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Beyond the unknown: understanding prehistoric patterns in the urbanised landscape of Flanders

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Abstract

Archaeological distribution patterns are often biased by cultural and environmental processes. These processes influence the preservation of archaeological phenomena in the landscape. Their impact starts when the site and structures are left or abandoned or objects are deposited or disposed of. However, in archaeological landscape research, these processes are seldom incorporated. Therefore, the potential impact of both environmental and cultural processes on the preservation of archaeological phenomena needs to be understood and their influence on the observed archaeological site distribution patterns needs to be measured. Furthermore the history, intensity and methodology of the archaeological research in the region influence the known archaeological distribution pattern and therefore an understanding of the archaeological practice in the region is necessary in the study of the past landscapes of that region. This paper presents a case study on the distribution pattern of Bronze Age barrows in the highly urbanised landscape of north-western Belgium. By integrating natural, cultural and archaeological processes in archaeological landscape research, the completeness and reliability of the archaeological dataset can be estimated. Efforts to estimate completeness and reliability of any dataset should be an integral part of every archaeological landscape research project, especially as biases or hiatuses in datasets can lead to serious misinterpretations or circular reasoning. Furthermore, knowledge of the biography of landscapes is not only important in the study and understanding of past archaeological landscapes, but also in the preservation of these landscapes and our ability to incorporate hidden past landscapes into the actual sustainable management of its cultural–historical heritage.

Keywords: Land use; Formation processes; Archaeological distribution patterns; Geographic Information Systems; Bronze Age barrow; Belgium

The north-western part of Belgium was densely inhabited throughout prehistory and history. After the definitive re-colonisation of the region during the Late Glacial era, as a response to climate ameliorations, the region was increasingly occupied and exploited by humans, first by hunter–gatherers,[1] and later by agro-pastoral communities,[2] reaching a first climax in the Roman period.[3] During the medieval period, the area belonged to the economic core of the county of Flanders, which thrived on a successful textile industry and international trade. This resulted in significant population growth, rapidly expanding cities and an intensive exploitation of the surrounding rural landscape.[4] Between the eleventh and fifteenth centuries, this was one of the

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[1] P. Crombé, J. Sergant, E. Robinson and J. De Reu, Hunter–gatherer responses to environmental change during the Pleistocene–Holocene transition in the southern North Sea basin: Final Palaeolithic–Final Mesolithic land use in northwest Belgium, *Journal of Anthropological Archaeology* 30 (2011) 454–471.

[2] P. Crombé, J. Sergant and L. Lombaert, L'occupation en région sablonneuse du nord-ouest de la Belgique au IV^{e} et au III^{e} millénaires: bilan des recherches récentes en région sablonneuse, in: F. Bostyn, E. Martial and I. Praud (Eds), *Le Néolithique du Nord de la France dans son contexte européen: habitat et économie aux 4e et 3e millénaires avant notre ère. Actes du 29e colloque interrégional sur le Néolithique, Villeneuve-d'Ascq, 2–3 octobre 2009*, Villeneuve-d'Ascq, 2011, 103–118; J. De Reu, *Land of the Dead. A Comprehensive Study of the Bronze Age Burial Landscape in North-western Belgium*, Ph.D thesis, Ghent University, 2012.

[3] W. De Clercq, *Lokale gemeenschappen in het Imperium Romanum. Transformaties in rurale bewoningsstructuur en materiële cultuur in de landschappen van het noordelijk deel van de civitas Menapiorum* (Provincie Gallia-Belgica, ca. 100 v. Chr. – 400 n. Chr.), Ph.D. thesis, Universiteit Gent, 2009.

[4] A. Verhulst, *Landschap en landbouw in Middeleeuws Vlaanderen*, Brussel, 1995.

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most densely populated regions in Europe. Today, Flanders is still amongst the most densely inhabited areas in the European Union.[5] The region has a rich history characterised by a continuously growing population and urbanisation. However, this brings with it important consequences for the preservation of past landscapes and our knowledge about them.

The aim of this paper is to investigate the distribution of Early and Middle Bronze Age barrows (ca. 2000–1100 BC) in the present-day landscape of the sandy lowlands of north-western Flanders (Belgium). Their distribution pattern is examined considering present and past land use, human perceptions towards landscapes, the physical geography and geology of the landscape, as well as the history and state of the archaeological research in the region. First, landscapes in the study are set in a wider geographical context. This is followed by a discussion of their character and evolution. Finally, we discuss the analysis of the spatial patterns and biases in the distribution of the Bronze Age barrows in relation to the landscape characteristics. This research is part of a comprehensive interdisciplinary study of the Bronze Age burial landscape in north-western Belgium, focussing on Bronze Age land use strategies and barrow building practices in relation to the landscape.[6]

The sandy lowlands of north-western Belgium

The study area is situated in north-western Belgium, largely between the North Sea coast in the west, the modern city of Antwerp and the border of the province East-Flanders to the east and the Dutch border to the north (Fig. 1). The maximum extent of the area under study is 105 km east–west, and 50 km north–south and the total surface area comprises approximately 440,475 ha.

Traditional landscapes and natural settings

Within the study area we can distinguish three traditional landscape-types stretching from north to south: (i) the polders of the estuary of the River Scheldt and the coastal plain of the North Sea, (ii) the sandy lowlands of north-western Belgium, or so-called Sandy Flanders and (iii) the loamy and silty uplands (Fig. 1).[7]

The largest part of the study area is occupied by the sandy lowlands of north-western Belgium, and this can be subdivided in two traditional regions: firstly the sandy soils inside the Flemish Valley with deep Quaternary cover sands, and secondly the central part of Sandy Flanders and the sandy soils outside the Flemish Valley with shallow Quaternary deposits, towards the east and west of the Flemish Valley (Fig. 1). The Flemish Valley is a Pleistocene valley filled with mainly sandy sediments of fluvio-aeolian origin deposited during the Pleniglacial and Late Glacial periods.[8] It is a low-lying area, situated between 2 and 10 m above sea level (up to 15 m in its tail-ends) and characterised by a subtle micro-topography, with minimal height differences to the order of only a few metres. The area is typically characterised by the succession of numerous rather small, low and elongated sand ridges and slightly lower-lying depressions and stream valleys. One sand ridge, the so-called Great Ridge, stands out due to its (relatively) larger dimensions (Fig. 1). The ridge is 80 km long and 1.5–3 km wide and rises up to 5 m above the landscape, forming a barrier for the drainage to the north. At the foot of the southern slope of the ridge, several lakes were formed during the Late Glacial period, which dried out at the start of the Holocene.[9] However, these depressions always remained marshy and peat-rich areas during the Holocene.[10] The largest of these depressions is the depression of the Moervaart, measuring approximately 15 by 2.5 km.[11]

The sandy soils outside the Flemish Valley are characterised by a shallow Quaternary deposit with sandy soils overlying Tertiary formations of alternating sands and clays, so-called cuestas (Fig. 1).[12] The tops of these cuestas rise above 20 m, where outcrops of the Tertiary sediments (e.g. clay, loamy and silty sediments) can be found. In the Polder area, the sandy infillings of the Flemish Valley are covered by Holocene marine and alluvial deposits from the North Sea and Scheldt River respectively.[13] Towards the south, the sandy lowlands are bordered by loamy and silty areas (Fig. 1). These areas are characterised by a more undulating topography with the hills of Central West Flanders and the Flemish Ardennes rising up to 50 m and more (Fig. 2).

An urbanised and fragmented contemporary landscape

According to Eurostat, Belgium is the third-most densely populated country in the European Union with an average population density of 356 inhabitants per km^2 in 2009.[14] In the Flanders region, the population density rises up to 466 inhabitants per km^2. Belgium is highly urbanised with 15 urban regions each counting at least

[5] Eurostat, *Population Density*, Brussels, 11-01-2012 (http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/themes).

[6] De Reu, *Land of the Dead* (note 2); J. De Reu, J. Bourgeois, P. De Smedt, A. Zwertvaegher, M. Antrop, M. Bats, P. De Maeyer, P. Finke, M. Van Meirvenne, J. Verniers and P. Crombé, Measuring the relative topographic position of archaeological sites in the landscape, a case study on the Bronze Age barrows in northwest Belgium, *Journal of Archaeological Science* 38 (2011) 3435–3446.

[7] M. Antrop and S. Van Damme, *Landschapszorg in Vlaanderen: onderzoek naar criteria en wenselijkheden voor een ruimtelijk beleid met betrekking tot cultuurhistorische en esthetische waarden van de landschappen in Vlaanderen*, Gent, 1995; M. Antrop, V. Van Eetvelde, J. Janssens, I. Martens and S. Van Damme, *Traditionele landschappen van het Vlaamse Gewest (volledig overzicht). Versie 6.1 – maart 2002*, Gent, 2002.

[8] G. De Moor and D. van de Velde, *Toelichting bij de Quartairgeologische Kaart. Kaartblad 14: Lokeren*, Gent, 1995; G. De Moor and I. Heyse, De morfologische evolutie van de Vlaamse vallei, *De Aardrijkskunde* 4 (1978) 343–375; I. Heyse, *Bijdrage tot de geomorfologische kennis van het noordwesten van Oost-Vlaanderen (België)*, Brussel, 1979.

[9] M. Bats, J. De Reu, P. De Smedt, M. Antrop, J. Bourgeois, M. Court-Picon, P. De Maeyer, P. Finke, M. Van Meirvenne, J. Verniers, I. Werbrouck, A. Zwertvaegher and P. Crombé, Geoarchaeological research of the large palaeolake of the Moervaart (municipalities of Wachtebeke and Moerbeke-Waas, East Flanders, Belgium). From Late Glacial to Early Holocene, *Notae Praehistoricae* 29 (2009) 105–112; M. Bats, P. De Smedt, I. Werbrouck, A. Zwertvaegher, M. Court-Picon, J. De Reu, L. Serbruyns, H. Demiddele, M. Antrop, J. Bourgeois, P. De Maeyer, P. Finke, M. Van Meirvenne, J. Verniers and P. Crombé, Continued geoarchaeological research at the Moervaart palaeolake area (East Flanders, Belgium): preliminary results, *Notae Praehistoricae* 30 (2010) 15–21; C. Verbruggen, L. Denys and P. Kiden, Belgium, in: B.E. Berglund, H.J.B. Birks, M. Ralska-Jasiewiczowa and H.E. Wright (Eds), *Palaeoecological Events During the Last 15,000 Years: Regional Syntheses of Palaeoecological Studies of Lakes and Mires in Europe*, Chichester, 1996, 553–574.

[10] L. Denys, C. Verbruggen and P. Kiden, Palaeolimnological aspects of a Late-Glacial shallow lake in Sandy Flanders, Belgium, *Hydrobiologia* 214 (1990) 273–278.

[11] M. Bats, P. De Smedt, J. De Reu, V. Gelorini, A. Zwertvaegher, M. Antrop, J. Bourgeois, P. De Maeyer, P. Finke, M. Van Meirvenne, J. Verniers and P. Crombé, Continued geoarchaeological research at the Moervaart palaeolake area (East Flanders, B): field campaign 2011, *Notae Praehistoricae* 31 (2011) 201–211; P. Crombé and C. Verbruggen, The Lateglacial and early Postglacial occupation of northern Belgium: the evidence from Sandy Flanders, in: B.V. Eriksen, B. Bratlund (Eds), *Recent Studies in the Final Palaeolithic of the European Plain. Proceedings of a UISPP Symposium, Stockholm, 14–17 October 1999*, Højbjerg, 2002, 165–180; I. Heyse, Preliminary results of the study of a vistulian Late Glacial drainage pattern in the Scheldtbasin (Belgium – Flemish Valley – Moervaart Depression), *Quaternary Studies in Poland* 4 (1983) 135–143.

[12] G. De Moor and A. Pissart, Het reliëf, in: J. Denis (Ed.), *Geografie van België*, Brussel, 1992, 129–215.

[13] De Moor and Heyse, De morfologische evolutie van de Vlaamse vallei (note 8).

[14] Eurostat, *Population Density* (note 5).

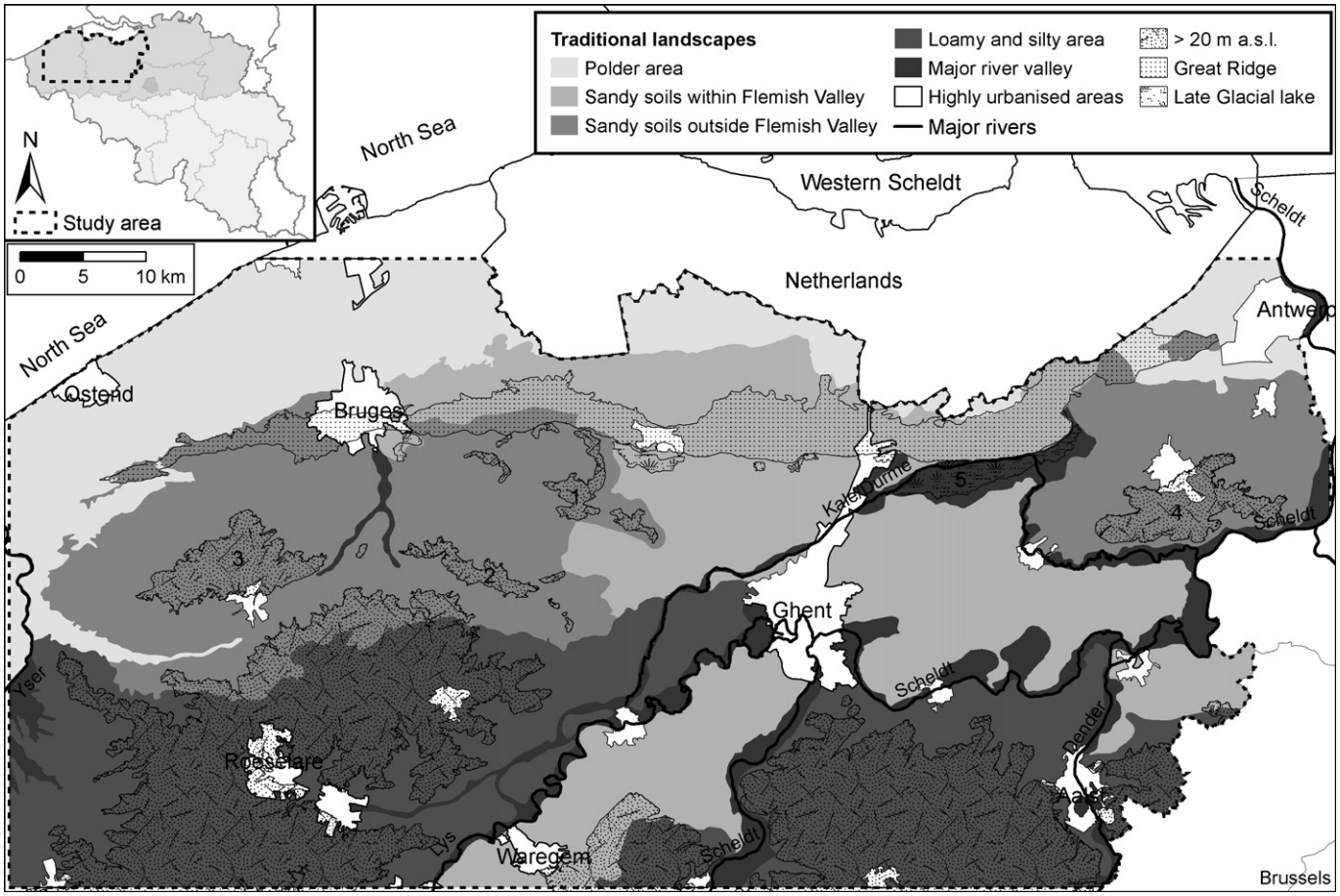

Fig. 1. Map of the study area in north-western Belgium showing the main landscape features (1: cuesta of Oedelem; 2: cuesta of Tielt; 3: cuesta of Hertsberge; 4: cuesta of the Land van Waas; 5: depression of the Moervaart).

80,000 inhabitants.[15] The study area contains three of these urban regions (Ghent, Bruges and Aalst), as well as numerous large and small cities, towns and villages. According to the Biological Valuation Map,[16] approximately 26.8% of the surface of the study area is taken up by built-up land, industrial zones and infrastructure and some 1.9% of the area are water bodies (Fig. 3). Another 64.6% is used as agricultural land (37.2% crop land and 27.4% pasture land). The remaining 6.7% is characterised by 'natural' vegetation cover (e.g. woodlands, nature reserves and heathlands).

The archaeological, Bronze Age landscape

Until the beginning of the 1980s, there were no known Bronze Age barrows in north-western Belgium[17]; the phenomenon had only been recorded in the Campine area, Walloon Brabant and in the Flemish Ardennes, where several monuments were preserved in the landscape.[18] In other European regions, numerous barrows have survived the ravages of time intact, with examples in the British Isles,[19] the Netherlands,[20] Scandinavia,[21] and Central

[15] V. Van Eetvelde and M. Antrop, The significance of landscape relic zones in relation to soil conditions, settlement pattern and territories in Flanders, *Landscape and Urban Planning* 70 (2005) 127–141.

[16] G. De Knijf, D. Paelinckx, H. Demolder, S. De Saeger and R. Guelinckx, De Biologische Waarderingskaart: een wetenschappelijk instrument voor het beleid, *Natuur.focus* 7 (2008) 100–106; S. De Saeger, G. Ameeuw, B. Berten, H. Bosch, I. Brichau, G. De Knijf, H. Demolder, G. Erens, R. Guelinckx, P. Oosterlynck, K. Rombouts, K. Scheldeman, F. T'jollyn, M. Van Hove, J. Van Ormelingen, L. Vriens, A. Zwaenepoel, G. Van Dam, M. Verheirstraeten, C. Wils and D. Paelinckx, *Biologische Waarderingskaart, versie 2.2*, Brussel, 2010.

[17] S.J. De Laet, *La Belgique d'avant les Romains*, Wetteren, 1982.

[18] M. Fourny, Nouvelle contribution à l'étude de la nécropole de la civilisation de Hilversum/Drakenstein (âge du bronze ancien et moyen). Examen des anciennes collections du Musée du Centenaire à Mons, *Vie archéologique* 5 (1985) 41–68; M. Fourny and M. Van Assche, Les tombelles protohistorique du Bois de la Houssière (Braine-le-Comte, Hennuyères et Roncquières, Hainaut). Monuments classés, *Amphora* 71–72 (1993) 2–39; F. Meex, *Grafheuvels en urnenvelden in de Kempen*, Brussel, 1976; L. Van Impe, *Ringwalheuvels in de Kempense Bronstijd. Typologie en datering*, Brussel, 1976; L. Van Impe and G. Beex, *Grafheuvels uit de vroege en midden-bronstijd te Weelde*, Brussel, 1977.

[19] R. Bradley, *The Prehistory of Britain and Ireland*, Cambridge, 2007; J. Last (Ed.), *Beyond the Grave: New Perspectives on Barrows*, Oxford, 2007.

[20] S. Arnoldussen and D. Fontijn, Towards familiar landscapes? On the nature and origin of Middle Bronze Age landscapes in the Netherlands, *Proceedings of the Prehistoric Society* 72 (2006) 289–317; E. Drenth and E. Lohof, Heuvels voor de doden. Begraving en grafritueel in bekertijd, vroege en midden-bronstijd, in: L.P. Louwe Kooijmans, P.W. van den Broeke, H. Fokkens and A. van Gijn (Eds), *Nederland in de prehistorie*, Amsterdam, 2005, 433–454; E. Lohof, *Grafritueel en sociale verandering in de bronstijd van Noordoost-Nederland*, Ph.D. thesis, Universiteit van Amsterdam, 1991; L. Theunissen, *Midden-bronstijdsamenlevingen in het zuiden van de Lage Landen. Een evaluatie van het begrip 'Hilversum-cultuur'*, Ph.D. thesis, Universiteit Leiden, 1999.

[21] M.K. Holst, H. Breuning-Madsen and M. Rasmussen, The South Scandinavian barrows with well-preserved oak-log coffins, *Antiquity* 75 (2001) 126–136; K.L. Johansen, S.T. Laursen and M.K. Holst, Spatial patterns of social organization in the Early Bronze Age of South Scandinavia, *Journal of Anthropological Archaeology* 23 (2004) 33–55; D. Löwenborg, Landscapes of death: GIS modelling of a dated sequence of prehistoric cemeteries in Västmanland, Sweden, *Antiquity* 83 (2009) 1134–1143.

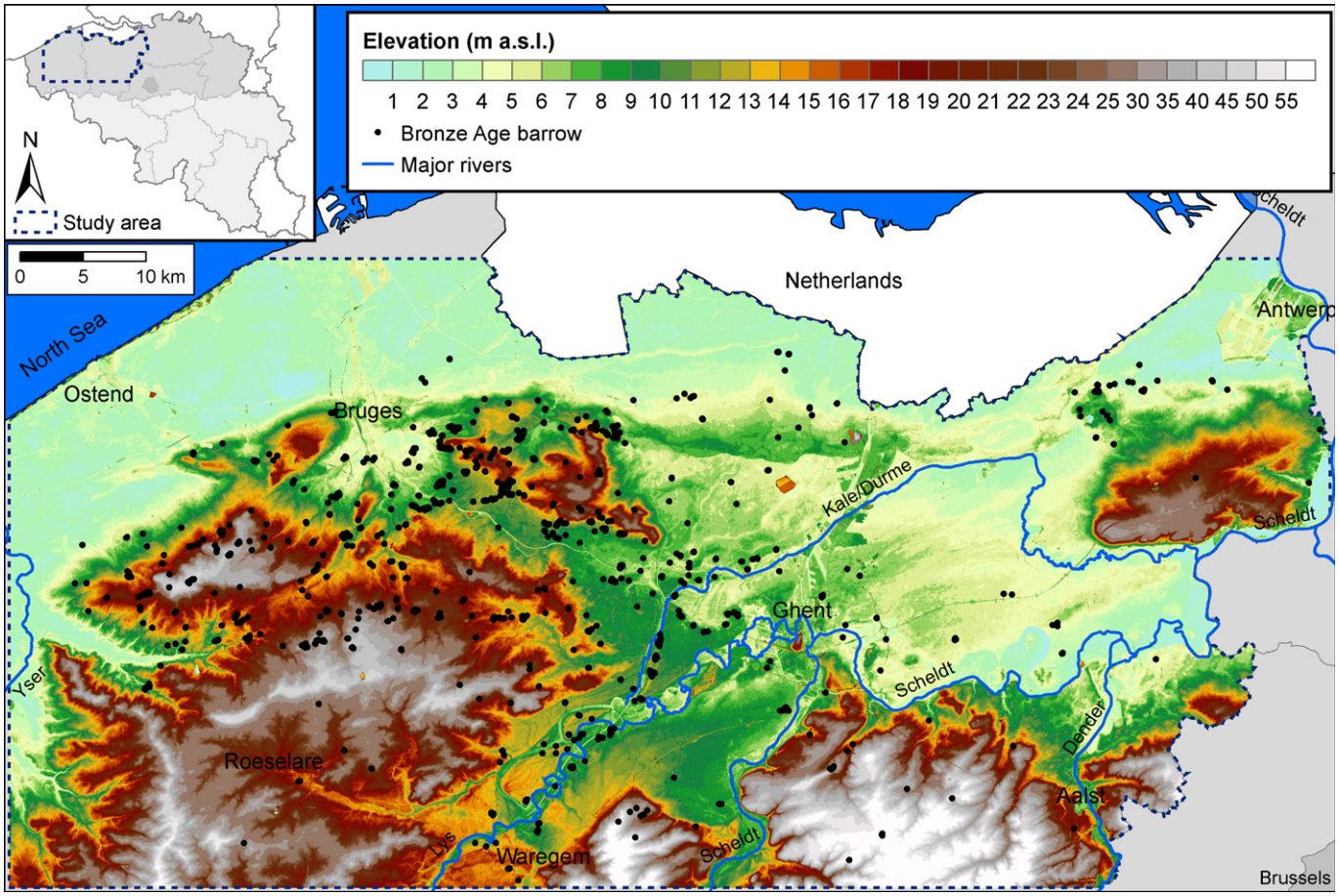

Fig. 2. Digital elevation model of the sandy lowlands in north-western Belgium with the distribution of the Bronze Age barrows.

Europe.[22] In north-western Belgium, however, these monuments have disappeared across the landscape, mainly due to intensive agricultural activities and erosion. Nevertheless, such intensively farmed areas have in fact offered a good opportunity to detect archaeological traces during aerial photographic surveys. Over the last thirty years, the Department of Archaeology of Ghent University has conducted intensive aerial surveys of the area, with a major focus on the sandy lowlands.[23] These surveys led to the detection of more than 1000 previously unknown barrows and gave an enormous boost to Bronze Age research in the region.[24] During the 1980s and 1990s, several excavations were conducted on Bronze Age barrow sites, mainly with the aim of evaluating and interpreting the circular features which were visible on aerial imagery. Later, several known and unknown sites were discovered and/or investigated within the framework of developer-led archaeology. To date, over 70 barrows have been excavated in the larger lowlands of the north-western Belgium region, leading to a better understanding of Bronze Age barrows in the area.[25] When brought together, the new information produced by systematic aerial surveys has led to a marked expansion in the number of known barrows, whilst the excavations have greatly extended our knowledge of their chronology and structure or morphology as monuments. From a chronological point of view, these burial monuments appeared around 2300 BC, during the Late Neolithic. The climax of the barrow building, however, can be placed during the Middle Bronze Age, largely between 1700 and 1400 BC. After that period, it is suggested that no new barrows were erected but that the old monuments were reused.[26]

[22] S. Forenbaher, Radiocarbon dates and absolute chronology of the central European Early Bronze Age, *Antiquity* 67 (1993) 218–256; M. Kuna, Burial mounds in the landscape, in: L. Smedja (Ed.), *Archaeology of Burial Mounds*, Plzen, 2006, 83–97.

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[24] J. Bourgeois and B. Cherretté, L'âge du Bronze et le premier âge du Fer dans les Flandres Occidentale et Orientale (Belgique): un état de la question, in: J. Bourgeois, M. Talon (Eds), *L'âge du Bronze du nord de la France dans son contexte européen. Actes des congrès nationaux des sociétés historiques et scientifiques, 125e Lille, 2000*, Paris, 2005, 43–81; J. De Reu, E. Deweirdt, P. Crombé, M. Bats, M. Antrop, P. De Maeyer, P. De Smedt, P. Finke, M. Van Meirvenne, J. Verniers, A. Zwertvaegher and J. Bourgeois, Les tombelles de l'âge du bronze en Flandre sablonneuse (nord-ouest de la Belgique): un status quaestionis, *Archäologisches Korrespondenzblatt* 41 (2011) 491–505.

[25] De Reu, Deweirdt, Crombé, Bats, Antrop, De Maeyer, De Smedt, Finke, Van Meirvenne, Verniers, Zwertvaegher and Bourgeois, Les tombelles de l'âge du bronze en Flandre sablonneuse (nord-ouest de la Belgique) (note 24).

[26] J. Bourgeois and M. Talon, From Picardy to Flanders: Transmanche connections in the Bronze Age, in: P. Clark (Ed.), *Bronze Age Connections. Cultural Contact in Prehistoric Europe*, Oxford, 2009, 38–59; De Reu, Deweirdt, Crombé, Bats, Antrop, De Maeyer, De Smedt, Finke, Van Meirvenne, Verniers, Zwertvaegher and Bourgeois, Les tombelles de l'âge du bronze en Flandre sablonneuse (nord-ouest de la Belgique) (note 24).

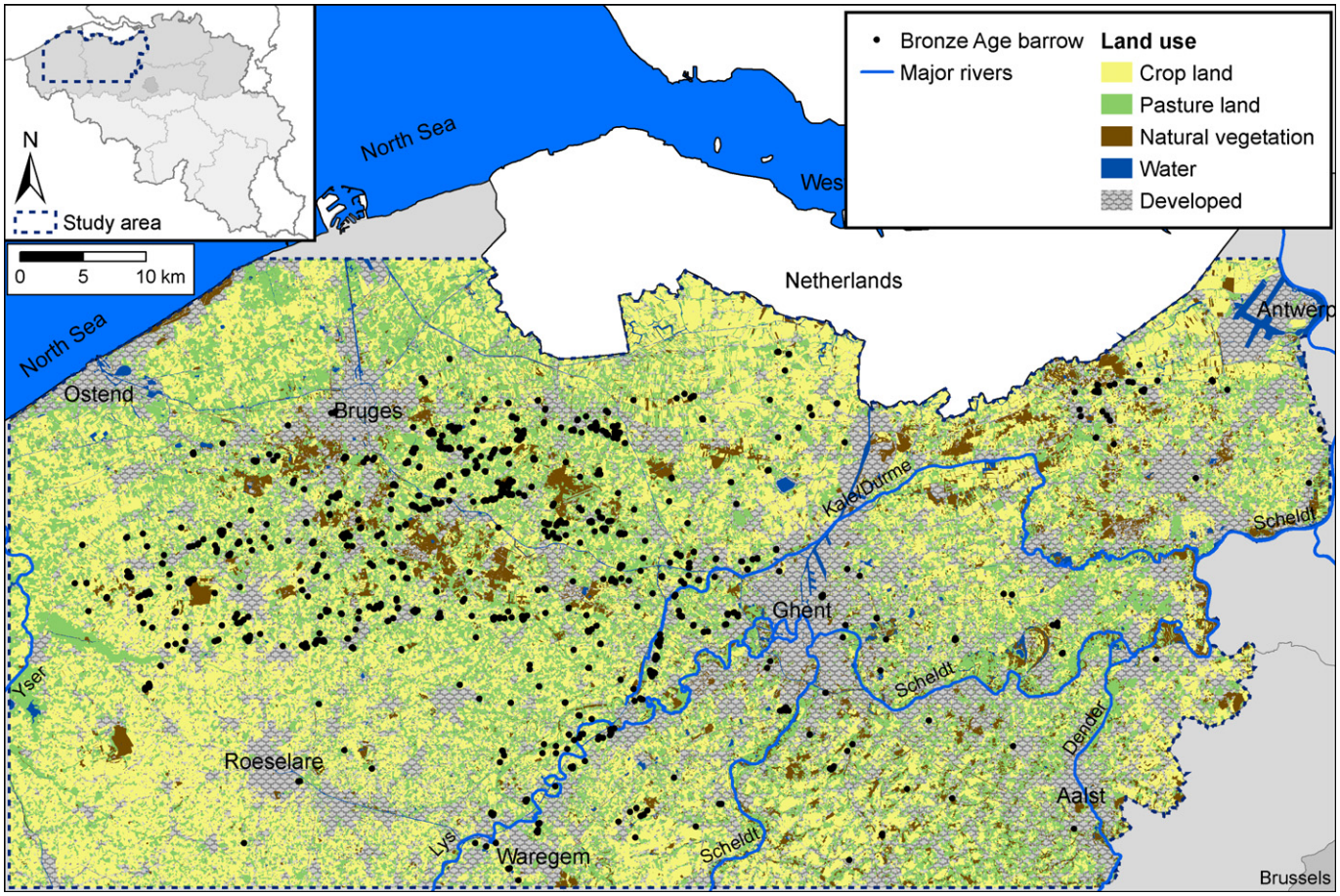

Fig. 3. Map of the study area in north-western Belgium showing the current land use patterns and the distribution of the Bronze Age barrows.

During the last few years the whole dataset was the subject of a systematic and thorough inventory covering a total of more than 1100 identified and precisely located Bronze Age barrows (Fig. 4).[27]

Landscapes past and present

Defining the landscape

In this paper the landscape is defined as in the European Landscape Convention, as follows:

> an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors.[28]

The relationship between natural environment, culture and landscape has been a core theme in geography since von Humboldt. The ideas of the cultural geographer Carl Sauer deserve more attention here because of their significance for archaeological research. In 1925, Sauer defined the cultural landscape as follows:

> The cultural landscape is fashioned from a natural landscape by a culture group. Culture is the agent, the natural area is the medium, the cultural landscape the result. Under the influence of a given culture, itself changing through time, the landscape undergoes development, passing through phases, and probably reaching ultimately the end of its cycle of development. With the introduction of a different – that is, an alien – culture, a rejuvenation of the cultural landscape sets in, or a new landscape is superimposed on remnants of an older one. The natural landscape is of course of fundamental importance, for it supplies the materials out of which the cultural landscape is formed. The shaping force, however, lies in the culture itself.[29]

First, Sauer describes how throughout history, there has always been an interaction between human and landscape, whereby humanity, the *agent*, especially in the last 10,000 years, increasingly used and modified the landscape, the *medium*, for its own purposes. This is in contrast to prehistoric times, when the human impact on the environment remained rather limited. However, during Mesolithic and Neolithic times the first evidence of intentional deforestations appears in north-western Europe.[30] From the Neolithic period

[27] De Reu, Deweirdt, Crombé, Bats, Antrop, De Maeyer, De Smedt, Finke, Van Meirvenne, Verniers, Zwertvaegher and Bourgeois, Les tombelles de l'âge du bronze en Flandre sablonneuse (nord-ouest de la Belgique) (note 24).

[28] Council of Europe, *European Landscape Convention. Florence, 20.X.2000*, Strasbourg, 2000.

[29] C. Sauer, The morphology of landscape from *University of California Publications in Geography* 2, 2 (1925): 19–54, in: T.S. Oakes, P.L. Price (Eds), *The Cultural Geography Reader*, London, 2008, 96–104.

[30] T. Brown, Clearances and clearings: deforestation in Mesolithic/Neolithic Britain, *Oxford Journal of Archaeology* 16 (1997) 133–146; A.-L. Cyprien, L. Visset and N. Carcaud, Evolution of vegetation landscapes during the Holocene in the central and downstream Loire basin (Western France), *Vegetation History and Archaeobotany* 13 (2004) 181–196; L. Prøsch-Danielsen and A. Simonsen, Palaeoecological investigations towards the reconstruction of the history of forest clearances and coastal heathlands in south-western Norway, *Vegetation History and Archaeobotany* 9 (2000) 189–204.

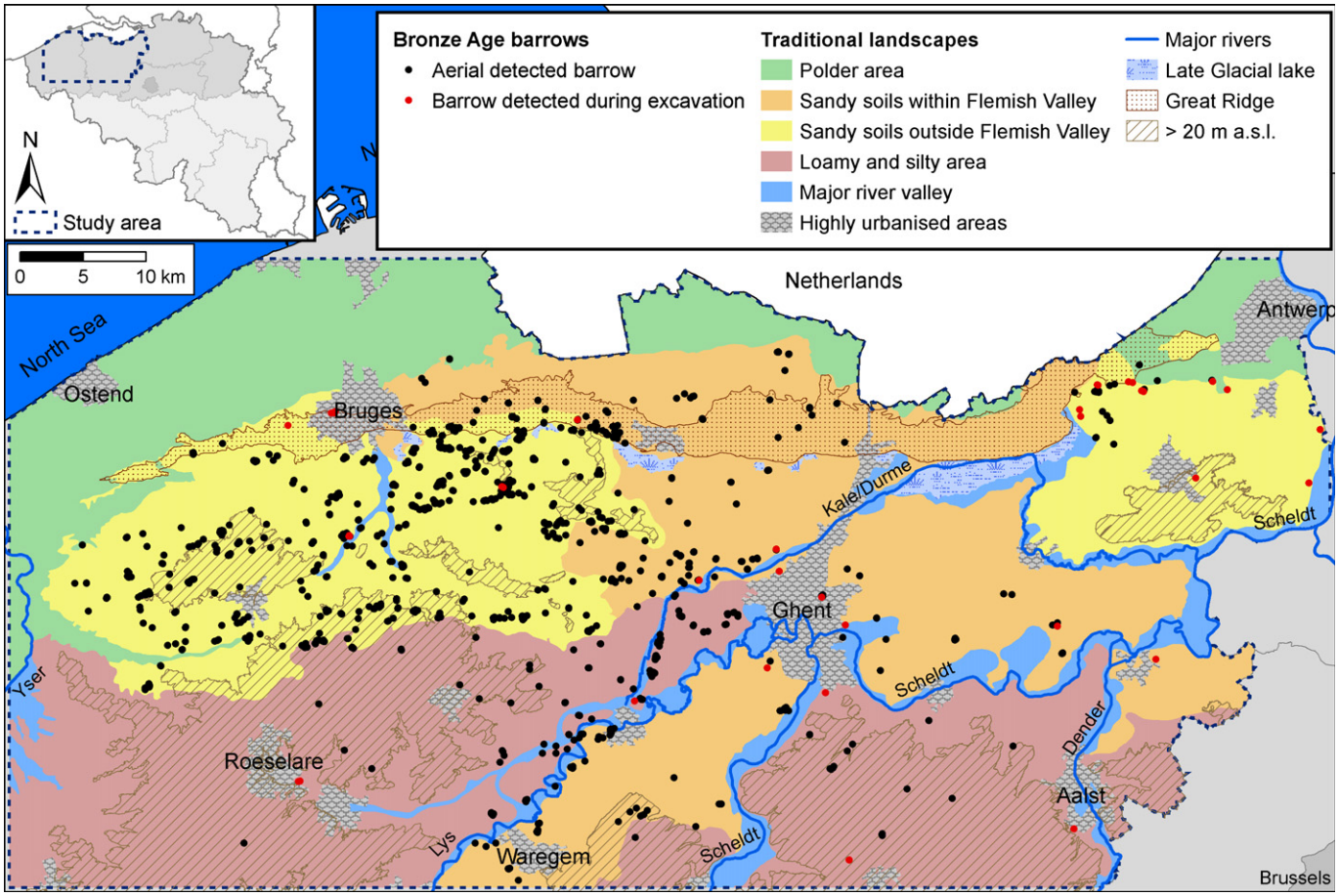

Fig. 4. Spatial distribution of the aerial detected barrows and the barrows detected during excavations in north-western Belgium.

onwards, with the emergence of agriculture in the region, human impact on the natural landscape became lasting and increased as the population grew. Second, Sauer outlines how landscape is an accumulation and has a multi-layered nature, whereby new landscapes are superimposed on older ones.[31] Every ordering and use of a landscape involves a reordering, reusing and new representation of the past landscape(s). This can best be described with the words of Meinig who referred to an aspect of landscapes which was 'so pervasive as to be easily overlooked: the powerful fact that life must be lived amidst that which was made before'.[32] Furthermore, a prehistoric and early historic landscape was in no sense 'empty', even if nobody lived there. The landscape had always mystical dimensions and was seen as being inhabited by ancestors, supernatural beings or spirits.[33]

Third, reflecting the *cycle of development*, Sauer explains how over time, cultural changes and changes in land occupation have an impact not only on the natural landscape, but also on the ancient cultural landscapes. These cultural changes involve changing land use patterns, typically characterised by a change in function, meaning, associations and values of places and elements in the landscape. Although important changes have only occurred during a limited number of relatively short periods, separated by longer periods of stabilisation, the frequency and magnitude of the landscape changes have increased exponentially over the course of history.[34] Cultural and natural landscapes are in a process of continuous transformation and there is no doubt that this process will only intensify in the future.[35]

Modern impacts on past landscapes

It was around 700 BC that the urbanisation process, and with it the development, modification, exploitation and shaping of the

[31] See also S. Rippon, *The Severn Estuary: Landscape Evolution and Wetland Reclamation*, London/Washington, 1997; N. Roymans, F. Gerritsen, C. Van der Heijden, K. Bosma and J. Kolen, Landscape biography as research strategy: the case of the South Netherlands project, *Landscape Research* 34 (2009) 337–359.

[32] D.W. Meinig, The beholding eye. Ten versions of the same scene, in: D.W. Meinig, J.B. Jackson (Eds), *The Interpretation of Ordinary Landscapes. Geographical Essays*, New York, 1979, 33–48.

[33] N. Roymans and F. Theuws, Long-term perspectives in man and landscape in the Meuse–Demer–Scheldt region. An introduction, in: F. Theuws, N. Roymans (Eds), *Land and Ancestors. Cultural Dynamics in the Urnfield Period and the Middle Ages in the Southern Netherlands*, Amsterdam, 1999, 1–32; N. Roymans and F. Gerritsen, Landscape, ecology and mentalités: a long-term perspective on developments in the Meuse–Demer–Scheldt region, *Proceedings of the Prehistoric Society* 68 (2002) 257–288.

[34] M. Antrop, The concept of traditional landscapes as a base for landscape evaluation and planning. The example of Flanders Region, *Landscape and Urban Planning* 38 (1997) 105–117; M. Antrop, Why landscapes of the past are important for the future, *Landscape and Urban Planning* 70 (2005) 21–34.

[35] T. Bloemers, The cultural landscape and heritage paradox. Protection and development of the Dutch archaeological–historical landscape and its European dimension, in: T. Bloemers, H. Kars, A. van der Valk and M. Wijnen (Eds), *The Cultural Landscape and Heritage Paradox. Protection and Development of the Dutch Archaeological–Historical Landscape and its European Dimension*, Amsterdam, 2010, 3–16.

surroundings, first began to spread in Europe, starting from Southeast Europe during the Greek and Roman eras.[36] Since the end of the nineteenth century and beginning in Western Europe, urbanisation increased exponentially. Since the second half of the twentieth century in particular, this process has a devastating impact on the landscape.[37]

The contemporary landscape in Flanders is a patchwork of cities and open spaces, sometimes referred to as a 'rurban' landscape,[38] a 'neo-rural' landscape,[39] or a 'metropolitan' landscape.[40] New landscapes have always been created, however over time the speed, frequency and magnitude of changes have increased, particularly since the second half of the twentieth century. These new landscapes, characterised by a functional homogeneity, are superimposed upon elements, structures and remnants of traditional landscapes, including past archaeological landscapes. In this process, the latter are becoming highly fragmented and are losing their identity.[41] Hidding and Teunissen distinguish four network concepts that define the structure of the present-day landscape: (i) the water network, (ii) the ecological network, (iii) the network for public transport and (iv) the economic network.[42] Processes such as urbanisation, industrialisation, densification of transportation networks, environmental degradation and population growth have had an enormous impact on the identity of traditional landscapes with their long and rich history and on the (preservation of) archaeological remains. In any such landscape, the cultural, natural and archaeological heritage is under a permanent threat.

Alongside these cultural processes, environmental processes have also lead to transformations in the landscape and degradation of archaeological remains.[43] These processes have an effect at different levels: on the artefact, the site and the region. The preservation of archaeological phenomena in their natural environment depends on a number of factors, including the structural properties of the archaeology itself (e.g. artefact material, organic vs. inorganic), the characteristics of the natural environment (e.g. soil and sediment characteristics and formation processes) and the wider environmental and climatologic processes and events (e.g. aeolian and hydrological processes, erosion, biological processes and weather events). The continuous interplay between all these factors affects the preservation potential of archaeological phenomena over time and also how (in)visible they are in the landscape today.

We have thus seen how the preservation and visibility of archaeological heritage are mainly influenced by post-depositional processes of natural and cultural origin. The impact of these processes starts from the moment that a site is left or abandoned or objects are deposited or disposed of. There are significant differences between the levels of preservation, for example, of organic and inorganic materials and between sealed and unsealed sites. Furthermore, the structural properties of these archaeological sites also determine their chances of surviving the ravages of time and thus how visible they will be for the present-day archaeologist. It is clear that large monumental structures have a significantly better chance of being preserved and detected than less developed settlement sites consisting of a few wooden houses and a well, or unmarked locations used for the ritual deposition of objects. However, 'archaeological processes' have also caused biases in our knowledge of past landscapes. Archaeological research in northwestern Belgium has led to thorough syntheses of certain elements of past societies, including sites (e.g. burial sites), objects (e.g. metalwork), chronological eras (e.g. Bronze Age) or regions. These subjects have received widespread attention due to their exceptional archaeological interest and visibility, while other aspect of past societies have received much less attention and are unfortunately still poorly understood. This has led to the development of biased distribution maps of certain archaeological phenomena, characterised by well-documented and less-documented phenomena, implicitly influencing interpretations and leading to misinterpretations. The implementation of the Valetta Convention[44] resulted in an expansion in archaeological research in many European countries.[45] Over the last decade, the developer-led archaeology in Flanders has generated a quantity of archaeological data and a spatial coverage far larger than the research-driven archaeology of the past century.[46] These commercially-instigated projects have displayed increased objectivity in observations and better thought-out sampling strategies,[47] leading to the gradual elimination of biases in our knowledge of archaeological site distributions.

When studying former archaeological landscapes, we first require a thorough evaluation of the observed archaeological distribution patterns to investigate their correspondence to the historic reality and thereby to detect biases in the datasets. It is therefore essential that we understand the potential impact of both environmental and cultural processes on the preservation of archaeological phenomena and also know the extent of the influence of these phenomena on the archaeological site distribution patterns we are observing. Furthermore, when studying past landscapes it is important that we incorporate the history and the wider aspects of archaeological research in the region, for we must

[36] M. Antrop, Landscape change and the urbanization process in Europe, *Landscape and Urban Planning* 67 (2004) 9–26.

[37] M. Antrop, Changing patterns in the urbanized countryside of Western Europe, *Landscape Ecology* 15 (2000) 257–270; Antrop, Landscape change and the urbanization process in Europe (note 36).

[38] Antrop, Changing patterns in the urbanized countryside of Western Europe (note 37).

[39] H. Gulinck, Neo-rurality and multifunctional landscapes, in: J. Brandt, H. Vejre (Eds), *Multifunctional Landscapes. Volume 1. Theories, Values and History*, Southampton, 2004, 63–73.

[40] A. van den Brink, A. van der Valk and T. van Dijk, Planning and the challenges of the metropolitan landscape: innovation in the Netherlands, *International Planning Studies* 11 (2006) 147–165.

[41] Antrop, Landscape change and the urbanization process in Europe (note 36).

[42] M.C. Hidding and A.T.J. Teunissen, Beyond fragmentation: new concepts for urban–rural development, *Landscape and Urban Planning* 58 (2002) 297–308.

[43] M.B. Schiffer, Toward the identification of formation processes, *American Antiquity* 48 (1983) 675–706; M.B. Schiffer, *Formation Processes of the Archaeological Record*, Albuquerque, 1987.

[44] European Convention on the Protection of the Archaeological Heritage: Council of Europe, *European Convention on the Protection of the Archaeological Heritage (revised). Valletta, 16.I.1992*, Strasbourg, 1992.

[45] Europe: K. Kristiansen, Contract archaeology in Europe: an experiment in diversity, *World Archaeology* 41 (2009) 641–648; Flanders: W. De Clercq, M. Bats, J. Bourgeois, P. Crombé, G. De Mulder, J. De Reu, D. Herremans, P. Laloo, L. Lombaert, G. Plets, J. Sergant and B. Stichelbaut, Developer-led archaeology in Flanders: an overview of practices and results in the period 1990–2010, in: L. Webley, M. Vander Linden, C. Haselgrove and R. Bradley (Eds), *Development-led Archaeology in Northwest Europe. Proceedings of a Round Table at the University of Leicester, 19th–21st November 2009*, Oxford, 2012, 29–55.

[46] De Clercq, Bats, Bourgeois, Crombé, De Mulder, De Reu, Herremans, Laloo, Lombaert, Plets, Sergant and Stichelbaut, Developer-led archaeology in Flanders (note 45).

[47] Bloemers, The cultural landscape and heritage paradox (note 35); W. De Clercq, M. Bats, P. Laloo, J. Sergant and P. Crombé, Beware of the known. Methodological issues in the detection of low density rural occupation in large-surface archaeological landscape-assessment in Northern-Flanders (Belgium), in: G. Blancquaert, F. Malrain, H. Stäuble and J. Vanmoerkerke (Eds), *Understanding the Past: A Matter of Surface-area. Acts of the XIIIth Session of the EAA Congress, Zadar 2007*, Oxford, 2011, 73–89.

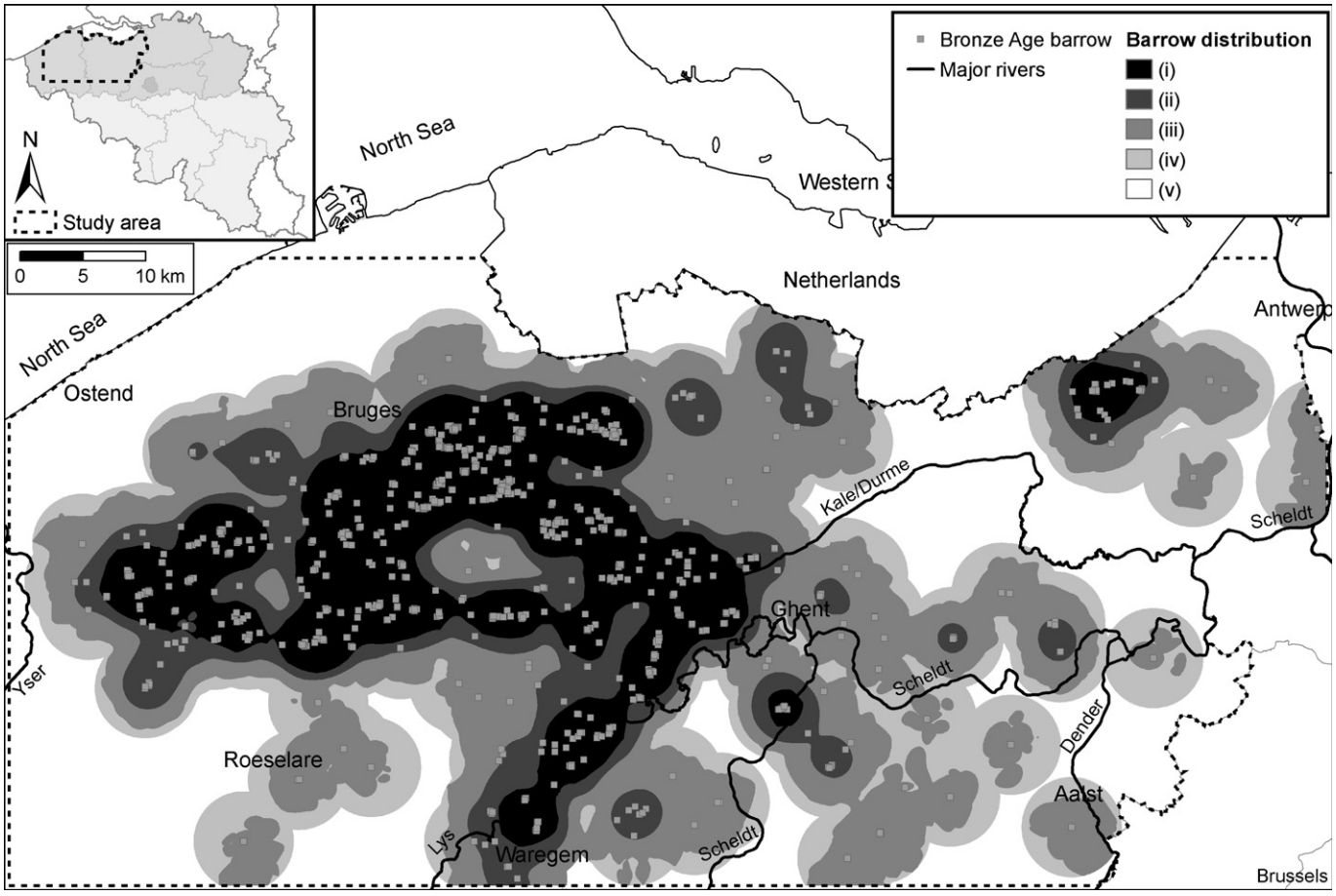

Fig. 5. Kernel density estimation of the Bronze Age barrows, in relation to the expected random distribution pattern; (i) overrepresentation, (ii) normal distribution patterns above average, (iii) normal distribution patterns below average, (iv) underrepresentation and (v) complete absence of features.

remember that what is currently known and visible of the past landscapes is only 'the tip of the iceberg'.[48]

Detecting biases in our knowledge of past landscapes

The Bronze Age barrows in the region of north-western Belgium are widespread, showing a clear non-random distribution across the landscape. Using kernel density estimates,[49] it is possible to roughly demarcate areas characterised by a high density, low density or complete absence of these later prehistoric phenomena. To define the level of density, the distribution pattern of the Bronze Age barrows is compared with the expected random density pattern. A random kernel density estimation was therefore generated from a Monte-Carlo simulation[50] of 1000 samples containing a number of random distributed points equal to the number of sites (1100) in the study area. As such, maps are generated that represent (i) overrepresentation, (ii) normal distribution patterns above average, (iii) normal distribution patterns below average (iv) underrepresentation and (v) complete absence of archaeological features (Fig. 5). The largest density of Bronze Age barrows can be found between the present-day city of Ghent and the coastal plain (Fig. 6). This area can be associated with the landscape unit of the sandy soils west of the Flemish Valley and includes the Tertiary cuestas of Oedelem and Hertsberge.[51] An overrepresentation of barrows is also observed around the upper valleys of the rivers Lys and Kale/Durme to the southwest and west of Ghent. Finally, a smaller cluster of monuments is apparent towards the northern extend of the cuesta of the Land van Waas. Other landscape units are mainly characterised by isolated (groups of) monuments or a complete absence of monuments (Fig. 6). These 'empty' regions include the Polder area, the region Aalter–Beernem, the central part of the Flemish Valley, the silty and loamy area and most of the Land van Waas.

To determine the value of the dataset, we need to analyse the observed archaeological distribution patterns within the framework of cultural (e.g. present and past land use strategies and landscape exploitations) and environmental (e.g. geological, geographic and geomorphologic processes) characteristics of the

[48] Bloemers, The cultural landscape and heritage paradox (note 35).

[49] M.J. Baxter and C.C. Beardah, Beyond the histogram. Improved approaches to simple data display in archaeology using kernel density estimates, *Archeologia e Calcolatori* 7 (1996) 397–408; M.J. Baxter, C.C. Beardah and R.V.S. Wright, Some archaeological applications of kernel density estimates, *Journal of Archaeological Science* 24 (1997) 347–354.

[50] J. Besag and P.J. Diggle, Simple Monte Carlo tests for spatial pattern, *Journal of the Royal Statistical Society. Series C (Applied Statistics)* 26 (1977) 327–333; F.H.C. Marriott, Barnard's Monte Carlo tests: how many simulations?, *Journal of the Royal Statistical Society. Series C (Applied Statistics)* 28 (1979) 75–77.

[51] De Moor and Pissart, Het reliëf (note 12).

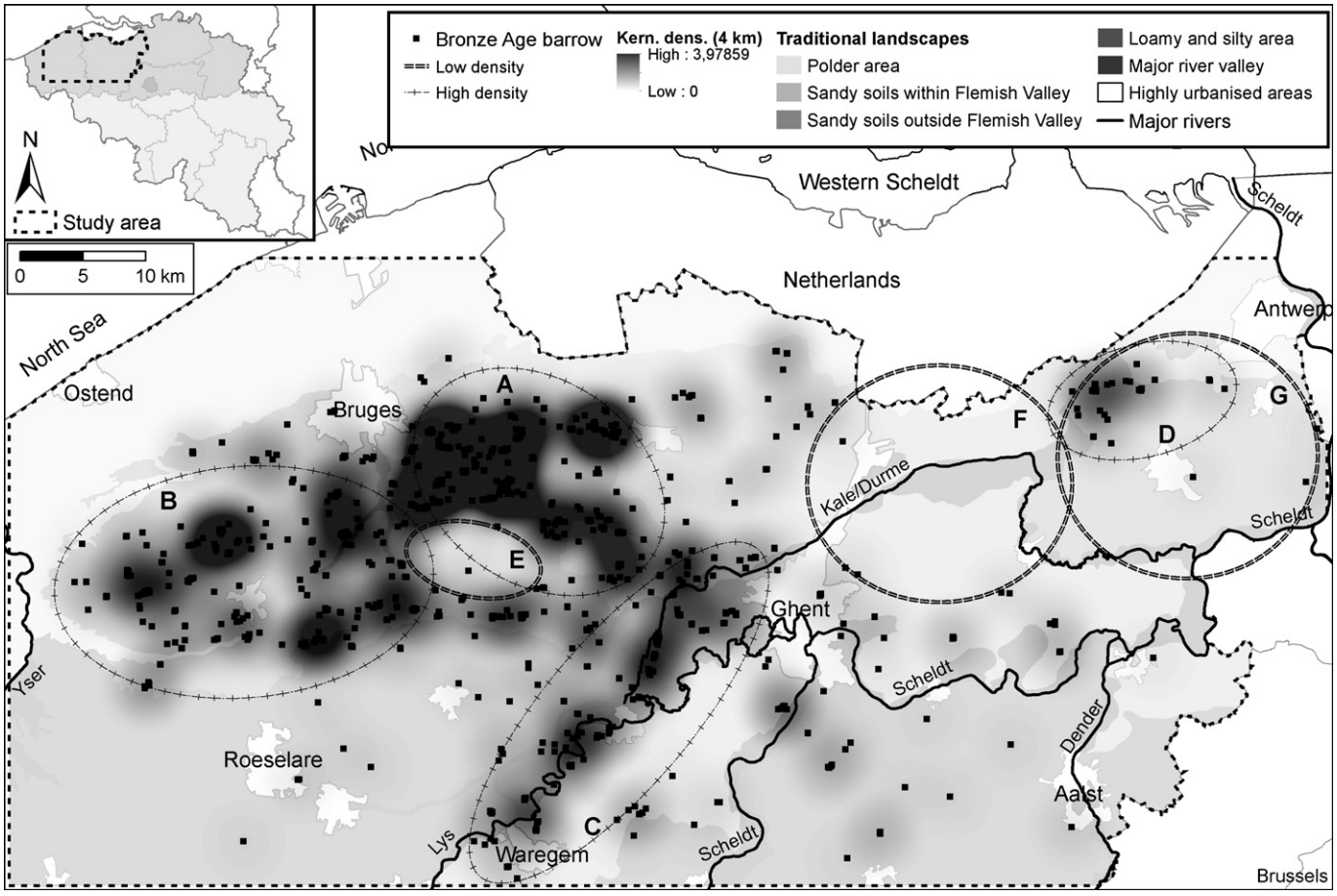

Fig. 6. Spatial distribution of the Bronze Age barrows in north-western Belgium shows clear overrepresentations (A: Tertiary cuestas of Oedelem; B: Tertiary cuesta of Hertsberge; C: upper valleys of the rivers Lys and Kale/Durme; D: the northern extend of the cuesta of the Land van Waas) and empty areas (Polder area; loamy and silty area; E: region Aalter–Beernem; F: lowlands around the depression of the Moervaart; G: cuesta of the Land van Waas).

landscape,[52] as well as in relation to the history, intensity and methodology of the archaeological research in the region. This strategy enables us to determine the completeness and reliability of the archaeological record while understanding the cultural and natural landscape transformations will help us put the past landscapes in a much clearer context.

Several steps were taken in order to assess the reliability of the dataset. First, the current state of the art of archaeological research was integrated in a GIS environment. To this end, all barrows were georeferenced using excavation plans or aerial imagery.[53] This resulted in a 'flood of positive dots on a map' representing the barrow locations. However, it is important to test how representative the distribution map is by integrating negative results as these document areas that were investigated or excavated but revealed no archaeological traces. As such, negative results form an integral part of the archaeological landscape research, and distribution maps thus display both positive and negative locations (Fig. 7).

Second, the natural environment must be critically examined in order to establish the preservation potential of the archaeological phenomena in the environment (e.g. sealed vs. unsealed sites, dry vs. wet soils, organic vs. inorganic materials, etc.). To do this, environmental characteristics are derived from sources such as the digital soil map,[54] the landscape atlas,[55] and the digital elevation model,[56] and these data are then mapped in the GIS environment. This enables us to better understand the relationship between the visibility of archaeological features and environmental characteristic.

Third, in order to assess the cultural processes we use the principle of a retrogressive analysis, based on the idea of landscapes as multi-layered spaces.[57] Starting from the contemporary

[52] Schiffer, *Formation Processes of the Archaeological Record* (note 43).

[53] De Reu, Deweirdt, Crombé, Bats, Antrop, De Maeyer, De Smedt, Finke, Van Meirvenne, Verniers, Zwertvaegher and Bourgeois, Les tombelles de l'âge du bronze en Flandre sablonneuse (nord-ouest de la Belgique) (note 24).

[54] AGIV and IWT, *Bodemkaart (1947–1973). Digitale bodemkaart van het Vlaams Gewest (CD-ROM)*, Brussel, 2001.

[55] AROHM and AML, *Landschapsatlas (CD-ROM)*, Brussel, 2001.

[56] AGIV, Digitaal Hoogtemodel Vlaanderen, *Nieuwsbrief GIS-Vlaanderen* 16 (2003) 3–21; AGIV, *DHM-Vlaanderen (2001–2004): Digitaal Hoogtemodel Vlaanderen (CD-ROM)*, Brussel, 2004; I. Werbrouck, M. Antrop, V. Van Eetvelde, C. Stal, P. De Maeyer, M. Bats, J. Bourgeois, M. Court-Picon, P. Crombé, J. De Reu, P. De Smedt, P.A. Finke, M. Van Meirvenne, J. Verniers and A. Zwertvaegher, Digital Elevation Model generation for historical landscape analysis based on LiDAR data, a case study in Flanders (Belgium), *Expert Systems with Applications* 38 (2011) 8178–8185.

[57] S. Rippon, The historic landscapes of the Severn Estuary levels, *Archaeology in the Severn Estuary* 10 (2000) 119–135; Roymans, Gerritsen, Van der Heijden, Bosma and Kolen, Landscape biography as research strategy (note 31); T.J. Wilkinson, The archaeology of landscape, in: J. Bintliff (Ed.), *A Companion to Archaeology*, Malden, 2004, 334–356.

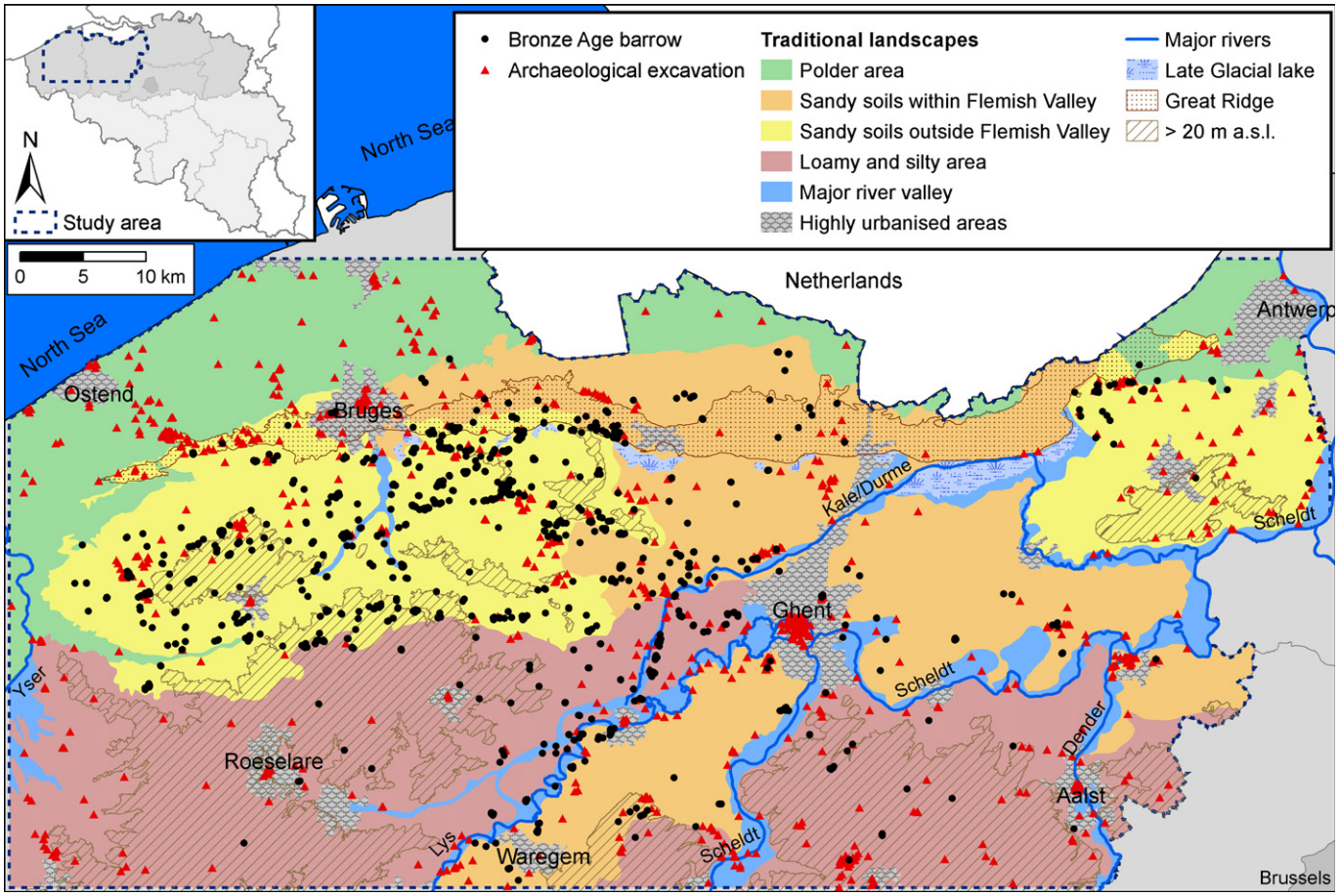

Fig. 7. Spatial distribution of Bronze Age barrows and archaeological excavations (until 2010, data Centrale Archeologische Inventaris Vlaanderen (CAI)) in north-western Belgium.

urbanised landscape, all current land use patterns are mapped in a GIS environment (e.g. developed areas, water bodies, agricultural areas and 'natural' vegetation). An important document for this stage is the Biological Valuation Map,[58] a survey and evaluation which provides information on the biotic environment, vegetation, land use and small landscape elements of Flanders and Brussels. In addition, historical sources (e.g. maps and documents) are also used to understand the impact of past activities on the preservation of archaeological phenomena. For north-western Belgium, the most important and large-scale activities were sand and peat extraction, the reclamation of land from the sea, riverbeds, marshes or swamps, the cultivating of natural areas and other large-scale agricultural activities.[59] There is much evidence of the reuse and remodelling of archaeological sites, and such phases of reuse and remodelling reflect the first cultural impact on sites that were still visible in the landscape. This gives us information about how sites were preserved in the landscape over time. The way in which landscapes, places and sites were reused or reordered reflects how these were perceived and experienced in later periods. Within this framework, the (at times total) dismantling of certain sites can lead to lesser visibility or even invisibility of these archaeological phenomena and biased distribution maps. Information about their long-term history can be derived from excavation data. Both past and current land use led to large-scale transformations of landscapes. This means that many landscapes we see as normal today had a different morphology in the past and were thus perceived and experienced very differently before their transformation.

Beyond the unknown: understanding biases in interpreting past landscapes

When studying archaeological landscapes it is important to incorporate and to understand the 'unknown' factor in the archaeological datasets. Going beyond the unknown, or trying to know the unknown, will definitely lead us to a better understanding and interpretation of past landscapes and the distribution pattern of archaeological phenomena. Furthermore, it will reduce the chances of circular reasoning and misinterpretations as a result of biased datasets.

At the end of the 1970s, pilot Jacques Semey was struck by clear anomalies he saw in the landscape below him as he was flying over north-western Belgium. Thus from the early 1980s onwards, in collaboration with the Department of Archaeology of Ghent University, systematic aerial survey was conducted in north-western Belgium, with a major focus on the sandy lowlands.[60] All

[58] Biologische Waarderingskaart, versie 2; De Saeger, Ameeuw, Berten, Bosch, Brichau, De Knijf, Demolder, Erens, Guelinckx, Oosterlynck, Rombouts, Scheldeman, T'jollyn, Van Hove, Van Ormelingen, Vriens, Zwaenepoel, Van Dam, Verheirstraeten, Wils and Paelinckx, *Biologische Waarderingskaart* (note 16).

[59] Verhulst, *Landschap en landbouw in Middeleeuws Vlaanderen* (note 4).

[60] Bourgeois, Meganck and Semey, Almost a century of aerial photography in Belgium (note 23); Bourgeois, Roovers, Meganck, Semey, Pelegrin and Lodewijckx, Flemish aerial archaeology in the last twenty years (note 23).

relevant features were photographed. Today, an exceptional dataset of 70,000 images is available, revealing just the 'tip of the iceberg' of past archaeological landscapes. However, photographs were only taken when a crop or soilmark was visible. As such, positive hits were documented, but there is no information about negative observations, and in particular no records of regions which were flown over, but which revealed no archaeological traces. Today, we can solve this problem by tracking the modern flight routes with GPS technology. Another way to solve this problem is to compare the observed distribution pattern of a certain archaeological feature, with the distribution patterns of other categories of archaeological traces visible on the aerial imagery. If feature A is not observed in a certain region, but features B, C and D have been observed, it could suggest and imply a historical absence of feature A in that region. If neither feature A, nor features B, C and D have been observed, this pattern can suggest a hiatus in the archaeological dataset.

Another way of interpreting negative results is to integrate negative archaeological excavation data into the distribution maps. This is particularly effective as the expansion of development-led archaeology over the past two decades has led to more 'random' sampling of the archaeological landscape. The quantity of data generated and the sheer areas covered by the development-led archaeology are on a far larger scale than the academic-driven research of the past century. By incorporating negative survey and excavation results into the archaeological distribution map and by comparing the spatial distribution of the positive and negative locations (Fig. 7), more reliable interpretations of the data can be made.

Furthermore, development-led archaeology also provided a sample of positive barrow locations that had not been discovered through aerial archaeology. This dataset is a more objective and representative sample of the Bronze Age barrow phenomenon than was detected through aerial surveys, as the latter method can lead to results being biased by environmental characteristics. In total, 40 Bronze Age monuments were discovered during (development-led) excavations and this information can be used to evaluate the patterns observed through aerial photography. A spatial analysis reveals that the barrows are more likely to occur on dry or moderate dry, sandy soils.[61] It could be suggested that this does not reflect the original distribution of barrows, but rather is due to the applied survey method, as crop and soil marks might occur faster on dryer soils than on wet soils. So to test this hypothesis, the same spatial analysis was performed on the monuments discovered during excavations. This spatial analysis revealed a similar distribution pattern of the excavated monuments therefore proving that the observations are valid, and are not just a result of the survey method. Indeed, in excavations too, barrows were found on dryer soils even more often than the aerial detected barrows (Fig. 8). Nonetheless, it is important to identify whether the present dataset is a representative sample of the wider phenomenon. If this is not the case, studies of the location of barrows in the landscape, for example their topographic position,[62] would be unreliable or even useless and would again lead to misinterpretations.

As mentioned above, environmental processes and geological characteristics can have a negative influence on how visible the barrows are, thus leading to biases in the distribution pattern. A first example can be found in the Polder area (Fig. 6). In this region, the sandy soils are covered by Holocene marine and alluvial deposits from the North Sea and Scheldt River respectively. As such, past landscapes such as the Bronze Age landscape, are sealed by peat and clay. On the one hand, although there is no Bronze Age evidence from the Polder region, it seems plausible that the coastal landscape was probably exploited during the Bronze Age and that barrows could thus be expected in the area, even if there is no evidence of this. However, on the other hand it is also possible that the coastal areas were simply unsuitable for barrow building and thus barrows were absent here, just like in the other wet, marshy, unstable or low-lying environments in the region. Indeed, the coastal landscape in Bronze Age times was characterised by a continuous peat growth.[63] Although it remains as yet unclear whether the gap in the distribution map is the result of a historic reality or a bias in our knowledge, the former hypothesis seems to be supported by the numerous excavations in the Polder area revealing no evidence of Bronze Age activities (Fig. 7). We find a similar situation when considering the absence of barrows in the alluvial plains of the (major) rivers. In these plains too, the Bronze Age landscape is sealed by thick layers of alluvial deposits. However, extensive excavations in this environment covering many hectares, for example in the context of harbour expansion on the left bank of the Scheldt near Antwerp,[64] revealed no evidence of Bronze Age activities. Furthermore, a spatial analysis of known barrows revealed a preference for topographically higher places in the landscape.[65] For example, the barrows around the upper valleys of the rivers Lys and Kale/Durme are concentrated on the higher sand ridges along the river's alluvial plains. Both observations therefore support the idea of an actual absence of barrows from the alluvial plains as opposed to a bias in data. In contrast, we have no definite conclusion yet when it comes to the general absence or low density of Bronze Age barrows on the loamy and silty soils towards the southern edge of the sandy lowlands (Fig. 6). It is as yet unclear whether this corresponds with the historic reality or with a bias in the data collection. Aerial surveys in these areas did not reveal useful results, while (recent) excavations also only revealed a limited number of sites (Fig. 6). This could simply suggest a low density of barrows in this region. A similar distribution pattern has been found in northern France where the higher grounds around the valley of the river Somme are characterised by an enormous concentration of barrows, while outside this area there are only a few isolated (groups of) monuments.[66]

About 95.4% of barrows have been detected on what is currently agricultural land, with an absolute majority of the barrows (about 78%) on crop land and the remaining 17.5% on pasture land (Fig. 3). Just 3.5% of barrows were detected on land which has development

[61] De Reu, *Land of the Dead* (note 2).

[62] De Reu, Bourgeois, De Smedt, Zwertvaegher, Antrop, Bats, De Maeyer, Finke, Van Meirvenne, Verniers and Crombé, Measuring the relative topographic position of archaeological sites in the landscape, a case study on the Bronze Age barrows in northwest Belgium (note 6).

[63] C. Baeteman, D.B. Scott and M. Van Strydonck, Changes in coastal zone processes at a high sea-level stand: a late Holocene example from Belgium, *Journal of Quaternary Science* 17 (2002) 547–559; C. Baeteman, Radiocarbon-dated sediment sequences from the Belgian coastal plain: testing the hypothesis of fluctuating or smooth late-Holocene relative sea-level rise, *The Holocene* 18 (2008) 1219–1228; K. Deforce, Middle and late Holocene vegetation and landscape evolution of the Scheldt estuary: a palynological study of a peat deposit from doel (Belgium), *Geologica Belgica* 14 (2011) 277–288.

[64] P. Crombé (Ed.), *The Last Hunter–Gatherer–Fishermen in Sandy Flanders (NW Belgium). The Verrebroek and Doel Excavation Projects. Volume 1: Palaeo-environment, Chronology and Features*, Gent, 2005.

[65] De Reu, Bourgeois, De Smedt, Zwertvaegher, Antrop, Bats, De Maeyer, Finke, Van Meirvenne, Verniers and Crombé, Measuring the relative topographic position of archaeological sites in the landscape, a case study on the Bronze Age barrows in northwest Belgium (note 6).

[66] S. Toron, L'emploi de la photographie aérienne en archéologie: nouvelle approche des monuments circulaires protohistoriques, *Mosaïque* 2 (2010) 1–12.

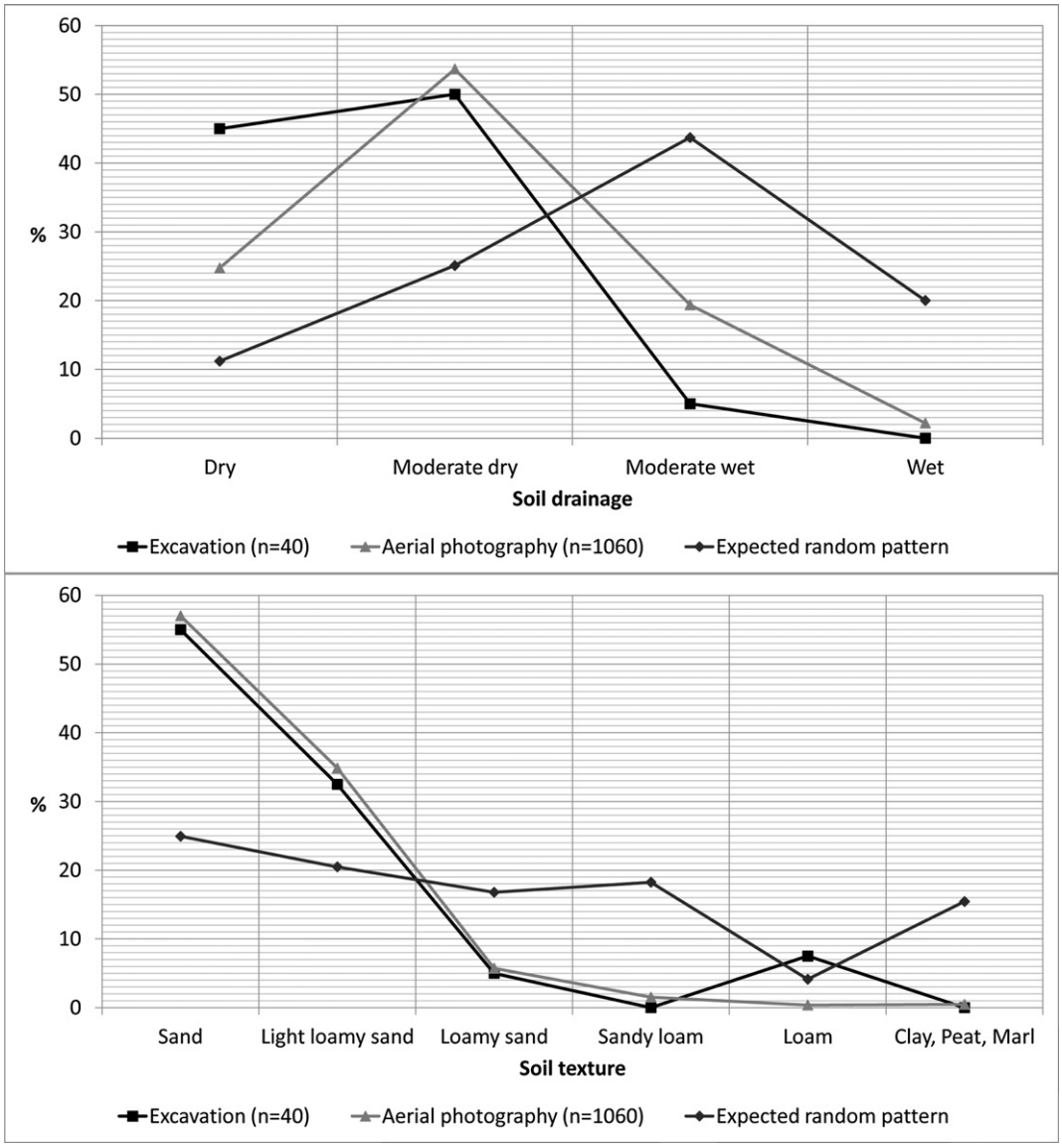

Fig. 8. Spatial distribution of the aerial detected barrows and the barrows detected during excavations across the different soil drainage classes (top), and the different soil texture classes (bottom).

on it currently. In all cases, the barrows on developed land are excavated monuments. The final 0.9% was detected on terrain that was agricultural land, but currently features 'natural' vegetation, reflecting recent changed land use patterns. As such, almost all barrows were detected on agricultural land, representing less than 65% of the study area. It is therefore important to map the preservation and visibility of the archaeological dataset in relation to the urbanised landscape. For this project, the current patterns of land use were mapped using the Biological Valuation Map, and divided into three categories: (i) types of land use where Bronze Age heritage has largely been destroyed (i.e. developed areas and water bodies), (ii) types of land use where Bronze Age heritage potentially can be preserved, which however, are unsuitable for aerial photographical surveys (e.g. terrains with dense vegetation including woodlands, nature reserves, etc.) and (iii) types of land use where Bronze Age heritage can potentially be preserved and which are also suitable for aerial surveys (e.g. agricultural land) (Fig. 9). This division makes immediately visible the biases in the data which are caused by the larger cities, including Ghent and Bruges. However this is not the only benefit, and this map can provide useful information about other regions too. In the region of Aalter–Beernem, for example, we can note a significant gap in the barrow distribution pattern (Fig. 6). However, as a significant part of this area is developed or covered by dense vegetation, it can also be argued that this gap in distribution may at least partly be caused by the present land use patterns, and not necessarily reflect the historic reality.

In other regions of the study area, historical sources provide valuable information about large-scale exploitations of the landscape in Medieval or Early Modern eras. By understanding these activities, we can also better understand the currently known distribution pattern of Bronze Age barrows in north-western Belgium. In the region of the Land van Waas, for example, most of the barrows were discovered during excavations, while aerial photographic surveys had only little success (Fig. 6). This is actually due to the agricultural techniques applied in this region during the ancient régime. At that time, the fields were made of square plots of land which allowed a drainage technique of spherical parcels which were rather higher in the middle (up to

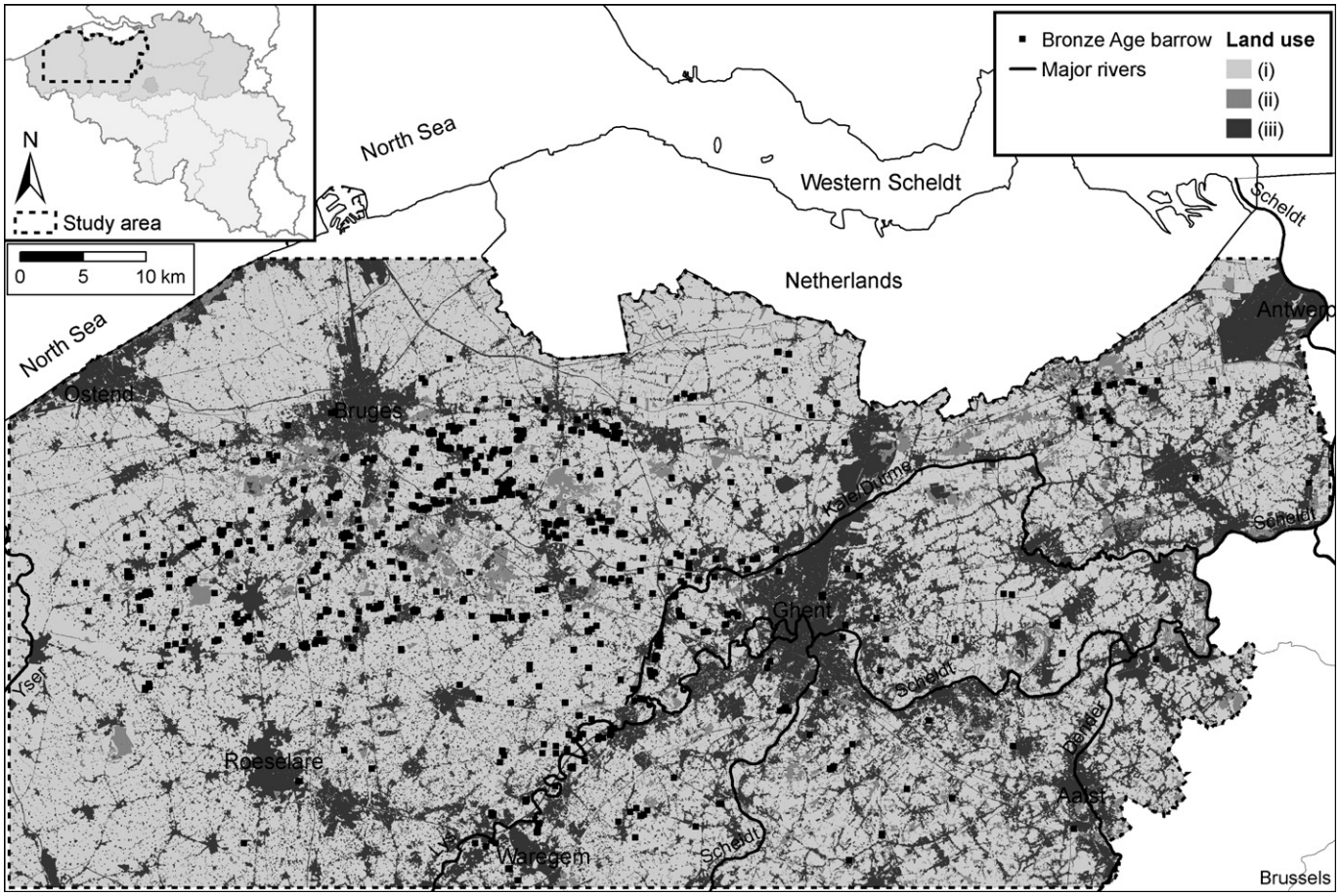

Fig. 9. Map of the study area in north-western Belgium showing potential for aerial photographic surveys based on the current land use patterns in relation to the distribution pattern of the Bronze Age barrows; (i) land use types where the Bronze Age heritage is largely destroyed, (ii) land uses where the Bronze Age heritage is potentially preserved, however that are unsuitable for aerial photographical surveys and (iii) land uses where the Bronze Age heritage is potentially preserved and that are suitable for aerial surveys.

several metres) than at their borders (*bolle akkers* in Dutch, *champs bombés* in French).[67] The construction of these fields is archaeologically dated to the fifteenth–sixteenth century,[68] although their origin may go back earlier to the thirteenth century.[69] It is clear that the presence of these raised fields prevents us now from detecting barrows through aerial photographs, and therefore suggests that the dataset is slightly biased by the presence of these raised fields. In addition, in the Land van Waas region, the non-random distribution pattern of the barrows is quite remarkable. There is a clear clustering of monuments towards the northern end of the cuesta of the Land van Waas, where the barrows are located on local, topographically more prominent, dry and sandy ridges. Two barrows are located on a sand ridge along the Scheldt River. Here too it is important to note the general absence of barrows on the more heavy, loamy and silty soils, even though they form the highest part of the cuestas (Fig. 10). A similar observation can be made around the cuesta of Oedelem, where the barrows also tend to occur on the locally prominent sandy parts while there are few or no barrows on the very prominent clay, loamy and silty soils on the highest part of the cuesta. Although this observation still needs to be verified by excavation data, it is important to note that the area of the cuesta of Oedelem belongs to the most intensively aerial surveyed regions of north-western Belgium. Regarding the more heavy soils, these surveys revealed several other types of cropmarks belonging the various chronological eras, while Bronze Age barrows remained absent.[70] This makes it more unlikely that the hiatuses are the result of biased datasets, but instead represent Bronze Age decisions.

The central, northern and lowest part of the Flemish Valley are characterised by a general absence of Bronze Age burial mounds (Fig. 6). Recent research using historical maps and documents proved the presence of large (Holocene) peat marshes in the northern part of this area. This peat was extensively extracted

[67] F. Dussart, Les types de dessin parcellaire et leur répartition en Belgique, *Tijdschrift van de Belgische Vereniging voor Aardrijkskundige Studies* 30 (1961) 21–65; F. Snacken, Streekindeling en begrenzing van het land van Waas, *Tijdschrift van de Belgische Vereniging voor Aardrijkskundige Studies* 30 (1961) 217–255; E. Thoen, Een 're-Marc-able landscape'; Het Land van Waas, de bolle akkers en de Vlaamse landbouw in de Middeleeuwen en het Ancien Régime, in: V. Van Eetvelde, M. Sevenant and L. Van De Velde (Eds), *Re-Marc-able Landscapes. Marc-ante Landschappen. Liber Amicorum Marc Antrop*, Gent, 2009, 132–142.

[68] R. Van Hove, De 'klassieke' bolle akkers van het Waasland in archeologisch perspectief, *Annalen van de Koninklijke Oudheidkundige Kring van het Land van Waas* 100 (1997) 283–328.

[69] Thoen, Een 're-Marc-able landscape' (note 67).

[70] For example, W. De Clercq, P. De Smedt, J. De Reu, D. Herremans, P. Masters, T. Saey, B. Stichelbaut and M. Van Meirvenne, Towards an integrated methodology for assessing rural settlement landscapes in the Belgian lowlands, *Archaeological Prospection* 19 (2012) 141–145.

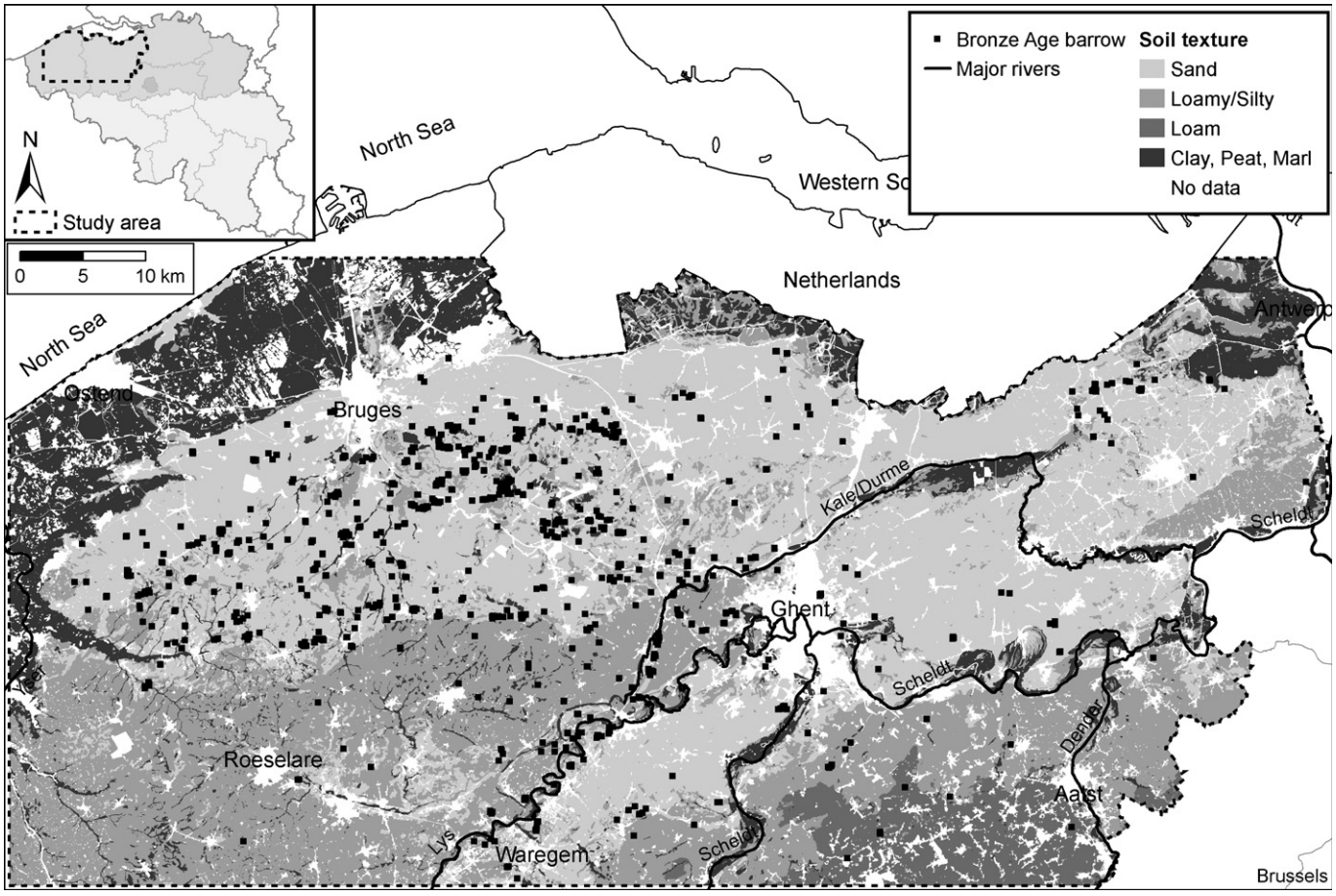

Fig. 10. Map of the study area in north-western Belgium showing the soil texture and the distribution of the Bronze Age barrows.

between the eleventh and fifteenth centuries by several abbeys active in the region.[71] Today, these moors and peat marshes are no longer present in the landscape, and the former moorland has been converted into arable land. The only visible remain of the previous landscape is the large depression of the Moervaart, a former Late Glacial lake that remained a boggy area throughout the Holocene.[72] The area was intensively inhabited by hunter–gatherers,[73] however it seemingly was not exploited by the agro-pastoral communities from the Bronze Age onwards, right up until the early medieval period.[74] One explanation for the general absence of sites in these regions could be the fact that moors were often considered as ideologically and culturally marginal or were considered as dangerous and full of natural and supernatural hazards.[75] Although it is unclear how this landscape was perceived and experienced in the Bronze Age, it was definitely not an easy accessible and exploitable environment. The environmental conditions of the region were definitely more suitable for hunter–gatherer land use and subsistence strategies than for agro-pastoral settling, exploitation and burial practices.

Excavation evidence has revealed that the Bronze Age barrows in the north-western Belgian landscape remained visible for at least 1500 years. The results of several excavations point to reuse of the barrows or burial sites, for example by the addition of new features, enclosures, ritual monuments or burials in later periods like the Iron Age and the Roman Period.[76] In addition to the land reclamations and intensive peat extraction in the Polder area in

[71] E. De Reu, Historisch–Geografisch onderzoek betreffende de moergronden in de vier ambachten tijdens de 12e, 13e en 14e eeuw, in: *Oudheidkundige Kring de Vier Ambachten. Jaarboek 1960–1961*, Hulst, 1961, 31–69; I. Jongepier, T. Soens, E. Thoen, V. Van Eetvelde, P. Crombé and M. Bats, The brown gold: a reappraisal of medieval peat marshes in Northern Flanders (Belgium), *Water History* 3 (2011) 73–93; K.A.H.W. Leenders, Venen en moeren: historisch–geografische benadering, in: A.M.J. De Kraker, H. Van Royen and M.E.E. De Smet (Eds), *Over den Vier Ambachten: 750 jaar Keure, 500 jaar Graaf Jansdijk*, Kloosterzande, 1993, 65–70; L. Stockman, Moergronden en turfuitbating in de ambachten Maldegem en Aardenburg en in de keure van Eeklo, *Appeltjes van het Meetjesland* 24 (1973) 73–88; C. Verbruggen and J. Semey, Venen en moeren: fysisch-geografische benadering, in: A.M.J. De Kraker, H. Van Royen and M.E.E. De Smet (Eds), *Over den Vier Ambachten: 750 jaar Keure, 500 jaar Graaf Jansdijk*, Kloosterzande, 1993, 61–65.

[72] Denys, Verbruggen and Kiden, Palaeolimnological aspects of a Late-Glacial shallow lake in Sandy Flanders, Belgium (note 10).

[73] Crombé, Sergant, Robinson and De Reu, Hunter–gatherer responses to environmental change during the Pleistocene–Holocene transition in the southern North Sea basin (note 1); Crombé and Verbruggen, The Lateglacial and early Postglacial occupation of northern Belgium (note 11).

[74] For example, I. Bourgeois, B. Cherretté and J. Bourgeois, Bronze Age and Iron Age settlements in Belgium. An overview, in: J. Bourgeois, I. Bourgeois and B. Cherretté (Eds), *Bronze Age and Iron Age Communities in North-western Europe*, Brussels, 2003, 175–190; De Clercq, *Lokale gemeenschappen in het Imperium Romanum* (note 3).

[75] S. Turner and R. Young, Concealed communities: the people at the margins, *International Journal of Historical Archaeology* 11 (2007) 297–303.

[76] For example, J. Bourgeois, J. Semey and J. Vanmoerkerke (Eds), *Ursel. Rapport provisoire des fouilles 1986–1987. Tombelle de l'âge du bronze et monuments avec nécropole de l'âge du fer*, Gent, 1989; B. Cherretté and J. Bourgeois, Circles for the dead. From aerial photography to excavation of a Bronze Age cemetary in Oedelem (West-Flanders, Belgium), in: J. Bourgeois, M. Meganck (Eds), *Aerial Photography and Archaeology 2003. A Century of Information*, Gent, 2005, 255–265; F. Vermeulen and J. Bourgeois, Continuity of prehistoric burial sites in the Roman landscape of Sandy Flanders, in: J. Pearce, M. Millet and M. Struck (Eds), *Burial, Society and Context in the Roman World*, Oxford, 2000, 143–161.

northern Belgium, the interior of north-western Belgium also became the subject of an intensive reclamation movement.[77] Between 1000 and 1300 AD, the County of Flanders was the driving force towards the cultivation of large parts of the rural landscape in north-western Belgium. There is no doubt that this persistent arable farming in the medieval period had a highly destructive effect on the barrows, as already recorded in the highly monumental Stonehenge landscape.[78] For, even if Bronze Age barrows were still preserved in the landscape around the end of the first millennium AD, the subsequent reclamations quite definitely caused their flattening and disappearance. From that time onwards, these monuments became hidden from view until J. Semey discovered their remains from the air and captured them systematically on photographs starting in the late 1970s.

Conclusion

Completeness and reliability are undoubtedly two crucial considerations in archaeological landscape research. Efforts to estimate the relative completeness and reliability of any dataset should be an integral part of every archaeological landscape research project, especially as biases or hiatuses in datasets can lead to serious misinterpretations or circular reasoning. It is for this reason that we argue for the integration of the study of the preservation potential of archaeological phenomena in their environment within archaeological landscape research. Cultural and natural processes have an especially great impact on the preservation of archaeological phenomena and on what we see and know of past landscapes. In addition, the history, intensity and methodology of archaeological research need to be understood and integrated. A thorough understanding of the impact of these cultural, natural and 'archaeological' processes on the archaeological record will provide a better understanding of the archaeological record itself, making it possible to understand the extent to which past archaeological landscapes are known. As such, we can avoid studying archaeological landscapes solely based on what is already known, by understanding what is still unknown. Only with this knowledge, can we begin the study of archaeological site distribution and start interpreting the observed patterns. In our own research, analysis of the pattern of Bronze Age barrows in relation to various landscape variables could only begin properly when the research concerning completeness and reliability of the dataset was finished.[79]

This kind of research can also lead to a more accurate predictive modelling of where sites might have been but are now destroyed (as in developed areas) or may lie undetected as yet (as in areas covered by a dense vegetation). Furthermore, the knowledge of the completeness and reliability of the archaeological dataset has great potential value if we want to know how to preserve an archaeological landscape or if we want to incorporate the hidden archaeological heritage of a landscape into the current sustainable management of its cultural–historical values.[80] It is for this reason that such data offer significant possibilities when applied in the spheres of heritage management, spatial planning and landscape design, both enhancing our understanding of past landscapes, and helping decision-makers to make the right decisions. As such, we believe that archaeological landscapes cannot be studied without a full understanding of the landscape and the formation processes of the archaeological record.

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[77] Verhulst, *Landschap en landbouw in Middeleeuws Vlaanderen* (note 4).

[78] F. Peters, Bronze Age barrows: factors influencing their survival and destruction, *Oxford Journal of Archaeology* 18 (1999) 255–264.

[79] De Reu, Bourgeois, De Smedt, Zwertvaegher, Antrop, Bats, De Maeyer, Finke, Van Meirvenne, Verniers and Crombé, Measuring the relative topographic position of archaeological sites in the landscape, a case study on the Bronze Age barrows in northwest Belgium (note 6); J. De Reu, J. Bourgeois, V. Gelorini, M. Bats, P. De Smedt, A. Zwertvaegher, M. Antrop, P. De Maeyer, P. Finke, M. Van Meirvenne, J. Verniers and P. Crombé, Towards a spatial understanding of the Bronze Age barrow landscape in northwestern Belgium, *Journal of Anthropological Archaeology* (In review); De Reu, *Land of the Dead* (note 2).

[80] See also T. Bloemers, H. Kars, A. van der Valk and M. Wijnen (Eds), *The Cultural Landscape and Heritage Paradox. Protection and Development of the Dutch Archaeological–Historical Landscape and its European Dimension*, Amsterdam, 2010.