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The brown gold: a reappraisal of medieval peat marshes in Northern Flanders (Belgium)

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Abstract Although the importance of peat as energy supplier in the medieval and early modern North Sea Area is well known, the location, extent and nature of the peat-producing areas—peat marshes or mires—remains amongst the major problems in the landscape history of the coastal wetlands. This is especially true for areas like Northern Flanders, where peat marshes have since completely disappeared. This article reconsiders the 'peat debate' between geoscientists, who rely on 'positive' soil evidence, and historians, who accept 'circumstantial' historical data so as to reconstruct former peat marshes. Based on a systematic comparison of the arguments of both geoscientists and historians, we argue that recent methodological advances, such as integration of historical and geophysical data in a GIS, allow for bridging the gap between the two approaches and to reconcile contrasting opinions on historical peat marshes. This is tested in a case study for two villages—Moerbeke and Wachtebeke—in Northern Flanders, where re-evaluation of both geophysical features (soil, elevation models, hydrology) and archaeological and historical data (maps, documentary evidence on landed property and peat extraction and toponyms) leads to a completely new model for the presence of (Holocene) peat marshes.

Keywords Flanders · Middle ages · Peat · Drainage · Energy · Landscape change

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Abbreviation

ARA Brussels, Algemeen Rijksarchief
RAG Ghent, Rijksarchief
RAB Beveren, Rijksarchief
SA Antwerp, City Archives

Introduction: Peat: fuelling medieval economic growth

Wood was the most important energy supplier in Europe before the Industrial Revolution, but it was not the only one. Some of the most spectacular episodes of demographic and economic growth before 1800 were fuelled not by wood but by another supplier of energy: peat. Peat is formed in freshwater marshes or mires when plant remains are inhibited from fully decaying in very wet, acidic and anaerobic conditions (Borger 1992). As is well known, peat was the most important source of energy during the boom of the Dutch economy in the 17th century (Cornelisse 2006; Unger 1984). However, it was already the predominant source of fuel for many Flemish and Brabantine urban economies in the 14th and 15th centuries. In the later Middle ages, Flanders and Brabant belonged to the most densely populated and urbanized regions of Europe; these regions were surpassed only by Northern Italy in regards to urbanisation ratios. With populations of 50,000 or more the Flemish industrial and commercial centres of Bruges, Ghent and Ypres greatly exceeded the energy demand that could be supplied by regional wood provisioning. By the 13th century, most Flemish forests had become degraded due to clearance and excessive grazing; the remaining parts were mainly preserved as hunting reserves (Verhulst 1995, pp. 104–117; Verheyen et al. 1999). Consequently, significant urban growth could only be fuelled through peat. This was the case for the Brabantine city of Antwerp, which had expanded from about 20,000 inhabitants around 1,400 to more than 100,000 in 1568. In the 1550s, Antwerp's peat-dependency was clearly demonstrated when towns in the neighbouring county of Holland implemented an export ban on peat, thereby inflating prices on the Antwerp market from about 120 Brabantine *groten* per *last* of peat (1 last equalling 10,000 blocks) in 1550 to about 400 by 1559 (Soly 1977, p. 261). The regional origins of these huge peat importations have long puzzled economic historians and historical geographers. During the 16th century, peat for Flemish and Brabantine towns was mainly imported from the Northern Low Countries: around 1570 about 1.15 million tons of peat were exported every year through the ports of Gouda and Rotterdam in Holland (Diepeveen 1950, p. 134; Cornelisse 2006, p. 104). Further east of the Low Countries, the provinces of Utrecht, Gueldres and Overijssel, also became major peat-producing and exporting regions (Gerding 1995). Before 1500, the situation had been quite different, as the energy demand of the Flemish and Brabantine towns was still largely met by inland peat production. Until the 15th century, Flemish and Brabantine peat was even exported to Holland, with Delft being a main market (Cornelisse 2006, p. 104).

This inland peat production remains highly enigmatic, especially for Flanders. As no important peat marshes (mires) subsist in coastal Flanders today, the location, extent and nature of the medieval peatlands, as well as the chronology of peat exploitation, remain highly uncertain. Since the 1950s two contrasting narratives about historic peat marshes have been developed by historians and geoscientists, respectively, each field using different methodologies and holding different opinions about what can be labelled scientific

evidence. Geoscientists have doubted the historical presence of peat in places where it has not been positively confirmed by soil samples. Historians, however, have accepted circumstantial evidence like place names or written data about peat extraction as corroboration of historical peat extraction (Soens and Thoen 2009).

In this article, we seek to re-open the question of medieval Flemish peat production through a cross-disciplinary confrontation of both the historical and natural evidence for peat marshes and peat exploitation in medieval Flanders. Historians have often ignored the physical and environmental constraints of peat growth, leading to inaccurate spatial identifications of former peat marshes. Geoscientists have underestimated the potential for systematic landscape transformation deployed by medieval society. Peatlands are extremely fragile eco-systems and even very moderate human interference can cause rapid distortion and radical transformation (Van Dam 2001). Today, new data and methodological advances in history and geosciences allow for locating disappeared medieval peatlands at the micro level. Via combining quantitative data on peat extraction, place names, field systems, land transactions, elevation records and soil samples into a Geographical Information System, large-scale medieval peat exploitations can be attributed to places where present-day hydrology would no longer allow for substantial peat growth. As we will argue, this environmental change can be attributed to highly intensive medieval exploitation and profound changes in local hydrology. In doing so we hope to shed new light not only on the energy supply of late medieval Flanders but also on the landscape and water history of the medieval peat marshes of the North Sea Area.

Holocene peat growth in coastal Flanders

In the coastal wetlands surrounding the North Sea, the formation of peatlands started around 6000 BP, when the period of rapidly rising sea-levels after the end of the last glacial period came to a close and coastal barriers could develop. Although peat formation was possible in the absence of protection by coastal barriers, conditions for peat growth became most favourable behind such barriers; such formations often continued for thousands of years and could result in accumulation of several metres of peat, depending on local hydrological conditions. The end of coastal peat growth appears to have been highly variable from place to place. This is difficult to determine, as the top levels of the peat have usually been removed or were reworked in later periods. From the late Iron Age onwards (first centuries BC), the peat growth gradually slowed or stopped. The coastal barrier was breached at several locations and sand and clay were deposited atop the peat (Baeteman 2008; Baeteman and Declercq 2002; Long et al. 2006). Consequently, peat growth stopped in the immediate surroundings of the coastal barriers, whereas in parts of the coastal peat marsh that were further inland peat growth could continue for centuries. In this process, natural causes of renewed marine influence interfered with human activity. After an initial phase of extensive use of the peat marshes (for hunting, fishing and grazing), drainage ditches were dug to enable arable farming (usually rye) or to extract peat for fuel or salt production. This blocked further peat growth and the drained top levels of the peat became prone to oxidation and subsidence, thereby introducing a lowering of the soil level, increased flood problems, exposure to sea influence and finally deposits of marine clay and sand sediment (Borger 1992). Only local and relative chronologies can be established: in some coastal peat marshes there is clear evidence for permanent human occupation involving peat extraction, salt making and/or arable farming dating from the Roman or even pre-Roman period, whereas in other regions such activities only happened after 1000

AD (Rippon 2000). Disappearance of the topsoil of the peat negatively affects geological and archaeological evidence: extraction or reworking of the peat can severely disturb or eliminate human artefacts.

In the present-day landscape of coastal Flanders, no important peat marshes remain in existence. However, layers of Holocene peat are present in the subsoil, although their spatial distribution is highly unequal. Based on a survey of existing literature, Deforce et al. (2007, p. 91) show concentrations of subfossil oligotrophic peat in the west of the coastal plain (parallel with the North Sea shore) and in the *Waasland* Scheldt Polder Region, located to the northeast of Flanders, on the left bank of the Western Scheldt (Crombé 2005), as illustrated in Fig. 1.

Peat growth has been studied in detail for some of these regions, including Furnes (Baeteman 2008; Baeteman and Declercq 2002) and the *Waasland* Scheldt Polder Region (Crombé et al. 2005). In the latter region, recent construction of several docks for the harbour of Antwerp has revealed important layers of peat, covered by several metres of very recent marine clay and sand sediments deposited after the inundations of the Eighty Years' War (1568–1648). In one place, the peat layer still reached a thickness of 1.9 m, even though it had been covered by 2.7 m of clay and sand (Gelorini et al. 2006). The pre-inundation thickness must have been considerably higher, as the peat had not yet been compressed or affected by human activities. Peat growth in this region would have continued until at least the 6th century AD, as confirmed by radiocarbon dating of the top level of the peat (Van Strydonck 2005; Gelorini et al. 2006; Kiden 1989). Archaeological excavations at Verrebroek (Crombé et al. 2005) have revealed a late medieval field system enclosed by deep drainage ditches and numerous spade marks proving local agriculture atop the peat. In order to facilitate tillage, the peat top was intermixed with (local?) sand, which contained pollen from cereals (Deforce et al. 2005). Historical research into this region has revealed important late medieval peat exploitation on behalf of the count of Flanders, lord of the *seigniory* of Beveren. On their estates in this region, the Flemish counts realised annual production of about 8,000 *last* of peat—one *last* equalling 10,000 blocks of peat—around 1,300; this figure had declined to 4–5,000 *last* in the beginning of the 15th century (Augustyn 1999, pp. 84–85).

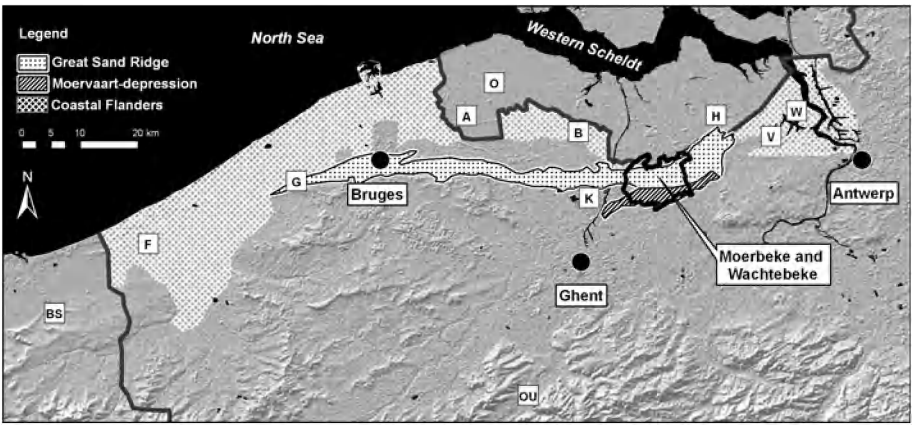

Fig. 1 Overview of Northern Flanders, indicating main landscape regions and places discussed in the text (*A* Aardenburg; *B* Boekhoute; *BS* Bergues-Saint-Winnoc; *F* Furnes; *G* Gistel; *H* Hulst; *K* Kluizen; *O* Oostburg; *OU* Oudenaarde; *V* Verrebroek; *W* Waasland Scheldt Polders) (map by I. Jongepier, based on elevation data, distributed by ESRI (2010))

This was probably one of the biggest peat exploitations of Flanders in the period, yet it would have been far from sufficient to fulfil the total Flemish peat demand. A modest household needed at least one *last* per year to meet its domestic fuel requirements; a rich bourgeois household, like that of *Simon Borluut* in mid-15th century Ghent, consumed 3 to 4 lasts of peat per year.[1] Even without taking into account industrial demand (for instance, from the energy-consuming brewing industries), the production on the count's *Waasland* estates would have been barely sufficient to fuel one mid-sized Flemish town. As a result, other peat production centres, and thus other peat marshes, must have also been exploited. Sub-fossil peat underneath clay soils is also present in most of the polder region along the Flemish North Sea coast, from the *Moëres*, near the present-day French-Belgium border, to the mouth of the Western Scheldt estuary, north of Bruges. However, most of this polder area had probably been covered by clay before 1000 AD and reclaimed and converted into arable or pasture land shortly afterwards. It is not impossible that at the inland edge of this area open peat marshes subsisted until the 12th century. For example, according to the oldest account of the counts of Flandres—the so called *Gros Brief* of 1187—the count extracted important monetary revenues of 'mor' near the towns of Gistel, Aardenburg and Oostburg (Verhulst and Gysseling 1962, pp. 171–172). At the end of the 12th century, the Cistercian Abbey Our Lady of the Dunes received permission to construct a building to guard the peat blocks that had been dug in the marshland 'desert' of the *Moëres* on what is now the French-Belgian border between Furnes and Bergues-Saint-Winnoc—"*ad custodiendas turvas quas in prefata fodi faciet solitudine*" (cited by Soens and Thoen 2009). However, by the late 13th century systematic peat extraction along the Flemish coast of the North Sea appears to have ceased. Historical data on peat extraction in 14th and 15th century Flanders repeatedly reference Northern Flanders, along the left bank of the Western Scheldt Estuary, where huge stocks of peat are mentioned. For example, at the end of the 13th century the monks of the Benedictine abbey of Saint Peter in Ghent declared that their *moorland* near Kalve (between Wachtebeke and Hulst in the north of Flanders) was sufficient to fuel a 'perpetual fire'—*sufficiens ad ignem perpetuo*.[2] Such sources might offer strong evidence that open peat marshes remained until the end of the Middle Ages. Unfortunately, they seldom mention where exactly the peat was dug, and to date seldom correspond with geophysical evidence.

Where were the mires of Northern Flanders? The mismatch between historical and geophysical data at the regional level

In trying to identify former peat marshes in Northern Flanders, historians, geographers, archaeologists and geologists have arrived at highly divergent and often mutually exclusive results. A 'peat debate' originated in the 1950s, focussing on the nature and extent of medieval peat growth. A similar debate occurred in other parts of the North Sea Area (Leenders 1989; Borger 1992). In Flanders the debate was all the more persistent, especially due to the absence of peat marshes in the present landscape and the geographical location of the Flemish coastal plain. The latter is situated almost entirely above sea level, thereby enabling natural gravity-based drainage of surface water to the sea; theoretically,

[1] Data derived from the financial household diary of Simon Borluut, 1451-1460: RAG, Borluut, 22, which will be shortly published by Marc Boone.

[2] RAG, Sint-Pietersabdij I, 10, f°61r.

this would be unfavourable to development of peat marshes. The major issues in the debate have been summarized by Verhoeve and Verbruggen (2006) and Soens and Thoen (2009).

First is the issue of the geographical extent of the former Holocene peat marshes. According to geoscientists, important Holocene peat growth would undoubtedly have left traces in the present-day soil. Consequently, in places where systematic soil samples have not revealed any trace of peat nor of its exploitation, its historical presence must be doubted. Generally speaking, two major soil regions are distinguished in Northern Flanders: the late Pleistocene Sandy Flanders and the Holocene polder region in the coastal areas and near the Western Scheldt. The northern part of Sandy Flanders includes a sandy ridge with a total length of about 80 km, stretching from Gistel near Bruges in the west to the left bank of the river Scheldt near Antwerp in the east (Fig. 1). The top of this sandy ridge reaches a height of +7 m TAW,[3] with parallel smaller and lower ridges. The northern sandy region sinks very smoothly to the coastal plain, the polder region, where the sandy soils are covered by recent marine clayish sediments deposited in the medieval or post-medieval period. Apart from some very local and recent peat formation near former tidal channels in the polder region, no 'peat soils' have been detected in this region. A peat substrate—more than 20 cm underneath the surface—is also absent, except for samples in the extreme northern part of the polder region. In the polders north of Boekhoute, for example, a small peat layer of about 15 cm was detected at a depth of 135 cm.[4] For Ameryckx the almost total absence of peat in the soil samples and the very clear and sharp border between Holocene clay sediments and the Pleistocene sand undoubtedly proved that peat had never previously developed in the Belgian part of Northern Flanders. If historians somehow found evidence in this region for peat digging, they must have misinterpreted the use of the Dutch word *turf*, which probably indicated the cutting of grass sods (Ameryckx cited in De Muynck 1976, p. 218, 224). Subsequent geomorphological studies have delimited the southern border of the peat substrate, being the most southern place where Holocene peat has been detected in the subsoil (de Muynck 1976; Van de Velde 1997). To the south of this peat border, peat layers are so fragmented that they cannot be discerned from other types of organic material. This peat border is situated in the most northern part of the area studied—similar to the border between the Pleistocene Sandy Flanders and the Holocene polder region (Maréchal 1992)—near the Belgian-Dutch frontier or even entirely on Dutch territory, which implies that peat is unlikely to be detected in soil samples for most parts of northern Flanders.

This delimitation of the peat border is dissimilar from existing historical findings. From the 1950s onwards, historians and historical geographers assembled a great deal of qualitative evidence about land that had been labelled *morum* or *morus* in Latin and *moer* in medieval Dutch and French—compare to *moor* and *moorland* in English—in the North of Flanders (Gottschalk 1955–1958, 1984; De Reu 1960; Stockman 1973). Based on this information, Augustyn (1992, pp. 432–434, 1999, p. 42) sought to map the distribution of medieval peat exploitations in western and northern Flanders. In the latter region 38 villages or smaller cities were identified where medieval peat exploitation had been documented; most of these locations are well south of the peat border based on the soil and geomorphology (Augustyn 1992). However, the connection between 'moor' place names and the historical presence of peat is complex, not least as the etymology of 'moer' is variable and place names might have 'migrated' through space. The transactions of

[3] TAW = Tweede Algemene Waterpassing (or Second General Levelling), referring to the mean low water level at Ostend, about 2 m below mean sea level and about 2.3 m below the Dutch NAP.

[4] Soil augering P13 on soil map Bassevelde 25 W (1965), see De Muynck (1976), p. 82.

moorland were especially numerous in the 12th and 13th centuries, when the count of Flanders granted or sold many of these lands to abbeys, noblemen and burghers of the booming Flemish towns. The count pretended ownership of the moorlands due to his usurped royal rights on 'wastelands' or 'wildernis' (Tys 2005). This qualification as wasteland was merely a judicial construction and does not mean that these lands were at the time 'untouched' by human activities. Previous use by local communities, either for common pasture lands, small-scale peat digging or even arable soil, is possible. It has also been questioned whether these moorland transactions referred to peatlands and not just too low-valued marshland. The historical sources seem to suggest the first option: especially in the 13th century, the prices paid for this kind of moorland were exorbitantly high and the plots were becoming smaller and smaller (for examples, see Augustyn and Thoen 1987; Soens and Thoen 2009). Moreover, many transactions made explicit distinction between the 'moer' sold and the '*treffons*' (French: *tréfonds* or subsoil), for which perpetual rent had to be paid to the count of Flanders. Historians interpreted this 'treffons' as the—sandy—underground revealed after excavation of the peat (Augustyn 1999, pp. 22–23). However, the topographical information in most transactions is fairly vague and itself insufficient to identify specific locations in the landscape where medieval *moorlands* could be found.

Apart from the spatial distribution and extent of the mires, the difference between bogs (*Hochmoore*), which are predominantly nutrient-poor (oligotrophic) and fed by rainwater, and fens (*Niedermoore*), which are predominantly fed by nutrient-rich groundwater, is another major issue in the discussion. In flat areas with the right impermeable subsoil and abundant rainfall, bogs can develop high above the water level (raised bogs, mainly consisting of *Sphagnum* mosses). For the central Holland peat lands, Pons (1992, pp. 48–49) has estimated that the top of the peat bogs reached 3.5 m above the present-day sea level at the start of the peat reclamations. A variant, well known for the British Isles, is the *Blanket bog*, which starts from depressions in a more undulating area and gradually covers the higher parts of the area as well. For the study area in Northern Flanders, Verhoeve and Verbruggen (2006, pp. 210–211) concluded that the location is too high, too dry and too lacking in necessary impermeable substrate to form peat bogs. If—presumably—only groundwater-fed fen could have occurred in the study area, then any peat growth there would have been restricted by elevation of the groundwater level (and thus, indirectly, by the sea level). For the study area, this would mean that in places where the Pleistocene sand substrate exceeds the water level no peat could have been formed. In Flanders, the highest point where peat growth has ever been confirmed on the slope of the Pleistocene sandy ridge is situated between +1 and +1.50 m TAW (near Verrebroek in the Waasland Polders) (Crombé et al. 2005; Meerschaert et al. 2006). Had peat growth occurred at higher places it would mean that either the local hydrological conditions in the past were different, or, conversely, that we are dealing with rainwater-fed peat bogs. Ovaa (1957), who worked on the soil maps of the Dutch part of this region, suggested that peat growth at higher places—i.e. on the Pleistocene sandy ridge—could not be excluded a priori: he found that in the lower depressions between the ridges there could be found at low depth a loamy substrate, which was impermeable and hence could have served as a base for peat growth. Furthermore, he stated that significantly wetter conditions must have previously existed in these depressions, as the drainage was considerably worse (Ovaa et al. 1957). Recent palynological analysis of 12th or 13th century peat blocks excavated at the former site of the Abbey of Ename near Oudenaarde, situated outside the coastal plain, has revealed that the medieval peat consumed by the abbey consisted of peat mosses and heather, both indicating oligotrophic conditions and thus peat bogs. In the 12th and 13th

centuries, this abbey acquired possessions in the north of Flanders, including 'moorland' near Kluizen in the sandy part of northern Flanders, which may offer evidence for the existence of raised bogs in the region at the time (Deforce et al. 2007).

As conclusive evidence for the historical presence of peat proved so difficult to find, historians have turned to what could be termed 'circumstantial evidence,' such as place names that include the word *moer* or specific types of field systems related to peat exploitation. According to Gottschalk (1984, pp. 120–126), peat reclamations in Northeast Flanders presented a so called *Blockstreifen* pattern. The basic subdivision was a *bunder* (1.33 hectares) of 100 *roeden* (385.5 m) in length and 9 *roeden* (34.5 m) in width (11 to 1), later subdivided by ditches in small strings. A road or waterway served as starting point—*caput mori*—for the reclamations. For the so called Meetjesland, near Eeklo and Maldegem, and largely situated on the Pleistocene sandy ridge, Augustyn and Thoen (1987, pp. 101–103) proposed that the basic subdivision of the area into *'maten'* or *'blokken'* served a similar purpose (although the 'maten' or 'blokken' are much larger than one 'bunder', often encompassing 33 hectares). Based on this typical field system, peat exploitations were identified in parts of the study area that are today completely devoid of peat. Geoscientists are not in favour of this type of evidence to indicate that this kind of field pattern was quite common throughout the coastal plain, at least in those areas where the field system had not been altered after the inundations and re-embankments of the Early Modern period. For geoscientists, the mere presence of such a 'reclamation landscape' is insufficient to prove the existence of former peat reclamations (De Muynck 1976).

In conclusion to this overview of the 'peat debate' in Northern Flanders, it becomes clear that much of the scientific disagreement concerning the distribution and quality of the Holocene peat cover is, first, related to characteristics of peat and peat exploitation. Minor layers of peat can be subjected to almost complete decomposition when the peat is drained and exposed to air (oxidation) and/or mingled with underlying sand or clay grounds when the land is turned into arable soil (Borger 1992). Second, the top layer of the peat may have been excavated, or oxidized due to air exposure; the peat may have been subsided significantly when drained or covered by later deposits of sand and clay sediments. As a result, the thickness of the peat as found in soil samples would be only a fraction of the original thickness before subsidence or oxidation. Disappearance of the top layer also renders accurate dating of the peat growth highly difficult (Waller et al. 2006).

Finding evidences at the local level: the case of Moerbeke and Wachtebeke

The preceding has made clear that rapprochement between historical and geological or soil arguments about the extent of medieval peat marshes can only be realised at the local level. Only by relating the historical data concerning acquisition of peatlands and peat extraction to specific places in the landscape can the debate be reopened. This will be illustrated with a case study of two villages in the north of Flanders: Moerbeke and Wachtebeke, just south of the present-day border between Belgium and the Netherlands and situated south of the physical-geographical 'peat border' mentioned previously (Fig. 1). At the border of Moerbeke, a hermitage was founded in 1197 or 1198 which would evolve into the Cistercian abbey of Boudelo (Asaert 1980; Pas 1998). Already in 1200 the count of Flanders Baldwin IX had endowed the abbey with a piece of 'moorland' close to Koudenborn in Moerbeke (Table 1). The abbey later acquired other pieces of 'moorland' in Moerbeke and more to the north, in the direction of Hulst (NL). One indication of the abbey's importance as a producer of peat (Prims 1923, pp. 2–3) is that, in the 15th century, Flemish peat on the

Table 1 Acquisitions of moorland (*morum*; *moer*) in Wachtebeke and Moerbeke by abbeys and hospitals before 1400

Year	Abbey (A) or Hospital (H)	Place	Size (hectares)	Description	Reference
1174–1176	St Peter Ghent (A)	Wachtebeke (Kalve-Wulfschoot)	134	moro	a
1200	Boudelo (A)	Moerbeke (Koudenborn)	Unknown	morrum	b
1200	Ninove (A)	Wachtebeke (Kalve?)	13	morri	c
1201	Ninove (A)	Wachtebeke (Kalve)	Unknown	morri	c
1228	Marquette (A)	Between (the *moor* of) Boudelo and Ertvelde	15	moro	d
Before 1233	St Bavo Ghent (A)	Wachtebeke (Kalve)	75	mori	e
1244	Marquette (A)	Between (the *moor* of) Boudelo and Ertvelde	668	moro	d
Before 1246	Comtesse Lille (H)	Wachtebeke (omgeving Marquette-moer)	20		f
1247	Nieuwenbossche (A)	Wachtebeke-Moerbeke	33	mori cum fundo	j
1249	Ninove (A)	Wachtebeke (Kalve)	67	tam mori quam terrae	f
Before 1250	St Peter Ghent (A)	Wachtebeke (Kalve-Wulfschoot)	23	moro	g
1273	Boudelo (A)	Moerbeke (Koudenborn)	33	moer	b
1276	St Bavo Ghent (A)	Wachtebeke (Kalve)	4	moer	e
1276	St Bavo Ghent (A)	Wachtebeke (Kalve)	6	moer	e
1280	Rijke Gasthuis Ghent (H)	Wachtebeke (Langelede)	18		h
1297	Boudelo (A)	Moerbeke	18	muer a tout le treffons	b
1297	Drongen (A)	Moerbeke	11		f
1297	St Bavo Ghent (A)	Wachtebeke	21	muer	e
1298	Loos (A)	Wachtebeke	16		f
1298	Nieuwenbossche (A)	Moerbeke	12	muer a tous les treffons	j
1321	Bijloke Ghent (H)	Moerbeke (Koudenborn)	7	muer	f
1356	Drongen (A)	Moerbeke	7	moers metten gronde	i
1356	St Peter Ghent (A)	Wachtebeke (Walderdonk)	5	moers metten gronde	g
1357–1358	Doornzele (A)	Wachtebeke	1	moers	i
1380	St Peter Ghent (A)	Moerbeke	11		g

References: *a* Tombeur et al. (1997); *b* Asaert and Vleeschouwers (1976–1983); *c* De Smet (1841); *d* Vanhaeck (1940); *e* Vleeschouwers (1990); *f* Gottschalk (1984); *g* Van Lokeren (1868); *h* De Smet (1975); *i* de Limburg Stirum (1898); *j* RAG, Nieuwenbossche, Charters)

Antwerp peat market was referred to as *bauwelosche* peat or peat from Boudelo. Yet Boudelo was not the only ecclesiastical institution to acquire peat in the villages of Moerbeke and Wachtebeke (see Table 1).

From 1175 until the end of the 14th century at least twelve abbeys and hospitals acquired *moorland* in Moerbeke and Wachtebeke. Other such institutions probably did so as well: according to accounts of rentals from the 14th and 15th centuries, at least five additional monasteries (the Cistercian Abbeys Ter Hagen in Zuiddorpe and Zwijveke near Dendermonde; the Benedictine Abbey of Affligem; the Urbanist Poor Clares of Ghent; the Temple House of Zaamslag and the Poor Clare Sisters of Petegem) and two Ghent hospitals (Children Alijn and Wenemaer) owned moorland within the two villages (Augustyn et al. 1983–1991). Nevertheless, these moorland transactions are insufficient to prove the existence of open peat marshes or large-scale peat exploitation. The spatial reference in the documents is vague and there is seldom any linkage to actual exploitation of peat. In order to determine the relationship between 'moorland' transactions and peat digging, the geomorphology and the soil of the study area are analysed in the next paragraph. Next, the monastic moorlands are localized through a retrogressive analysis of the field system. Finally, quantifiable data on late medieval peat exploitation are linked to specific places in our test region.

The geomorphology and soil conditions of the study area

The geomorphology of both Moerbeke and Wachtebeke is dominated by the previously mentioned Pleistocene sandy ridge, which crosses both parishes in their northern part. The Moervaart depression lies southwards of the sandy ridge and is about 15 km long, with a maximum width of about 2.5 km. This depression is part of the *Vlaamse Vallei* (Flemish Valley), formed by the incision of watercourses during the Saale Ice Age (De Moor and Heyse 1978; Heyse 1979, 1983). During the Eem interglacial, a major part of this valley was flooded and marine and estuary sediments were deposited. Later, in the Weichsel Ice Age, fluvio-aeolian sands were deposited, resulting in an almost complete infilling of the palaeovalley. Near the end of this last ice age, i.e. during the late Pleniglacial and Late Glacial, the Pleistocene sandy ridge was gradually formed and obstructed the northbound course of the waterways, leading to formation of a swampy paleolake, which would evolve into the present-day Moervaart depression (De Moor and Heyse 1978; Verbruggen et al. 1996; Bats et al. 2009, 2010). During the Younger Dryas, at the transition towards the Holocene, the paleolake dried up, probably due to the incising of a meandering river (Bats et al. 2009, 2010). This river gully, which was 20–30 m wide and 6-7 m deep, was rather quickly colmatated with marl sediments (gyttja) and peat. Peat also started to grow outside the gullies, but probably never formed a thick deposit. Most of this peat is now taken up in the actual plough layer; only in the deepest parts of the former lake is its basis still preserved.

In the extreme north of both parishes, marine sediments were deposited atop the sandy ridge during the late medieval and post-medieval period (in the so called Polder of Moerbeke). From the south to the north the study region thus changes from a shallow depression, a relatively steep sandy ridge, a smooth slope, and a low-lying polder area (Fig. 2). In the period of medieval land clearances both the village centres of Moerbeke and Wachtebeke and major hamlets like Kalve would be established on the higher parts of the sandy ridge, near the northern edge of the Moervaart depression.

Using Digital Elevation Data (LIDAR), we can easily obtain an accurate picture of the elevation of the study area (see Fig. 2). Most of this area is situated above 2 m TAW, with the lowest parts in the Moervaart depression in the south and in the polder area in the

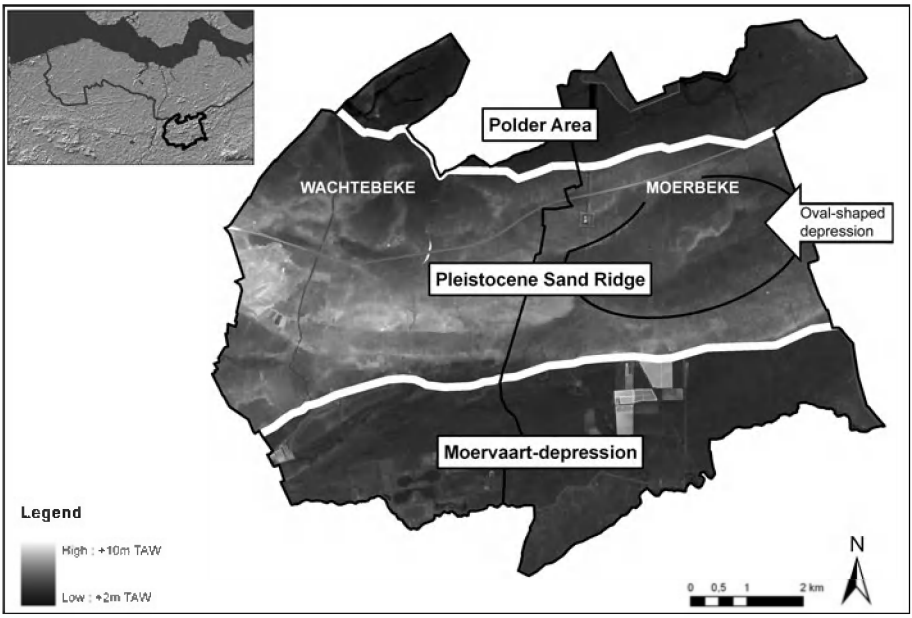

Fig. 2 DEM model of Moerbeke and Wachtebeke with basic geographic units. For this figure the original LiDAR (Light Detection and Ranging) elevation data were processed into a raster grid of 10 m by 10 m. *Source* LiDAR elevation data, distributed by Agentschap voor Geografische Informatie Vlaanderen (2003) (map by I. Jongepier, based on LiDAR data)

North. The Great Sand Ridge in the middle reaches heights of +7 m TAW, and is thus well above the +2 m TAW level indicated by Verbruggen as the maximum height of peat growth. If elevation determined the presence of peat in the area, then no peatlands would have been present in the largest part of the study area. Today, the detailed soil maps of the region indeed indicate that the soils of the Ridge consist of sand, partly wet and partly dry. A number of soil corings (Bats et al. 2009, 2010) and test pits (Hoorne et al. 2009) have revealed minor sequences of humiferous to peaty sediments situated close to the present surface, most often at about +3.5 to 5 m TAW. Based on pollen analysis, radiocarbon and OSL dating (Derese et al. 2010; Crombé et al. 2000) these organic layers can be attributed to the Late Glacial; most of these layers, however, are only a few decimetre thick.

The Moervaart depression itself lies below +3 to +4 m TAW. According to the soil maps and recent auger surveys (Bats et al. 2009, 2010), peat has very limited distribution within this former lake area. (Early) Holocene peat only occurs within the meandering river gully and in the deepest part of the former lake, i.e. in a small strip at the northern edge of the Moervaart depression where it meets the Pleistocene Sand Ridge. Interestingly, soil distortion indicates that part of the peat from the gully has been extracted. The rest of the depression consists of very chalk-rich soils, qualified on the soil maps as lake marl. These sediments are in fact *gyttja*, a nutrient-rich organic mud typically deposited at the bottom of lakes (Verbruggen 1971; Crombé et al. 2005, p. 108, 128). In the Moervaart, these gyttja reach a depth of maximum 2 m and date to the Late Glacial. No other soil evidence for Holocene peat growth in the Moervaart depression could be found. In sum: the soil evidence still does not reveal any important trace of Holocene peat formation outside the confined area of the old river gully in the Moervaart depression. As noted in the

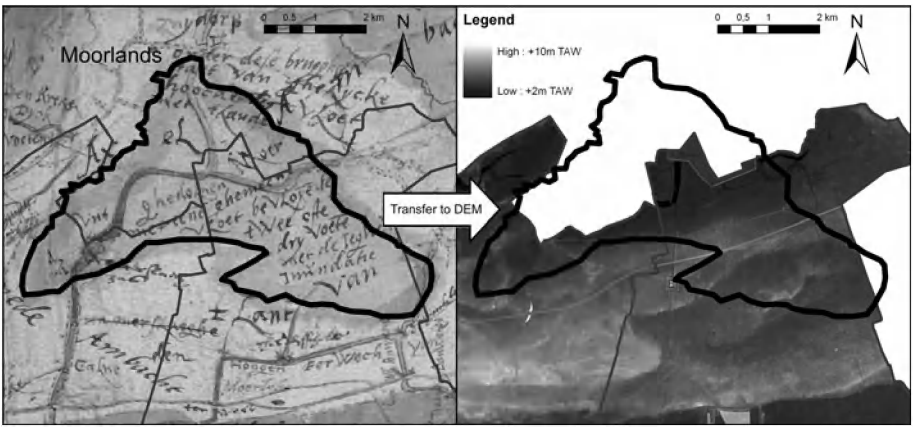

Fig. 3 *Left* the inundated lowest part of the moorlands on a late 16th century map of Northern Flanders. On the moorlands is written: *Uutghedolven moer met eenen ghemeene vloet bevloyen de twee ofte dry voeten met de jeghewoerdeghe inundatie* ('dug out moorland inundated two to three feet—54 to 81 cm—during high tide') *Source* ARA, Kaarten en Plans, II 176. *Right* the shape of these moorlands transferred to the DEM (map by I. Jongepier, based on LiDAR data)

next paragraph, the monastic *moorlands* were by and large situated elsewhere, namely, on the Pleistocene Sand Ridge.

Situating the medieval moorlands in the landscape

The first cartographic evidence for the 'moorlands' of Moerbeke and Wachtebeke dates to the second half of the 16th century.[5] Most interesting is a map realised after the so called Farnese strategic inundations of the 1580s, which indicates the 'former moorlands that have been dug out and are inundated by now' (see Fig. 3). These moorlands are situated on the northern slope of the Pleistocene sandy ridge, and partly correspond with a round to oval-shaped depression on the ridge which could be observed on the DEM (see Fig. 2).

To determine whether the depicted moorlands were the remnants of much larger open peat marshes in this region, their correspondence with the medieval monastic moorlands was analysed. The latter were retrieved through partial reconstruction of the pre-1800 field system in the parishes of Wachtebeke and Moerbeke in a GIS, based on the 19th century cadastral maps, 17th and 18th century parish surveys of Moerbeke and Wachtebeke[6] and detailed land registers which have been preserved for some of the monastic estates.[7] Information for other monastic institutions was less detailed, although the approximate location of their estates is easily mapped.

[5] The oldest is found on a mid-16th century map in SA, Topographical Collections, 12 # 11990, indicating the 'Great Moorlands' in the north of Moerbeke and the 'Moorlands of Marquette' in the north of Wachtebeke.

[6] For Moerbeke: RAG, Oud Gemeentearchief Moerbeke, 100-101; for Wachtebeke: Survey of 1662/1663, reworked by De Coninck and Martens (1989).

[7] For the Cistercian abbey of Boudelo (1741): RAG, Oud Gemeentearchief Moerbeke, 100–101; for the Norbertine abbey of Drongen (1738): RAG, Abdij van Drongen, 57; for the Benedictine abbey of Ghent St Bavo (1576): RAG, kaarten & plans, 458. The monastic property of the abbey of Boudelo around 1481 is estimated, based on RAG, Boudelo, 1327 and the remains of this property in 1741.

Two main observations can be derived. First, both the 18th and the 19th century field systems show a predominance of very small oblong plots, with a length-to-width ratio of 5 to 1 and higher. As noted, this field system was often associated with systematic peat exploitation, although the direct relation is questionable. Interestingly, this predominance of small oblong plots is found on both the higher and lower places of the Pleistocene sandy ridge in the northern part of the study area, but much less often in the southern part, the Moervaart depression. Second, the ecclesiastical estates are organised in a very remarkable way as parallel stretches of land, with the main exploitation centres or manors—the *curtes*—located on a central axis, close to the top of the sandy ridge where the village centres of Wachtebeke and Moerbeke were founded.[8] The estates themselves were oriented—obliquely rather than perpendicularly—towards the central axis, as were the main waterways and roads. All this clearly originates from a highly systematic type of reclamation, initiated from the central axis and steadily penetrating into the wilderness c.q. the moorland. This is confirmed by the demarcations mentioned in transactions, which often left the northern boundary undefined or extended 'as long as our moor stretches'[9] or 'to the middle of the moor'.[10] When count Guy de Dampierre of Flanders sold about 18 hectares of *morus* to the abbey of Boudelo in 1297, the shape of the plot is mentioned (Asaert and Vleeschouwers 1976–1983, nr 377). With a length of 100 *roeden* and 139 *roeden* at the 'upper side' and 109 *roeden* at the 'bottom side', this plot had a trapezoid shape often associated with peat reclamations.

Quantitative data on peat extraction in the study area

After localizing the monastic estates was reconstructed, the actual peat-digging activities on these estates were estimated. No quantifiable data before 1400 have been preserved for most of the abbeys and hospitals. At that time some of the ecclesiastical landowners were heavily involved in peat digging in the study area (see below). In other cases, no indication of peat exploitation is found. For example, on the moorlands of the abbey of Ninove, situated on the higher parts of the Pleistocene sandy ridge near Kalve (Table 1), no traces of peat exploitation could be found—anymore?—in the accounts preserved from 1427 onwards. By then the abbey's estate had largely become low-valued *woestinen ende heiden* (wastelands and heathlands). An attempt to convert 76 hectares of the estate into arable lands in 1450 apparently failed and in 1496 the abbey sold its entire Kalve estate.[11] Peat exploitation continued on other estates, however. The Terhage abbey, for example, owned most of its moorland in the low-lying northern part of the study area (the Moerbeke Polder) and was still engaged in peat exploitation in the 15th century.[12] More important are the abbeys of Drongen and Boudelo. The moorlands of these abbeys were largely situated on the northern slope of the sandy ridge and were active in peat extraction throughout the 15th

[8] Boudelo Abbey built its exploitation center at Koudenborn in the extreme east of the area. The manor of Drongen—*Drongenhof*—was situated close to the village center of Moerbeke. The abbey of Ninove also founded a manor on this central reclamation axis (Kalve) (Gottschalk 1984, p. 39). In contrast, the *curtes* of the Ghent abbeys of St Peter and St Bavo were situated on small sand ridges within the Moervaart depression itself, respectively south of Wachtebeke and south of Moerbeke (Wulfsdonk).

[9] Donation by count Ferrand and countess Jeanne of moorland to the abbey of Marquette in june 1228 '*Ita longe quam idem morus noster extendidit*' (Vanhaeck 1940, I, no. 10, p. 8).

[10] Confirmation of a grant of moorland to the abbey of Boudelo in 1247: Asaert and Vleeschouwers (1976–1983, p. 244).

[11] RAB, Ninove Abbey, 136 and 832.

[12] RAG, Terhagen Abbey, 4.

Table 2 Quantities (*Q*) in *last* of peat (1 last equalling 10.000 blocks) dug on the Boudelo estate in Moerbeke 1446–1545 *source* RAG, Boudelo, 270–271, 274, 438

Year	*Q* peat (last)	*Q* peat (sold)	Outsourcing (pound)	Outsourcing (*Q* peat)	*Q* peat total (last)
1446	982.0	326.6	3.4	22.4	1004.4
1481	1541.2	?	0.0	0.0	1541.2
1513	753.5	66.0	107.0	1116.5	1870.0
1540	158.0	0.0	0.0	0.0	158.0
1541	200.0	0.0	0.0	0.0	200.0
1542	200.0	0.0	0.0	0.0	200.0
1543	120.0	0.0	0.0	0.0	120.0
1544	132.0	0.0	0.0	0.0	132.0
1545	127.0	0.0	0.0	0.0	127.0

and into the 16th centuries. Amongst these other estates, Boudelo was obviously the most important peat extractor, as illustrated in Table 2.[13]

On the Boudelo moer, between 1,000 and 2,000 *last* of peat were dug each year during the 15th century. As such Boudelo was on its own able to meet the fuel demand of more than a thousand households. Some of this peat was sold—*Bauwelooschen turf* or peat from Boudelo was one of the varieties one could buy at the Antwerp market (see previous). Other parts of the production were distributed to institutions and secular persons, and the final part was used for the abbey's own consumption. From the second quarter of the 16th century onwards, the amount of peat dug was much lower and was used mainly for auto-consumption and distribution. In the same period, important parts of the peatland itself were sold to cover the abbeys' financial needs, which became very urgent in this period (de Kraker 1997).

A detailed account of peat digging on the Boudelo estate in 1481 has been preserved.[14] This source mentions the names of peat diggers and the quantity and quality of the peat dug out. It also includes a relatively detailed geographical description of where the peat was dug: each peat extraction was situated by referring to one of the three *leden* or canals that ran through the Boudelo estate: the Arincxlee (later Haringlede), the Willebuus- (or Willibrords-) lee and the Broeder Lievins Lee (Fig. 5). The first two can be retraced in the present landscape and ran south-north, starting at the highest part of the sandy ridge, where the exploitation centre of Koudenborn was situated. Peat was extracted either west, east or 'at the end' of each of these canals. With regard to the Arincxlee 256.1 *last* were dug to the west; 216.6 to the east and 31.6 at the end. From these data, we can affirmatively conclude that important peat extraction activities took place in the study area, or, more precisely, on the northern slope of the sandy ridge. The area between the canals where peat exploitation occurred is now situated between 4 and 7.5 m TAW, well above the maximum height of +2 m TAW put forward in earlier studies (see previous). Part of the Boudelo estate is

[13] Part of the peat extraction by the abbey was 'outsourced' through a specific lease system, the so called *moerpacht*. Peat diggers bought the licence to dig a certain amount of peat for a fixed price. As exploitation costs were rather high (often more than 50% of the market price for peat), and a certain margin of profit for the peat digger must be included, we supposed that the lease price was half the market price. This allowed us to estimate the amount of peat that was dug through the *moerpacht* system. For the abbey of Saint Bavo this hypothesis is confirmed for some years for which both the sale price and the *moerpacht* per last are registered (Denys 1995, pp. 94–95).

[14] RAG, Boudelo, 1327.

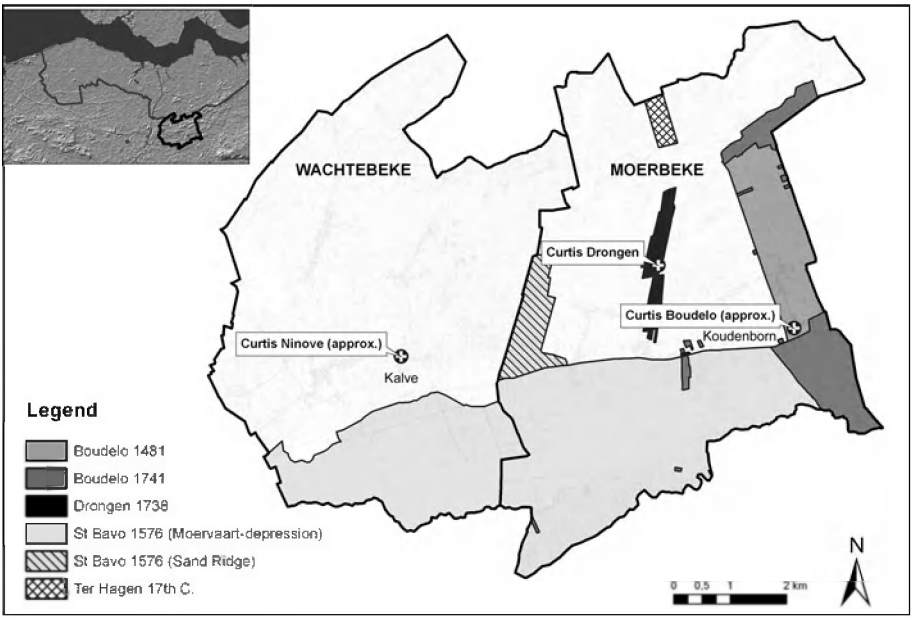

Fig. 4 Location of selected monastic properties in Moerbeke and Wachtebeke (map by I. Jongepier based on archival sources in notes 8 and 9 and cadastral maps of P. C. Popp, c. 1860)

situated in an oval-shaped, shallow depression on the ridge, which is visible on the DEM and corresponds to the moorlands indicated on 16th century maps (Figs. 4 and 5).

The Drongen estate was considerably smaller, with at least 17 hectares of moorland acquired in 1297 and 1356 (Table 1).[15] The exploitation centre or *curtis* of this estate—the Drongenhof—was situated on the highest part of the sandy ridge, near the village centre of Moerbeke. From there, the estate stretched into the western part of the oval-shaped depression. On this plot the abbey extracted between 100 and 150 last a year in the 15th century (Table 3).

The quantities of peat dug by Boudelo and Drongen might provide information on the thickness of the peat layer. As one last of peat measured about 22.75 m^3 (Augustyn 1999), an annual peat production of 100 last by the Drongen Abbey would correspond to extraction of 1 m of peat from 0.22 hectares. As peat production continued for more than two centuries, Drongen would have needed at least 44 hectares of peatland in case of a 1-m thick peat cover, or 22 hectares if the peat cover was 2 m thick. For Boudelo, the figure was more than ten times higher. Of course, the thickness of the peat would have varied locally, meaning that the peat layer was probably thicker than 2 m in one location yet thinner than 1 m somewhere else. The quality of the peat might also give an indication about the thickness of the peat layer. Unfortunately, historical qualifications of peat seldom correspond to present-day biological typologies, such as the distinction between fens and bogs, oligotrophic or eutrophic peat (see previous). Our sources mostly distinguish between 'white' peat, which was the cheapest in price and exploitation cost, and 'black'

[15] In 1738, Drongen Abbey owned 61.6 hectares of land in Moerbeke, but most likely not all of this was former moorland.

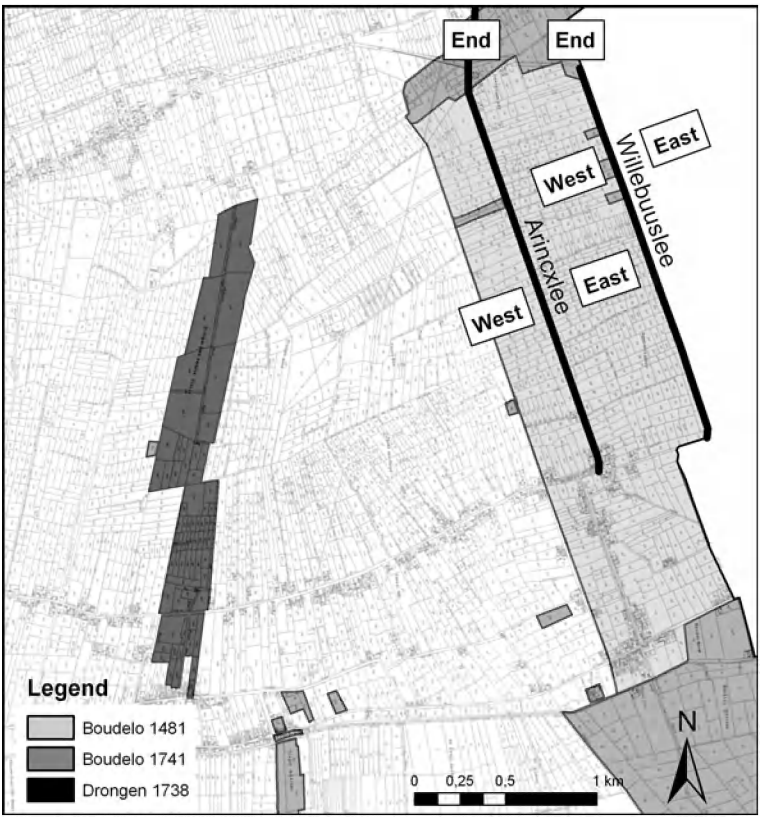

Fig. 5 The Drongen and Boudelo peat extraction (map by I. Jongepier based on archival sources mentioned in note 15 and cadastral maps of P. C. Popp, c. 1860)

Table 3 Quantity (*Q*) and quality of peat exploited on the Moerbeke estate of the abbey of Drongen

		Q peat (last)	Quality
1410/12/24	1411/12/24	34	Black
		56.5	White
1417/12/24	1418/12/24	61	White
		20	Derdepits`
		21	Blacks
1495/05/02	1496/05/02	125	White
		25	Derdepits`

peat. Peat mosses (*Spaghnum peat*) produce the whitest quality of peat, and this may be an argument for the existence of raised peat bogs, consisting of peat mosses, in this region. Another distinction was made between third, fourth and fifth 'pit' (*derdepits, vierdepits* and *vijfdepits*), presumably referring to the depth of the extracted peat. The deeper the 'pit', the

higher the cost for extraction and the more expensive the peat.[16] In Moerbeke and Wachtebeke, the 'pit' was used as an exploitation unit, and a variable quantity of peat could be extracted from each pit (often between 3 to 6 last but sometimes as much as 10 last at a time).[17] For reasons of drainage (the upper layer is dry enough to exploit) and safety (deep pits would collapse), peat diggers usually limited themselves to 1 m at a time. This could imply that the third pit corresponded to a peat layer of about 3 m, the fourth pit to 4 m and the fifth pit to 5 m, but this is fairly hypothetical. Nevertheless, on the peat exploitation of St Peter Abbey near Wachtebeke two *last* and 2 *voeder* of peat (i.e. 20,800 peat blocks) could be dug at a time on one square *roede* (14.85 square metres). A last of peat that measured 22.75 m^3 would imply that the peat layer there was at least 3 m thick.[18]

The peat exploitation of St Bavo Abbey is more difficult to situate. Between the second half of the 14th century and the first half of the 16th century, this abbey extracted between 200 and 300 *last* of peat a year on its Moerbeke and Wachtebeke estates (Denys 1995: annexes 1–4: 14). This was more than Drongen but considerably less than Boudelo. St Bavo was by far the most important landowner in the region, due to the huge Wulfsdonk estate (about 1,537 hectares), which was sold to the abbey by the count of Flanders Thomas and his wife, Jeanne, in March 1241, and which contains the central part of the Moervaart depression (Verhulst 1958, pp. 570–579). In the original grant this land was called *Onlende*, referring to a ditch that ran through the estate. To the north the *Onlende* bordered the *morum* stretching from Kalve to the possessions of the abbey of Boudelo, which implies that the *Onlende* was clearly distinguished from the *morum*.[19] From later transactions it becomes clear that the Noordlede (later Moervaart), immediately south of the sandy ridge, was considered the border between the *morum* and the *onlende* (Verhulst 1958: ibid). In the *morum* (and hence north of the Noordlede), St Bavo acquired some 103 hectares of moorland situated between Calf and Wulfsdonk (Table 1). The moorlands coincide with the uppermost northern part of the Moervaart depression, for which recent soil surveys have confirmed Holocene peat; they also stretched more to the north, on top of the sandy ridge. The present state of the enquiry does not allow for determining where exactly St Bavo extracted peat. In the 17th century local peat digging on the abbey's estate was undertaken on the wet meadows of the Moervaart depression; accounts even mention the sale of *moerhout*, remnants of prehistoric trees hidden in the peat. However, the scale and financial importance of these activities are not comparable to the semi-industrial peat exploitations of the later Middle Ages. Could it be possible that early Holocene fen peat in the depression coexisted with elevated peat bogs atop the sandy ridge? Only further in-depth historical, geo-physical and archaeological investigation into the development of St Bavo's *Wulfsdonk* estate might solve this aspect of the problem.

[16] When selling part of its peat production in 1448–1449, the abbey of Boudelo received 41 Flemish d. (*denarii*) *groten* per last for white peat; 40 to 54 d. for *derdepit* of a lesser quality and 98 d. for *'puri derdepits et partim vierdepits'* (pure 3rd pit and 4th pit). To dig the peat, the abbey paid 17 to 18 d. for white peat; and 22 to 25 for 3rd and 4th pit (excluding transport): RAG, Abdij van Boudelo, 270 and 438.

[17] RAG, Sint-Pieterabdij II 1251/2, accounts 1472. Augustyn (1999, pp. 80–81) only mentions three to six last, but in the accounts up to 10 last per pit was found. The evidence cited by Augustyn that the pit would have measured one square *roede* or 14.85 m^2 is not convincing. The size of a pit varied.

[18] RAG, Sint-Pietersabdij II, 1251/2 1472-1486: 'item noch ghemaect uit eender roe moers 2 last ende 2 voer smackaerts' (see also Augustyn 1999, p. 81, although with a different calculation).

[19] Deed of 1–21 March 1241 (n.s.): '*vendidimus totam illam terram, que vulgo dicitur Onlende; que terra, sive onlende, tales habet terminus: verus orientem, Onlende abbatis et conventus de Bodelo; versus occidentem, allodium, sive Onlende, sancti Bavonis, quod vulgo dicitur Licht, et ultra aqueductum, qui Nortlede dicitur, Vevorde; versus septentrionem, morum, qui a loco, qui vulgo dicitur Calf, extenditur versus Bodelo; versus meridiem, terram domini Rassonis de Gavera, que se extendit versus Exarde*': Vleeschouwers 1990–1991, pp. 276–277).

Conclusion

Freshwater peat marshes are fragile and constantly evolving ecosystems. Moreover, they are prone to sudden and radical transformation, for example, due to changes in seawater level or to human intervention. The most radical transformation of peat marshes occurs when the marsh is drained and the peat is systematically extracted. The subsequent conversion of the peat marsh into arable land or salt marsh sealed the fates of many peat marshes in the medieval and early modern North Sea Area. The occurrence and former extent of medieval peat marshes remains an important issue in the landscape history of the coastal wetlands. Soil evidence and historical data often seem to produce mutually exclusive results. For Northern Flanders, a reappraisal of the contrasting arguments developed by geoscientists and historians concerning the occurrence of disappeared peat marshes reveals the main problems involved in the peat debate: geoscientific approaches often started from present-day hydrological and soil conditions to delimit regions of earlier peat growth, whereas historical approaches often encountered difficulties in properly situating areas of medieval peat extraction in the landscape. However, an integrated approach combining soil data, elevation data (DEM) and historical data on land use, field names, field systems and infrastructure and concentrating on well-defined and concise study areas not only allows for locating peat extraction with a higher degree of accuracy but also identifies new locations, where peat exploitation had previously been considered improbable.

This is demonstrated for two villages in the north of Flanders, Moerbeke and Wachtebeke, where medieval monastic estates, consisting of moorland, could be localised and linked to archival evidence about peat production. When quantifiable archival data become available—in this region from the 15th century onwards—peat exploitation in the case study proved to be concentrated in the northern part of the Late Glacial Moervaart depression and, more surprisingly, in the lower parts of a Pleistocene sandy ridge, more specifically in an oval-shaped depression identifiable on the DEM. Estimates of the thickness of the peat layer on the sandy ridge remain hypothetical, but nevertheless the top of the peat must have surpassed present-day water levels significantly. Consequently, we are dealing with either bog peat, fed by rainwater only, or, conversely, with historical water levels considerably exceeding present-day water levels. On the higher parts of the sandy ridge, no peat extraction occurred in the 15th century and landowners like the Ninove Abbey near Kalve engaged in the conversion of moorland into arable soil. As infrastructure and plot system on these higher moorlands very nearly mirrored the situation in the lower parts, it remains to be investigated whether these higher moorlands had once also been covered by peat.

The interdisciplinary methodology for the location of disappeared medieval peat marshes used in this article awaits further testing on other coastal regions where the presence of peat is contested. This is feasible as digital elevation data, (digitized) pre-1800 land surveys and soil data become more widely available. As for the archival data on peat production, monastic estates usually offer the best chances, especially for the medieval period. In this way, a reappraisal of medieval peat marshes not only facilitates better insight into the energy supplies of pre-modern Europe, but may also improve our understanding of the landscape history and archaeology of the coastal wetlands, not least in helping to explain chronological gaps in the settlement history of an area that may be attributed to development and subsequent removal of peat cover.

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