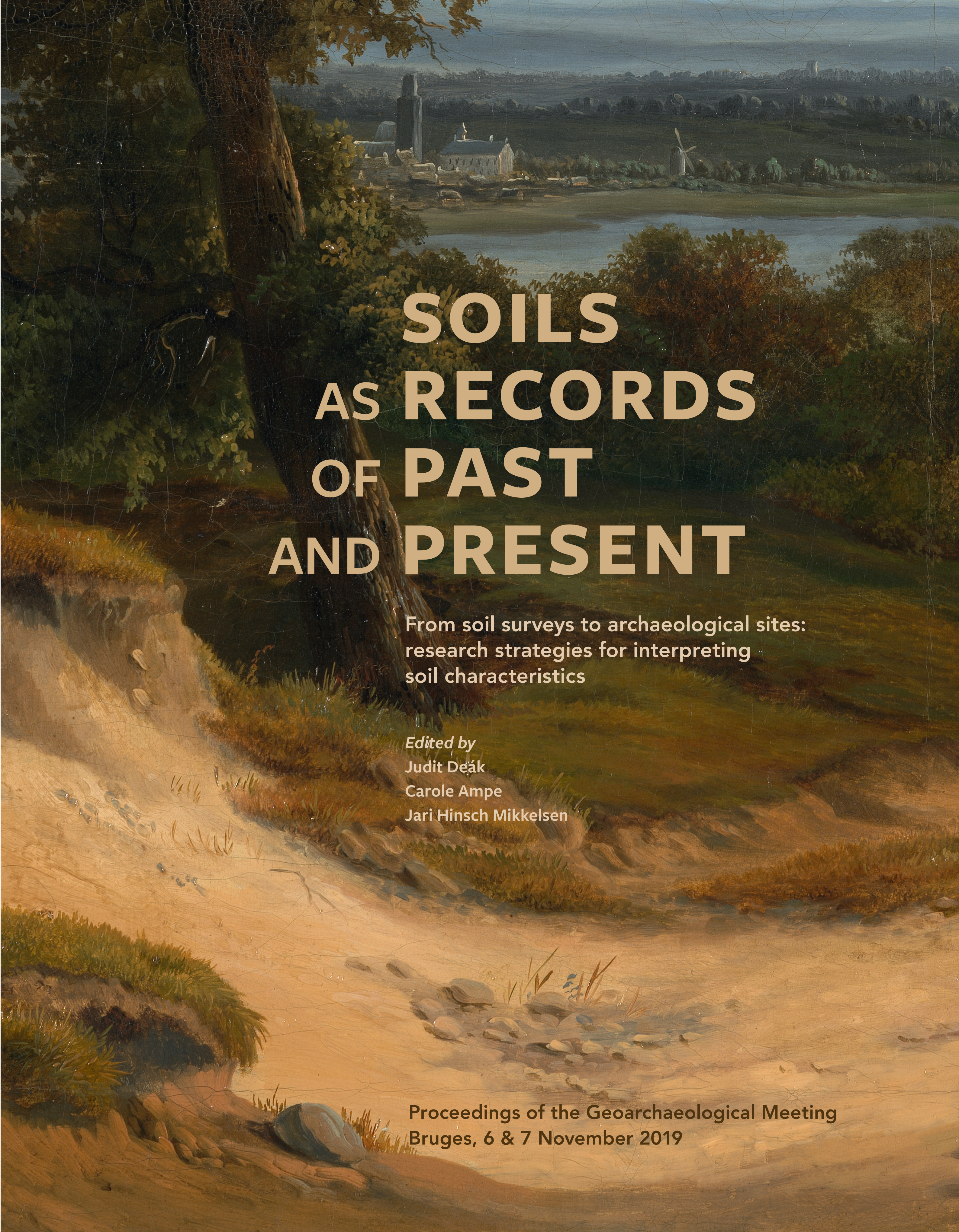

SOILS AS RECORDS OF PAST AND PRESENT

From soil surveys to archaeological sites: research strategies for interpreting soil characteristics

Edited by
Judit Deák
Carole Ampe
Jari Hinsch Mikkelsen

Proceedings of the Geoarchaeological Meeting
Bruges, 6 & 7 November 2019

This book is published on the occasion of the Geoarchaeological Meeting:

Soils as records of Past and Present.
From soil surveys to archaeological sites: research strategies for interpreting soil characteristics

on 6 & 7 November 2019 in Bruges, Belgium.

Editors
Judit Deák, Carole Ampe and Jari Hinsch Mikkelsen

Technical editor
Mariebelle Deceuninck

English language reviewer
Caroline Landsheere

Graphic design
Frederick Moyaert

Printing & binding
Die Keure, Bruges

Publisher
Raakvlak
Archaeology, Monuments and Landscapes of Bruges and Hinterland, Belgium
www.raakvlak.be

Citation recommendation
Judit Deák, Carole Ampe, and Jari Hinsch Mikkelsen (Eds.). Soils as records of past and Present. From soil surveys to archaeological sites: research strategies for interpreting soil characteristics. Proceedings of the Geoarchaeological Meeting Bruges (Belgium), 6 & 7 November, 2019. Raakvlak, Bruges.
ISBN 978 90 76297 811
Doi: http://10.5281/zenodo.3420213

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www.CH-QUAT.ch
Swiss society for Quaternary research

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RÉPUBLIQUE ET CANTON DE NEUCHÂTEL
DÉPARTEMENT DE LA JUSTICE,
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