The use of auger survey to detect prehistoric artefact distributions in Flanders (1996-2017)

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"*It goes without saying – I hope – that what is old is by no means necessarily good, but what is new is not necessarily better*" (Corry, 2011)

1. *Introduction*

Current evidence indicates that Flanders has a long history of hominin occupation, extending at least 300 000, and possibly even 500 000, years back in time (Van Baelen, 2017; Van Baelen & Ryssaert, 2011; Meijs *et al.*, 2014). Its archaeological record includes soil features and distributions of non-portable and portable artefacts, preserved within a broad range of depositional contexts and affected by a complex and diverse set of past and on-going formation processes. These material remains and the context in which these remains occur allow us to study aspects of past hominin behaviour in relation to past environments. These remains first and foremost need to be discovered before they can inform us about past behaviour and the remote world in which these hominins lived, or before they can be adequately dealt with in the context of archaeological heritage management in those areas where present-day human activities directly or indirectly impact upon this vulnerable soil archive.

Many years ago, McManamon (1984: 45) noted that "[t]*here is no general resolution in the problem of site discovery, but the fact that it is increasingly recognized as a problem to be dealt with explicitly is an improvement*". Equally pertinent to the Flemish situation, this quote essentially indicates that the most appropriate manner to discover these material remains is through archaeological survey. While such an active search can be instigated under different circumstances and with different goals in mind, most of the current archaeological discoveries in Flanders are made prior to the imminent danger of their destruction as a result of land development projects, in what is commonly referred to as developer-led archaeology. Within this context, the prime impetus to undertake surveys is a specific threat -as opposed to scientific research questions- and as a result these surveys aim to detect and assess in a systematic, reliable and cost-efficient manner all archaeological remains that are under threat of partial or complete distortion or destruction. Following the implementation of the archaeological legislation in 2016, this type of fieldwork has become predominant and as such is strictly regulated by the Flemish government. In Flanders, the current legal framework is set out in the so-called '*Onroerenderfgoeddecreet*' (2013) and as in many other parts of Europe, it relies on the *European Convention on the Protection of the Archaeological Heritage (Revised)* (1992). It is strongly influenced by ideas, concepts and practises of cultural heritage management, most of which are taken for granted and no longer scrutinized by field archaeologists. Since its development in the last decade of the 20th century and even prior to its full implementation during the last few years, this so-called Malta (-inspired) archaeology coincided with a privatization of the archaeological discipline. In this competitive market of bidding for contracts, survey is mainly conducted by archaeologists contracted by archaeological companies. In an attempt to insure a minimum level of quality and comparability of archaeological fieldwork within this pressing environment, the Flemish organization for Immovable Heritage (i. e. *Agentschap Onroerend Erfgoed*, *AOE*) has developed a set of mandatory norms to guarantee an efficient and qualitative investigation of the Flemish archaeological record. Known as the Code of Good Practise (*Code van Goede Praktijk,* CGP, current version 3.0), these norms are complemented by a set of non-mandatory guidelines describing how things -including archaeological survey- should best be organized.

A major part of the (prehistoric) archaeological record in Flanders consists of knapped stone artefacts located at, near and deeply below the present-day surface and embedded in sandy, loamy or clayey deposits. In many instances these durable lithic artefacts are the only behavioural residues of past hominin behaviour scattered across the (buried) landscape. Elements of this lithic record have been fortuitously or deliberately exposed since at least the early 19th century (Goodrum, 2013). After more than two centuries of fortuitous finds, planned surveys and/or excavations it is clear that at least part of the artefact distributions take the form of small, discrete clusters. Regardless of their topographical position and depositional context these clusters show a large variation in size, density, shape and composition, and consist either exclusively of lithic artefacts or are found in spatial association with similar distributions of organic remains. Another important characteristic of these clusters is the vertical distribution of the artefacts, often amounting to several decimetres and nearly always resulting in the presence of a hidden subsurface -and often also an exposed surface- component. The location and visibility of artefacts relative to the present-day surface is therefore an important factor to take into account in survey designs, with a crucial distinction between exposed surfaces with high visibility and buried deposits with very low or no direct visibility at all.

Over two decades ago, Crombé & Meganck (1996: 101-104) wrote that "[a]*fter three excavation campaigns* [...] *it was decided in the summer of 1996 to organize an extensive survey campaign in order to get a detailed picture of the site and its direct surroundings. The gathered information should enable us to organize future excavations on the site in a better and a more efficient way. Because of the rather thick sedimentary cover, the survey could only be realized by systematically augering and sampling the site*". Referring to the Mesolithic site of Verrebroek–Dok 1, this quote is the first reference to archaeological auger sampling in regular grid lay-outs together with systematic sieving of soil samples in Flanders. It reflects the introduction of this novel approach into the repertoire of Flemish survey practises, only as recently as the mid-1990s, a few years after it had found its way into Dutch survey practises. More than two decades later, this kind of subsurface sampling is considered to be the most practical, reliable, effective and cost-efficient approach currently available to discover and assess clustered artefact distributions in areas where the remains are (deeply) buried by younger deposits or have been covered by vegetation.

Since its first introduction at Verrebroek–Dok 1 twenty-odd years ago, auger sampling has been applied at well over 230 different locations in Flanders, as part of at least 90 development-led and scientific projects and often within the context of multi-phased survey trajectories. Despite being a (slowly) growing tradition, no reflective overview of this survey approach has appeared to date, a few evaluations of the applied methodologies notwithstanding. By providing a preliminary overview of auger sampling in Flanders since its first introduction in the summer of 1996 until the end of 2017, this paper tries to fill this void. Based on this inventory, we show that its methodology is characterized by a large amount of variation. Focussing on grid lay-out, auger devices, treatment of collected soil samples, and the role that auger sampling plays within each of the survey trajectories, a critical assessment of these aspects of auger sampling in Flanders will be provided.

2. Dataset & methods

Our inventory relies on a study of ca. 360 written accounts, including journal articles, monographs, book chapters and field reports, in addition to information taken from the database of known archaeological sites in Flanders managed by AOE (i. e. the *Centrale Archeologische Inventaris*, *CAI*). Apart from a range of variables related to the location, extent, shape and environmental context of the surveyed areas, several variables related directly to methodological aspects of the auger survey were recorded as well. These include: the incentives and reasons to undertake a survey; the finality of survey (i. e. whether it is aimed at discovering new or assessing previously discovered remains); an outline of the fieldwork trajectory with number, nature and relative position of other survey phases relative to the auger sampling and the nature of the follow-up trajectory; information on the surveyors (name and type of institution, e. g. company, university, government); prior knowledge and expectations; the number of planned, completed and sampled auger points; auger device and diameter; grid lay-out including the pattern and interval between the auger points; observation methods and techniques including sieving strategy and mesh width; the number of samples that yielded archaeological remains including numbers of lithic artefacts and of carbonized plant remains; and recommendations based on the survey results including argumentation and applied criteria. The preliminary review presented below relies on an extensive dataset of auger sampling conducted in Flanders during the past 22 years. While extensive, this inventory is not exhaustive: for at least a small number of other projects, reports were unavailable to us or became available only after we completed our analyses. Yet, despite these omissions the current inventory is considered representative (enough) to discern, quantify and discuss some of the major regional and chronological trends of auger survey in Flanders.

3. Results

3.1. Geographical variation

Auger survey projects, each of which may contain one or more surveyed areas, are not uniformly distributed across Flanders and the province of East-Flanders stands out in many respects (Fig. 1). It not only contains the highest number of projects (39 %), but at the same time also has the highest number of surveyed areas (42 %) and auger points (45 %), and represents the largest sampled area, corresponding to 0,04 % of the total surface of the province. West-Flanders and Antwerp each represent 20 % of all surveyed areas. There is, however, a marked difference between these two provinces in the relative number of auger projects (14 % *versus* 23 %), auger points (8 % *versus* 25 %) and sampled area (0,020 % *versus* 0,012 % of the province's total surface). Despite having less surveyed areas compared to West-Flanders (12 % *versus* 21 %), Limburg contains a relatively higher number of projects (18 %), auger points (21 %) and a larger sampled part of the province surface (0,015 %), with percentages similar to those of the province of Antwerp. Flemish-Brabant lags behind in all these respects; it barely represents 6 % of all projects, corresponding to only 1 % of the auger points and a sampled surface of only 0,002 % of the province area.

No auger projects are currently known from the dunes along the Northsea coastline (Fig. 1). With only one project in an area of 891 km^2, good for scarcely 0,9 % of all auger points, the loamy area in the southern part of Flanders, covering 7 % of its surface and stretching over the provinces of West-Flanders, East-Flanders, Flemish-Brabant and

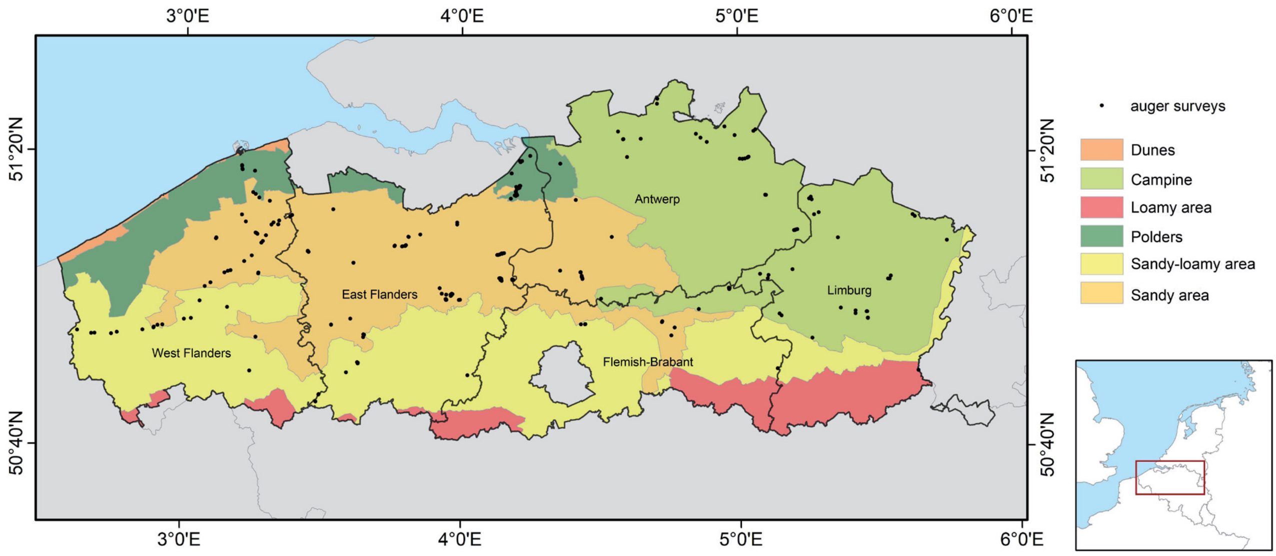

Fig. 1 – Location of auger survey projects in Flanders.

Limburg, is also heavily underrepresented. This equally applies to the sandy-loamy area situated to the north of it and dispersed over the same four provinces. While the surface of this area corresponds to 29 % of the whole of Flanders, it only has 10 % of the auger projects and surveyed areas, corresponding to hardly 2,5 % of all auger points. The sandy areas of the Campine, Sandy Flanders and the Polders on the other hand show a different picture. Most auger projects (40 %) and sampled areas (47 %) are from the sandy soils of Sandy Flanders that corresponds to only 28 % of Flanders' surface, including parts of West-Flanders, East-Flanders, Antwerp and Flemish-Brabant. It contains 38 % of all auger points, comparable to –but also slightly less than– the percentage encountered in the Campine (39 %) in the north-eastern part of Flanders. The latter area covers a surface similar in size (29 %), stretches over Antwerp, Limburg and Flemish-Brabant and is also dominated by sandy soils. While it contains the most auger points of all geographical regions, the relative number of projects (33 %) and sampled areas (28 %) is lower than for Sandy Flanders. Finally, the Polders in West-Flanders, East-Flanders and Antwerp, corresponding to 7 % of the total surface of Flanders, represent 15-16 % of all projects and sampled areas and one-fifth of all auger points. Except for a number of projects in the coastal polders around the town of Bruges, these Polder-projects are situated near Antwerp in the *(Waasland) Scheldepolders*. These polders not only represent the first, but also form one of the most intensively surveyed areas in Flanders.

3.2. *Temporal variation*

During the first decade after its introduction the number of auger projects fluctuated on a yearly basis but overall remained low, with a maximum of only 4 per year and a total number of 15 (Fig. 2a). The second decade (2006-2015) witnessed a clear rise with a total of 49 projects and between 3 and 10 projects per year. The mean number of projects per year during this second decade almost doubled compared to the previous one. After a steady increase between 2005 and 2011 the number of projects drops again significantly between 2012 and 2015. Following the implementation of the 2016 archaeological regulation, a clear rise is noted. Modest in 2016, this rise becomes more marked in 2017, leading to the highest number of projects per year (N = 19) so far, almost twice as high as the 2011 peak.

A slightly different curve appears when the number of surveyed locations, instead of the number of projects, is considered (Fig. 2b). Here, too, the first decade is characterized

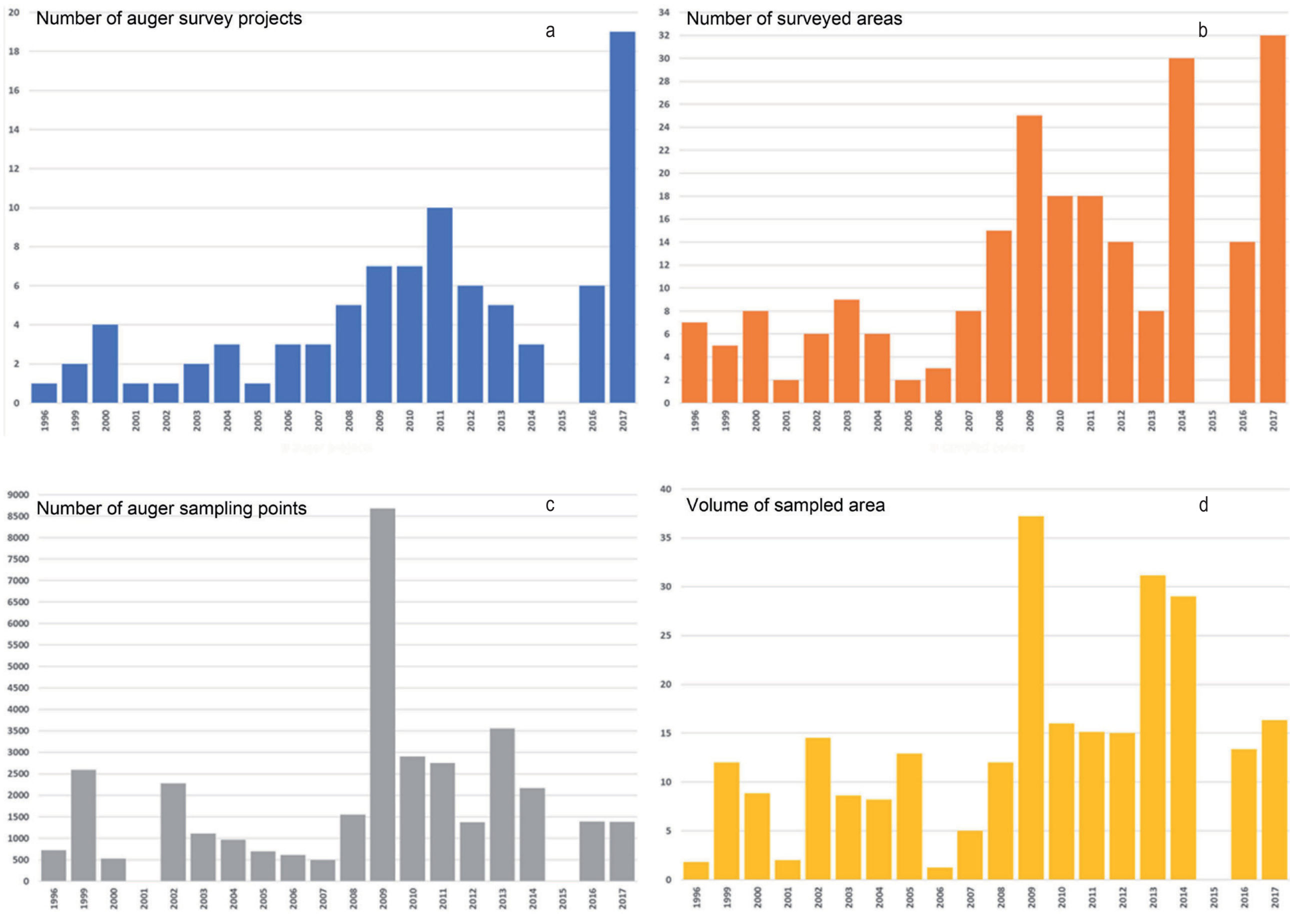

Fig. 2 – Chronological evolution of auger projects, surveyed areas, auger points and sampled volume.

by modest numbers when compared to more recent times (N = 45 or 20 % of the sampled areas, corresponding to a mean value of 4,5 per year). After 2005 the number of surveyed areas increases, resulting in a total of 139 (60 %) during the second decade, or a mean of nearly 14 per year. The highest numbers during this period were reached in 2009 (N = 25) and in 2014 (N = 30), the latter peak largely reflecting 28 sampled areas as part of a single project. In agreement with the increase in projects due to the new regulations, the number of surveyed areas (N = 46) also dramatically increased during the past two years, with a mean of 23 per year.

The annual number of auger points (Fig. 2c) and the extent of the sampled surfaces (in ha, Fig. 2d) show different patterns, nuancing the rising trends observed above in the number of projects and surveyed areas in recent years. Both are well represented for the period between 2008 and 2014 with values of 63 % for the number of auger points and 58 % for the sampled surfaces. A first peak of over 2 500 auger points appeared already before the turn of the millennium and can be linked to the large-scale project at Meer-Meirberg. While the number of projects and sampled areas were both relatively modest in 2002, the projects that took place during that same year resulted in a second peak in the number of auger points (N = 2 274) corresponding to a sampled surface of 14,5 ha. All these auger points were part of a single (methodological) project by the Flemish organization for Immovable Heritage including surveys at several locations in Opglabbeek and Ravels. The next five years saw a continuous decrease in number of sampled auger points, reaching less than 500 in 2007. This happened at a time when the number of projects and surveyed areas were already increasing again as well as the sampled surface after it had dropped dramatically from ca. 13 ha in 2005 to only slightly more than 1 ha in 2006. The year 2009, when a first high peak of 25 surveyed areas was reached, coincides with the highest number of auger points (N = 8 681) and the highest sampled surface (37,5 ha). These peaks are mainly due to one very large project at Lommel-Kristalpark III where no less than 3 875 points were sampled in a zone of ca. 11 ha, representing 45 % of all corings from that year. Between 2010 and 2014 the number of auger points fluctuated yearly between 1 375 and 3 555 whereas the sampled surfaces range from 15 to 32 ha, reaching two additional peaks in 2013 and 2014. Remarkably, the recent exponential increase in number of projects and surveyed areas following the implementation of the 2016 regulations is not at all reflected in the number of auger points or sampled surfaces which remain below 1 400 auger points for sampled areas of ca. 13 and 16 ha. This discrepancy between the (high) numbers of projects and sampled areas on the one hand and the (lower) number of auger points and surveyed surface on the other hand suggest that in recent years the rise in projects corresponds with a reduction in size of the project areas and/or the use of grids with larger distances between the auger points.

3.3. Surveyors

Surveyors engaged in auger survey have diverse backgrounds and include members of archaeological companies, universities and local and regional governmental agencies. Most of the projects were done by archaeologists connected to commercial archaeological units (45 %), representing at least 16 different companies, and by scholars from the archaeological departments of the universities of Ghent, Leuven and Brussels (25 %). Governmental agencies represent the remaining 30 % and are mainly represented by the heritage consultants of the Flemish organization for Immovable Heritage in its different consecutive forms (i. e. I.A.P., VIOE, AOE). The role of (inter-)municipal and provincial agencies remains limited. In 13 % of all inventoried projects members of different institutions joined forces. Such temporal partnerships are most often set up by universities and governmental agencies. For both groups 23 % of their projects are part of such cooperation, usually the two working together, although collaborations between universities and companies or between government agencies also occur. Over 96 % of the projects by archaeological companies are done by individual units. During the first decade auger survey was the exclusive domain of universities and governmental agencies, both of which remained active (at least) until around 2012. From around 2010 onwards their involvement gradually declined in favour of the young commercial units and -to a lesser extent- (inter-)municipal agencies, a trend that follows wider developments in Flemish survey archaeology (De Clercq *et al.*, 2012). The last decade and in particular the last two years were largely dominated by commercial practices as part of developer-led archaeology.

3.4. The place of auger sampling in survey practices in Flanders

While the amount of auger surveys may seem impressive at first sight, their numbers are negligible when viewed within the complete picture of archaeological survey in Flanders between 1996 and 2017. Few reliable published accounts on the evolution and nature of survey practices throughout this period are available, apart from a number of partial overviews of mechanical trial trenching between 1992 and 2009 (De Clercq *et al.*, 2012) and between 2004 and 2014 (Haneca *et al.*, 2016). The CAI remains the most extensive inventory of previous archaeological research in Flanders and provides the best estimates. When comparing the present auger dataset to the CAI, the marginal character of auger survey stands out, despite the recent increase in this type of survey projects (Fig. 3). A glance at the new portal site of AOE, that contains information on the number and nature of archaeological field interventions since the implementation of the new legislation in 2016, confirms this picture as auger survey represents less than 3 % of all (development-led) survey fieldwork since 1996, in contrast to well over 51 % for mechanical trial-trenching.

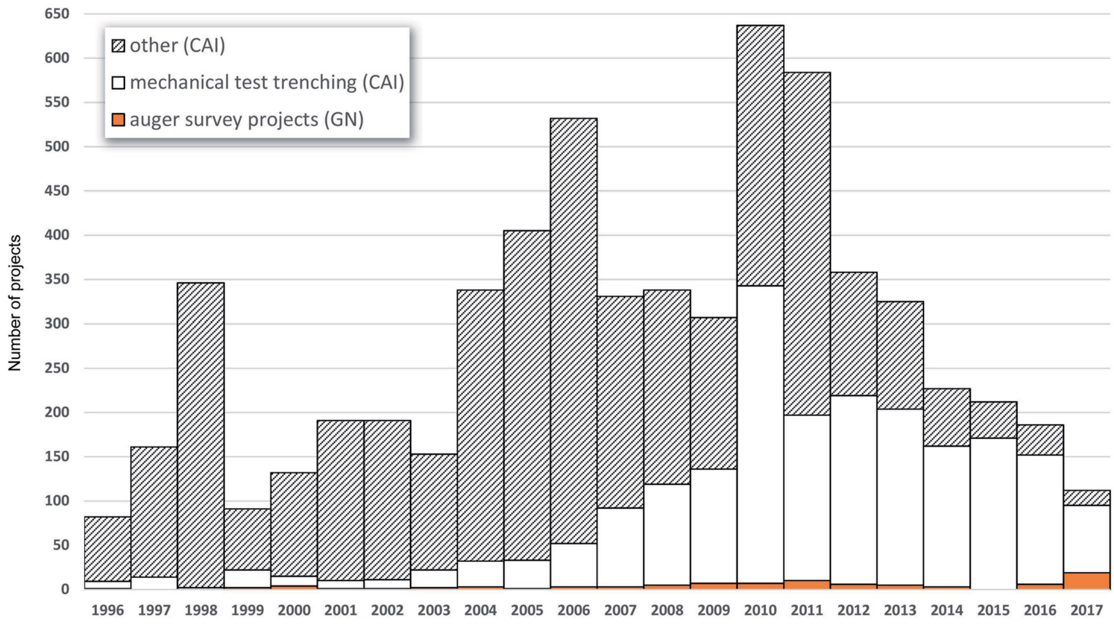

Fig. 3 – The role of auger survey in survey practices in Flanders between 1996 and 2017.

3.5. *Variation in the nature of the survey trajectory*

All auger surveys from our dataset are part of multi-phased survey trajectories. These trajectories may include one or more of the following phases: desk-top study, geophysical survey, palaeo-environmental coring/test-pitting, fieldwalking, mechanical trial trenching, manual test pitting, archaeological monitoring of development projects and archaeological augering. The trajectories are diverse, both with respect to the number and nature of the phases but also with regard to the relative position of these phases within the trajectory. In the 221 surveyed areas where the survey trajectory was completed before the end of 2017 no less than 62 different combinations in trajectory are recorded. The number of phases in the trajectory varies from 1 to 7. Trajectories with three and four phases dominate and account for nearly 70 % of all surveyed areas (resp. 42 % and 27 %), followed by five- and two-phased surveys (resp. 12 % and 10 %). In general, the number of phases in a survey trajectory increases through time. One- or two phased surveys are dominant only during the initial period of auger survey (1996-2003) and become rare in more recent times. One-phased surveys remain limited to the first year of auger survey and only about one-third of all two-phased surveys occurred between 2008 and 2017. Surveys including more than two phases become dominant from 2002 onwards. Three-phased surveys are particularly numerous during 2007, 2011 and 2014, while 2017 saw a large number of surveys with four or five phases.

Regardless of the variation in number, nature and relative order of phases in the trajectory, auger sampling was frequently (47 %) preceded by a desk-top assessment and by (at least one, but sometimes two or more phases of) palaeo-environmental coring. This particular sequence of 'desktop assessment > palaeo-environmental coring > archaeological coring' occurs from 2003 onwards. Although it has been a dominant combination during more recent years, it can by no means be considered as a standard procedure. In nearly one fourth of the project areas a desk-top study led directly to auger sampling without a prior field assessment of local soil conditions and palaeo-topography, two criteria that are frequently relied upon in the decision process of whether auger sampling is deemed necessary. This sequence of 'desktop study > archaeological coring' mainly occurred during the early years (1999-2003), but also regularly turns up from 2012 onwards and was even the dominant strategy in the projects in 2014. Interestingly, in ca. 13 % of all project areas, mainly between 2006 and 2012, auger sampling was preceded -instead of followed- by mechanical test trenching and/or open-area excavations after the fortuitous discovery of lithic artefacts and/or intact podzol profiles. Yet, this survey-sequence should be discouraged, as both mechanical approaches are not only highly inadequate and cost-ineffective to detect and assess (clustered) artefact distributions in a systematic manner, but also have a very destructive effect on these remains. In 10 % of the cases field-walking preceded archaeological auger survey, a practise that is noted throughout the entire period, but was more dominant during the early years (1999-2001) than in more recent times.

At least 65 % of the (first-phase) auger sampling campaigns did not result in a continuation of the survey trajectory geared towards detecting and assessing (prehistoric) artefact distributions. Given that it is one of the primary goals of archaeological survey -at least in development-led contexts- to find out in a reliable and cost-efficient manner whether or not archaeological remains are present in a threatened area, this high percentage is not surprising, were it not for the observation that in 42 % of these cases at least one univocal indication -in the form of one or more lithic artefact(s) and/or charred hazelnut shells- was discovered in at least one of the auger samples. In these cases the number of positive auger samples varied between 1 to 176, or between 0,4 and 75 % of all sampled auger points. Clearly, the presence of one or more lithic artefacts in one or more auger samples is in many cases not considered sufficient to continue the assessment in an additional survey phase in order to obtain a better a better understanding of the precise meaning of these indicators, regardless of whether these locations are subsequently being destroyed. While the discovery of archaeological remains in one or more auger samples did not always result in a follow-up study, at least 29 % of all first-phase auger surveys were further evaluated, despite the observation that in 8 % of such cases no archaeological indicators were actually recovered during auger sampling. In those cases where at least one lithic object was encountered resulting in a follow-up assessment, the number of positive auger points varied between 1 and 781, representing between 0,4 and 72 % of all sampled auger points. When viewed through time it becomes clear that first-phase auger surveys most often did not result in a follow-up study. This is particularly true for the period from 2008 onwards, at a time when the total number of auger projects was generally higher compared to the preceding decade (except for 2013 and 2015). During seven of the ten years between 1996 and 2007 at least half of the surveys each year led to a follow-up investigation with yearly values of follow-up studies during this decade ranging between 11 and 100 % (mean: 51 %). After 2008, however, such values were hardly reached again, with lower percentages varying between 0 and 38 % (mean: 22 %). The causes for this apparent shift require a more in-depth analysis of the dataset.

The nature of prehistoric survey trajectory following first-phase auger sampling also varies widely. In 61 % of the cases it was followed directly by a second-phase of auger sampling using a finer grid interval. In 63 % of these trajectories consisting of two consecutive phases of auger sampling, the prehistoric survey trajectory ended, while in 25 % of the cases it led to an additional test-pit assessment. In two instances these test-pits ultimately resulted in an excavation of prehistoric artefact clusters. Many of the auger surveys in this second phase focused exclusively on the areas immediately surrounding the ‘positive’ auger samples from the previous phase. Ca. 17 % of the first-phase auger surveys resulted directly in a test-pit evaluation, without an intervening augering phase. In three instances this resulted in an excavation of prehistoric artefact clusters. In 18 % of the projects where the first-phase survey was not the final phase of the prehistoric survey trajectory, these first-phase auger surveys led directly to an excavation, without additional coring and/or test-pit assessment in-between. In several survey areas lithic clusters were unearthed through (intentional) archaeological excavations that occurred either prior or subsequent to the archaeological auger sampling. It should be noted that such excavations represent only a (small) part of the excavated prehistoric dataset in Flanders, given that at many of the excavated sites no auger survey took place and remains were discovered through other methods such as fieldwalking or were found as a by-catch during mechanical trial trenching. Not all of the excavated sites located within the boundaries of auger survey areas were actually discovered through the preceding auger sampling. At least in one case (i. e. Holsbeek–Rotselaarsebaan) did the auger sampling not result in the discovery of archaeological indicators and were the lithic artefacts only discovered during a subsequent phase of mechanical trial trenching. In other instances (some of) the excavations predated -and sometimes even instigated- the auger survey.

3.6. Variation in grid lay-out

Auger grid lay-out refers to the grid pattern and the interval between the individual augering points. Many different grid patterns have been used and reported (Fig. 4), with triangular patterns being the most dominant (78 %), particularly during the first phase of auger sampling. Rectangular configurations occur in 10 % of all surveyed areas and only during first phase auger surveys. Other patterns including square-shaped configurations, transects or random compositions are less common (4 %).

Important is the dominant focus during second-phase auger sampling on the immediate surroundings of (some of the) positive auger points from the preceding auger survey. All too often, the 'negative' auger points are (incorrectly) viewed as evidence for the absence of prehistoric remains. The dominance of isosceles triangular configurations through time is evident: other patterns not only appear later in time but also are much less frequently applied. The recent increase in the use of square-shaped patterns is striking. The more frequent use of rectangular patterns between 2009 and 2011 relates to the Sigma-projects

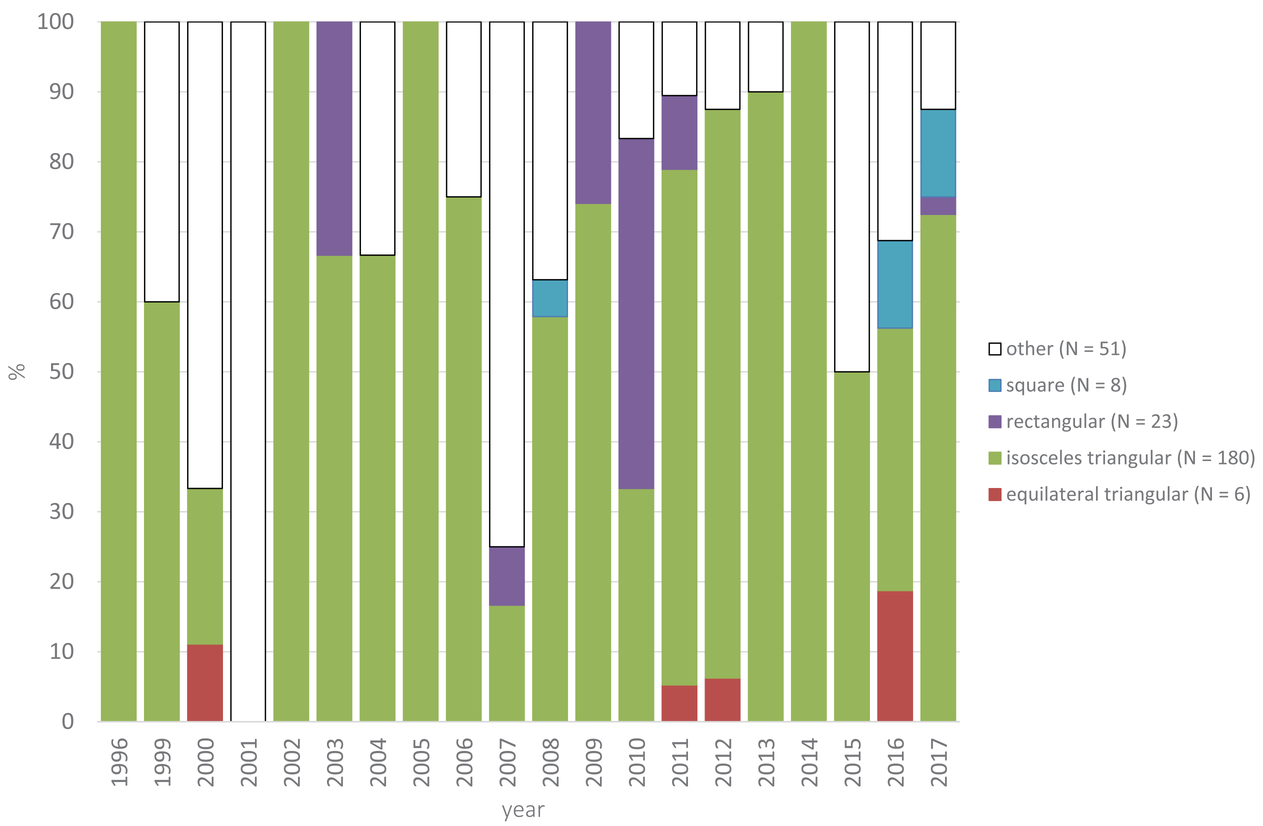

Fig. 4 – Chronological variation in grid pattern.

of AOE. Throughout the reports of these Sigma-surveys this grid pattern was presented as compromise between the use of 5 and 10 m triangular grids in response to budget and time constraints. The rarity of equilateral triangular patterns, since long considered to be the most suitable configuration to deal with the intersection probability of a phenomena with a circular or unknown shape, is another curious observation. Whereas this can be understood for the early years of auger survey, it now represents an outdated practice as the use of isosceles instead of equilateral triangular configurations was initially prompted purely for practical reasons, during times when specialised GPS-equipment to plot auger points in the field were not yet available and points had to be plotted manually using measuring tape and Pythagoras. Yet, such specialist equipment nowadays is widely available, affordable and fully integrated in archaeological research. Given the obvious advantages of equilateral triangular configurations over all other configurations it is remarkable that this pattern has not yet systematically found its way into archaeological auger survey, nor that it is not prescribed as a standard in the CGP.

Grids with a 10 m interval between the auger points are most popular (39 %), and become even more (42 %) when only first-phase auger sampling is considered (Fig. 5). Grids in 5 m-variations account for 32 % of the surveyed areas and are mainly applied during second-phase auger phases (e. g. 62 % of all surveyed areas from this phase compared to less than 30 % of all areas from first-phase surveys). All other interval variations occur less frequently. An exception is the 20 x 25 m grid applied in many separate survey areas during a recent survey project as part of the gas pipeline construction between Alveringem and Maldegem. Both 5 and 10 m grid intervals have been in use almost continuously since the onset of auger sampling in Flanders. The 5 m interval was clearly dominant during the first few years and shows a peak in 2008 and 2009, corresponding to 11 projects and 23 surveyed areas. The use of 10 m intervals was limited during these early years, but its ap-

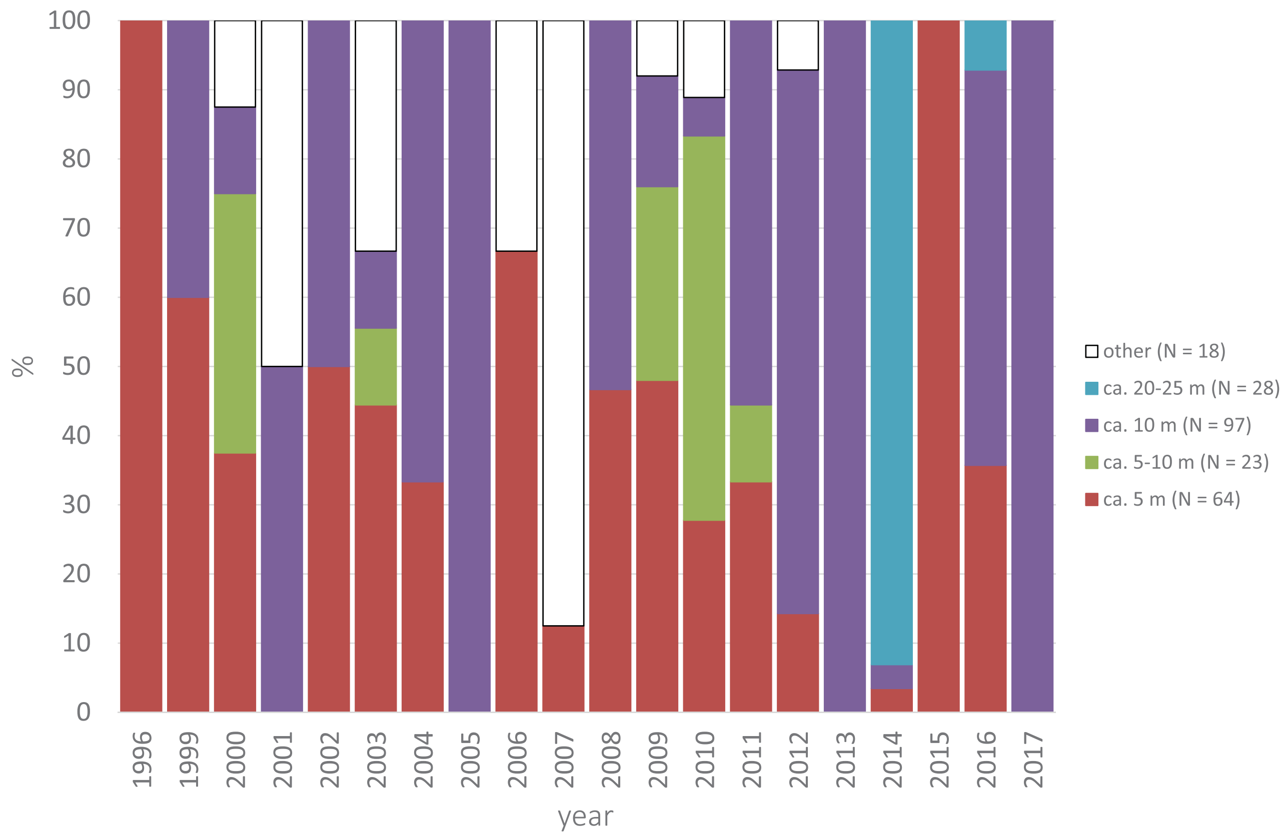

Fig. 5 – Chronological variation in grid interval for first-phase auger surveys.

plication increases through time, a trend that is particularly clear from 2011 onwards and corresponds with a marked decrease in the use of 5 m intervals. These patterns become even more pronounced when only the first-phase auger projects are taken into account.

The data presented above indicate the predominant application of triangular grid patterns (ca. 80 %) and ca. 10 m grid intervals (ca. 40 %). When combining these two variables it becomes clear that one-third of the project areas from first-phase auger projects was surveyed using a triangular 10 m-grid. Less frequent are triangular grids in a 5 m-interval (23 %) or with a 20/25 m-interval (12 %), as well as rectangular grid in a 5/10 m resolution (8 %). All other combinations occur only incidentally. Second-phase auger surveys show a different pattern which is characterized by finer resolutions (i. e. 5 m-intervals) but are often limited to the immediate surroundings of the positive auger points from the first-phase auger survey (30 %). Triangular patterns in a 5m-interval (25 %) or in a 2,5 m interval (10 %) and square-shaped patterns in a 10 m interval (10 %) have been used much less during the latter type of survey.

With regard to grid pattern and interval many discrepancies can be noted between the maps, the raw data and the texts in the original reports. Recalculations of distances between auger points based on the raw data and/or distribution maps from the reports, instead of simply relying on the reported text-accounts presented in those reports, exposes a large amount of hidden variation in grid lay-out. The first element we noted is that such a recalculation could not be done properly for 25 % of the areas because insufficient information was provided. A second observation is that the same terms were used by different surveyors to refer to different grid lay-outs, masking a considerable amount of variation, or that different terms were used when referring to the same phenomena. It also has to do with the fact that authors use their terminology sometimes to refer to the distance between auger points, in other cases to the distance between auger points and transects and in still other cases even to neither of the two. While covering only three grid-variants based on what is reported in the text of the reports (4 x 5 m; 5 x 5 m; 5 x 6 m), our recalculations revealed that these ca. 5 m patterns actually correspond to six different variants, including both triangular and square shaped patterns, with distances between auger points varying between 4 and 7 m (e. g. 4 x 5,4 m; 5 x 5 m; 5 x 5,6 m; 5 x 6,5 m; 5 x 7 m; 5,8 x 6 m). Only two of these patterns are -more or less- equilateral triangular configurations, with distances between the auger points of either 5 m (e. g. 5 x 5 m-grid) or ca. 6 m (e. g. 5,8 x 6 m-grid). All other triangular configurations are isosceles variants. Likewise, the two most commonly applied ca. 10 m patterns as reported in the text of the reports (e. g. 10 x 10 m; 10 x 12 m) actually refer to no less than ten different variants, including triangular, rectangular and square-shaped patterns, with distances between auger points ranging from 9 to nearly 14 m (e. g. 9 x 10 m; 10 x 10 m; 10 x 11,2 m; 10 x 12 m; 10 x 13 m; 10 x 13,9 m; 11,7 x 12 m; 12 x 12 m). Again, only two of these grid lay-outs correspond to more or less equilateral triangular configurations, with distances between the auger points of either 10 m (e. g. 10 x 10 m-grid) or ca. 12 m (e. g. 11,7 x 12 m-grid). It goes without saying that this (hidden) variation makes it extremely difficult to compare survey results across different projects.

3.7. Variation in auger type and diameter

Different types of auger devices, relying on manual or mechanical force, have been used in auger sampling. The pros and cons of these different devices received considerable attention in Dutch and Flemish survey literature (e. g. Borremans, 2015; Tol *et al.*, 2004; Hamburg *et al.*, 2014; Hissel & Van London, 2004; Hissel *et al.*, 2005; Van Zijverden & Moor, 2014; Verhegge *et al.*, 2016). In most auger surveys only a single type of auger was applied. A combination of two different types is only reported in 2 % of the cases. Manual Edelman augers have been used in 94 % of all surveys, with diameters ranging from 7 up to 20 cm. A manual guts auger (2,5 cm) was reported only once, during the early years of auger sampling (e. g. at Doel–Deurganckdok sector C). Mechanical devices, including Sonic Drill Aqualock and Archimedes, are less common (4 %) and only applied in settings where the remains are buried more deeply. No differences are noted between first-phase and second-phase surveys in the use of auger devices. While manual types continuously dominated auger sampling, mechanical devices were introduced from 2006 onwards and have only been used discontinuously.

Augers with a diameter of 7 cm occur only incidentally, and are associated with Edelman and Sonic Aqualock devices. This diameter was not used prior to 2011 and is mainly limited to the last two years. A 10 cm diameter was used discontinuously from 2003 onwards and was dominant between 2004 and 2005 and between 2009 and 2010. It, too, is associated with the Edelman device and to a lesser extent with the Sonic Aqualock, the latter only being applied in 2016 and 2017. 12 cm augers are introduced from 2007 onwards. While already present during the early years of auger sampling, 15 cm diameters were not reported for the period between 2001 and 2005. From 2006 onwards this diameter was used discontinuously, gaining a more widespread application in the past three years. The 20 cm auger, both the manual Edelman as well as the mechanical Archimedes devices, shows a different pattern and was more popular around the turn of the millennium, while its popularity has diminished during more recent times, particularly from around 2009 onwards.

Focussing on Edelman-devices, one can observe marked regional differences in diameters (Fig. 6). Overall, smaller diameters (≤ 12 cm) predominate in Sandy Flanders and to a lesser extent in the Polders when compared to the other regions, while larger diameters (≥ 15 cm) are more characteristic for the Campine. In Sandy Flanders, where in 14 % of all cases the diameter was not reported, the use of a 10 cm diameter dominates (44 %), followed by a 15 cm diameter (33 %). A 12 cm auger (7 %), and to a lesser extent a 7 cm auger (1 %), have also been applied but no 20 cm-auger surveys are reported. A 15 cm auger was discontinuously used in this region throughout the entire period, but mainly from 2006 onwards, and was dominant during several of these years. A 12 cm auger was mainly applied between 2010 and 2013. From 2004 onwards a 10 cm auger became more common and dominated between 2004 and 2005 and between 2008 and 2010. It was however not reported for the period between 2013 and 2016. In one recent

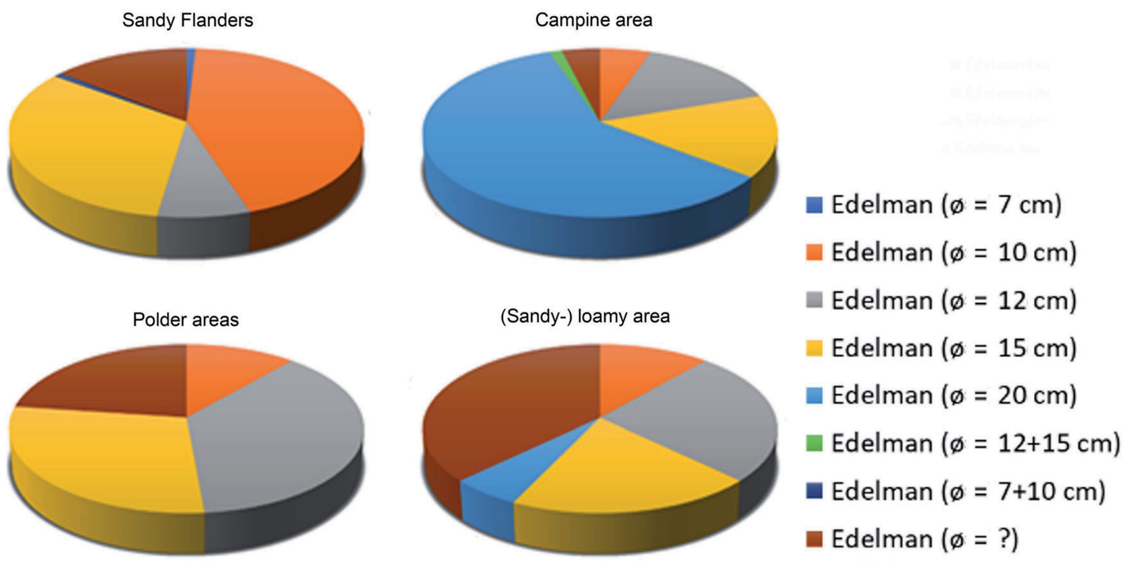

Fig. 6 – Regional variation in (Edelman) auger diameter.

project a 7 cm auger was used (e. g. Stekene–Merlandstraat). In clear contrast with Sandy Flanders, auger survey in the Campine area is dominated by 20 cm ('mega') augers (59 %) followed by 15 cm augers (16 %). To a lesser extent 12 cm and 10 cm augers have been used (respectively 14 % and 5 %). Prior to 2009, this area witnessed the exclusive use of large (≥ 15m) diameters, in particular the 20 cm ('mega') auger, which was introduced by AOE from the very beginning of auger sampling in this region and remained dominant until 2008. From 2010 onwards until the end of 2017 smaller diameters (≤ 12 cm) were also used alongside these larger augers, only to become dominant during 2010 and 2011. For the Polder area, auger diameter remains unknown in 23 % of the cases. In this area 12 cm augers dominate (37 %), followed by a 15 cm (29 %) and to a lesser extent a 10 cm (11 %). The largest diameter in these Polders, where remains are often buried under thick peri-marine and peat deposits, is 15 cm but its use is limited in time to the earliest periods of auger survey (1996-2000) for the Waasland Scheldt polders and to the most recent times (2017) for the coastal polders. The use of a 12 cm auger is more restricted in time, between 2008 and 2013, and again related to both of the polder areas. A 10 cm auger occurs at three different points in time: in 2004, 2011 and particularly 2016. The available information is less accurate for the (sandy-) loamy area, as diameter was reported for only 63 % of the cases. Here, too, 12 and 15 cm augers dominate (respectively 26 % and 20 %) followed by a 10 cm (11 %). In 6 % of the cases from this area a 20 cm auger was used. The projects from 2003 in the Scheldt-river valley as part of two methodological projects from Ghent University (e. g. at Eine, Ename and Oudenaarde) applied 10 cm augers, corresponding to the smallest diameter in this region. During more recent projects in the (sandy-) loamy region larger diameters were introduced, including 12 cm augers during 2007-2008 and 2015-2017, 15 cm augers during 2009 and 2015 and 20 cm augers in 2007. This latter case led to the discovery of some of the earliest archaeological remains currently known from Flanders, at the bottom of a brick-yard quarry ca. 10 m below the present-day surface (e. g. Kesselt–Op de Schans).

3.8. Variation in sample recovery and inspection

Auger sampling essentially relies on inspection of soil samples that are brought to the surface prior to inspection. Before inspection takes place, the samples first need to be processed, very few details of which are provided in the reports. While information on the precise circumstances and the actors (and their experience) involved in the sieving, drying and inspection processes is often lacking, these factors can have a major impact on the final results. As to the nature of the residue to be inspected -an important factor for the visibility of the archaeological remains embedded in them- a similar comment can be made. In some cases the presence of roots, other organic remains or natural gravels have been reported as an important obstruction to this visibility. In some reports on wet sieving the dried residue was further processed prior to inspection to enhance the vis-

Fig. 7 – Variation in mesh width in wet and dry sieving.

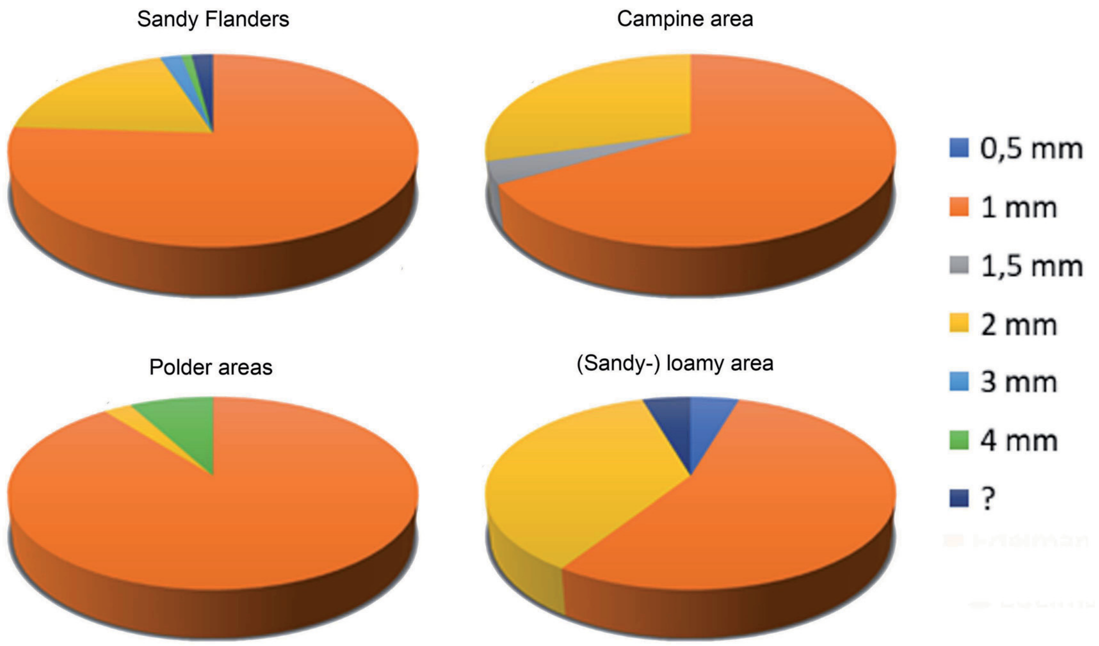

Fig. 8 – Regional variation in mesh width in wet sieving.

ibility. This included dry size-grading over different meshes to separate the larger from the smaller fraction, and to remove inconvenient sediment particles that adhered to the wet residue.

Sieving is dominant amongst the applied observation methods (86 %). Yet, in some cases samples were inspected on the spot by means of other approaches, including sediment cutting or crumbling (e. g. Antwerpen–Cadixstraat, Holsbeek–Rotselaarsebaan). In the first case cutting was used -alongside sieving over 2 mm meshes- when the sediment 'did not lend itself' to sieving, although it remains unknown how often it was actually applied within this project. For the survey at Holsbeek–Rotselaarsebaan crumbling was chosen because of difficulties with wet sieving of clayey sediment (Sevenants *et al.*, 2010), an issue that appeared to be much less of a problem during subsequent excavations of the same deposits as this excavation involved systematic wet sieving over 2 mm meshes (Van Baelen & Vanmontfort, 2011).

Much variation is present in the sieving methods and techniques (Fig. 7-8), particularly in the use of water and in the dimensions of the meshes as well as other practicalities of the sieving process and subsequent processing of the samples, although detailed information on these latter aspects often lacks from the reports (except for the occasional photograph that provides a glimpse of the sieving, drying and/or sorting process). As was the case for auger type and diameter, some of this variation in sieving procedures has also a regional dimension. The use of a mechanical (shaker) sieve installation was reported at least in one case (e. g. Wuustwezel–Het Moerken), but probably has been used in other projects as well. For most projects information on the manual or mechanical nature of the sieving equipment is not provided. When sieving is applied, wet sieving is the preferred approach (78 %). In over three quarter of these cases, the wet sediment was first dried again (to the air) before inspection of the dried sediment occurred. In all other cases this drying process was not explicitly mentioned in the reports so it remains unclear whether or not inspection occurred on wet or dry residue. For 18 % of all surveyed areas where sieving was applied no water was used at all. As far as can be inferred from the reports dry-sieving often occurred at or near the auger spot, while wet-sieving occurred either at or near the project area or at external (temporary or more permanent) sieving facilities, depending on the availability of (natural or artificial) water sources. Thus a major difference between wet and dry sieving seems to be that in the latter case the soil samples are most often sieved and inspected at the auger spot, while in the case of wet sieving the processing time is more elaborated and the soil samples are first transported to a sieving location, then to a location for drying (either simply to the air or with some additional devices to speed up the drying process) and only afterwards inspected when the sieved residue is dry. Wet-sieving is characteristic for all regions, and the sole approach in the Polders, Sandy Flanders and the (sandy-)loamy area. Dry-sieving is only attested for the Campine area, where it even is the dominant inspection approach (56 % compared to 33 % for wet-sieving).

When sieving is applied, meshes of 2 mm or less are favoured (77 %). In many cases where sediments were sieved the reported mesh size was 1 mm (≥ 60 %), occasionally in combination with 2 or 4 mm-meshes, while in at least 17 % of the cases 2 mm instead of 1 mm meshes were used. In all but one of the cases with meshes of ≤ 2 mm -and leaving aside two unknown cases- these smaller mesh sizes all relate to wet-sieving. In 23 % of the surveys where sieving was applied meshes larger than 2 mm were used, including 3 mm (19 %), 4 mm (4 %) and/or 6 mm (1 %), sometimes in combination with one another (e. g. Averbode - De Buts and Meer–Meirberg where a size-grading combination of 3 and 6 mm meshes are reported). Except for some unreported instances (11 %) and several cases of wet-sieving (11 %), larger meshes are most often linked with dry sieving (78 %). Thus, a clear relationship exists between the use of water for sieving and the applied mesh sizes, with smaller meshes (≤ 2 mm) almost exclusively being connected to wet-sieving (≥ 97 %) and larger meshes (≥ 3 mm) mainly -but not exclusively- being linked with dry-sieving (≥ 78 %). When water is used, small meshes (≤ 2 mm) are dominant for all regions, ranging from 92 % in the Polders to 100 % in the Campine area (but keep in mind that in the latter area dry-sieving is the dominant approach). Meshes of 1 mm, in particular, are most frequently used for wet sieving in each of the four regions, and account for 55 % in the (sandy-)loamy area, over 67 % in the Campine area and 76 % in Sandy Flanders, to 89 % in the Polders. The extensive use of 1 mm meshes in the Polders, and to a lesser extent in Sandy Flanders, corresponds with a much lower frequency in the use of 2 mm meshes compared to the other two regions (e. g. 3 % and 19 % versus 29 % in the Campine and 39 % in the (sandy-)loamy areas). On the other hand, 2 mm meshes are more frequent in the (sandy-)loamy area, where sediments often are more fine-grained. For this latter area the ratio between ≤1 mm meshes on the one hand and ≥ 2 mm on the other hand is only 1,5 while this figure rises to 2 for the Campine area (where 2 mm meshes are also frequently used for wet sieving), over 3,5 for Sandy Flanders to 8,5 for the Polders (where 2 mm meshes are relatively rare compared to 1 mm meshes). Wet-sieving not only is much more frequent compared to dry-sieving, it also has a more continuous use through time. Except for 2001 and 2002, it was applied during each year and often also is the dominant strategy (except in 2003, 2006 and 2014). Dry-sieving was used in a more discontinuous manner and was particularly common between 1999 and 2004. During the first decade, until 2006, it is exclusively used by the Flemish Heritage Agency at different locations in the Campine area (e. g. Meer–Meirberg; Bocholt–Kreielerbos and Smeetshof; Brecht–Moordenaarsven 4; Opglabbeek–Ruiterskuilen, Schaapsven and Turfven; Ravels–Witgoor, Landschap De Liereman Duinengordel, Lommel–Maatheide, Merksplas–Hoekeinde-Bembt Horst-zone 2 and Wuustwezel–Het Moerken). During the last decade dry-sieving is less frequent and mainly used by other institutions. Looking at the relationship between wet-sieving and mesh sizes through time, it is clear that most mesh widths are only used occasionally (e. g. 0,5 mm in 2011; 1,5 mm in 2017; 3 mm in 2006; 4 mm in 2012). In contrast, 1 mm meshes are present throughout the entire period and mostly in a dominant manner. Interestingly, its role has diminished in the last few years in favour of 2 mm meshes which have been in use only sporadically prior to 2015 and are set as a standard in the CGP.

3.9. *Combined variation in grid, auger, sample recovery and inspection*

The variation observed for grid lay-out, auger device and inspection of soil samples is also apparent when these variables are viewed in combination with each other. This exercise resulted in no less than 120 different combinations. Given that the entire dataset includes less than 300 records, many of these combinations contain only one or a few records. Unique combinations -represented by only one record- account for 28 % of the records and represent the majority (63 %) of all combinations. Only nine combinations (8 %) contain at least five records. Yet, these nine combinations represent only 38 % of all records, reflecting once more the enormous variation in methodology in auger sampling in Flanders. When ignoring the records for which the value of at least one of the three variables is unknown just over 60 % of the records remain. Repeating the above exercise for these remaining records still results in 66 different combinations, representing 55 % of all combinations from the entire dataset. For this reduced dataset only seven types of combinations contain at least five records, representing 42 % of the remaining records, and still reflecting the large variation in archaeological auger survey in Flanders. This subset of the inventory is dominated by a group of 27 areas investigated prior to the construction of a gasoline pipeline between Alveringem and Maldegem. In each of these (small) trajectories an isosceles triangular grid configuration with a distance of ca. 20-25 m between adjacent auger points was applied. Given the small character of the areas, the grids only included a maximum of two transects. In all cases an Edelman auger was used, but information on auger diameter and observation method remains unknown, as it was expressed only in general terms in the reports. It includes the use of a 7, 12 and/or 15 cm diameter auger and dry sieving on 4 mm meshes or crumbling of the sediment, but it remains unclear from the publications where each of these combinations was applied. The second most applied combination has 16 surveyed areas and refers to Sigma-projects by the Flemish Heritage Agency throughout 2009 and 2010, which focussed on the wetland areas along the course of the Scheldt and its tributaries. These surveys are all characterized by the application of a rectangular grid pattern with an interval of 5/10 m between the auger points, considered by the surveyors to be a compromise solution due to time and money constraints. Auger points along the same transect were placed ca. 5 m apart, while adjacent transects were spaced at a distance of ca. 10 m. For all the projects in this second group a 10 cm Edelman-auger type was used together with wet-sieving over 1 mm meshes followed by drying of the sieved residue. In another Sigma-project by the Flemish Heritage Agency (e. g. Cluster Kalkense Meersen, Berlare–Paardeweide) a similar approach was applied, but with 2 mm instead of 1 mm meshes. A third group represents 5 % of all records, and includes only survey projects from the Campine area. The survey methodology for this group is characterised by the use of an isosceles triangular grid where adjacent auger points along the same transect are situated at a distance of 6m and adjacent auger points at adjacent transects at a distance of 5,8 m, thus approaching an equilateral triangular grid with a ca. 6 m resolution. It is combined with the use of an Edelman 20 cm 'mega'-auger and dry-sieving over 3 mm meshes. Apart from a few projects (e. g. Lommel–Kristalpark III-zone 1; Beringen–Lossingstraat), this combination was almost exclusively applied by surveyors from the Flemish Heritage Agency and more particularly between 2000 and 2008. Earlier, in 1999, the same approach was also used at Meer–Meirberg but with the extra addition of a 6 mm-sieve (next to the 3 mm meshes). In a survey from 2006 at Wuustwezel–Het Moerken a similar approach was used in combination with an Archimedes auger type. Apart from the three combinations discussed above several other groups include between five and ten surveyed areas. Two groups with nine records are similar to one another and characterized by the use of an isosceles triangular grid with a ca. 10 m resolution. Yet, the actual distance between the auger points in each of the two groups is different. While auger points on each transect from both groups are always spaced 10 m apart, auger points at adjacent transects are situated 13 m apart in the first group (thus creating a distinct isosceles triangle) but only 11,2 m apart in the second group (thus more approaching an equilateral pattern). All of the projects from both groups applied an Edelman auger with a diameter of 12 cm in combination with wet sieving (and drying) over 1 mm meshes. A third group with nine records also refers to an isosceles triangular pattern with a distance of 10 m between auger points on the same transect and 13 m on adjacent transect. Yet, instead of a 12 cm diameter auger and 1 mm meshes, it made use of a 15 cm Edelman auger and 2 mm meshes.

4. Discussion

As a recent addition to archaeological survey practices in Flanders, auger sampling designed to detect and assess (clustered) artefact distributions has significantly altered the understanding of the prehistoric record in this area, revealing its diverse, extensive and complex character. Representing less than 2 % of all field surveys undertaken since its introduction well over two decades ago and less than 3 % since the adoption of the new legislation in 2016, this type of survey, however, remains marginal and has so far only been applied to detect and assess prehistoric (lithic) artefact distributions. The same applies to pedestrian survey, a different type of survey which accounts for less than 1 % of the more than 1 500 field interventions reported since 2016. Taking into account the general consensus amongst archaeologists that augering and field walking are the most appropriate approaches –in contrast to mechanical trial trenching– to detect find distributions exposed at the present surface (e. g. field walking) or obscured below the surface (e. g. augering), these percentages are remarkable low. The most striking is that *both* approaches are hardly represented in current development-led survey practices, as one would expect at least one of the two survey approaches to be better represented based on the location of the remains relative to the present-day surface. These low percentages contrast sharply with those for mechanical trial trenching which is widely used to detect and assess archaeological soil features and other structural remains. This marked difference in the frequency of these complementary survey approaches suggests the existence of a double standard and the use of different selection criteria when searching for these two different kinds of archaeological remains that make up the record. While an in-depth analysis of the selection criteria used to justify an archaeological survey in a development-led context is beyond the scope of the present paper, the information presented above indicates that the decision to use appropriate survey and assessment strategies to find and assess artefact distributions -either buried or exposed- is often driven by implicit or ad hoc reasoning, as well as a frequent appeal to authority. While acknowledging the importance of expert judgement in decision processes, authorities -like everybody else- must prove their contentions based on explicit, verifiable data and solid (scientific) reasoning.

To date, auger sampling has mainly been confined to the northern sandy zones of Flanders, often at specific topographical locations (i. e. sandy elevations, river dunes, locations close to -former- open water sources, gradient zones, etc.), in areas with well-developed and well-preserved sandy podzol profiles. In contrast, artefact distributions in the southern sandy-loamy and loamy parts of Flanders, where soil-development and preservation are often more difficult to evaluate, remain almost entirely unexplored. Initially almost exclusively driven by scientific research questions and realised by universities and by the Flemish organization for Immovable Heritage, the study areas where these early methodological auger campaigns took place, were all situated in the sandy parts of Flanders. Characterised by well-developed and -preserved podzol soils, most of these locations were confined to those topographical locations that were assumed to have a large potential for the presence of well-preserved prehistoric remains. As a result, the hypothesis that such locations, intensively explored by prehistorians, represented also preferred prehistoric settlement locations (i.e. 'site-complexes') became a widespread notion in the archaeological literature of the past two decades and an important element in the decision making process to conduct surveys in the context of other (development-led) projects.

Untested assumptions and predictive models of prehistoric land use and preferred settlement locations underlie many of the present-day survey strategies. Criticizing such popular models which are often solely based on landscape topography as being too simplistic and too general in nature, several scholars have recently urged to abandon these and -if possible- to develop updated, more complex and realistic models to guide survey practices (e. g. Grøn, 2018; Peeters *et al.*, 2017). Starting from the observation that "[o]*ne can only guess why archaeology has been allowed to pick the simple and easy-to-handle modelling principles, while ignoring the more difficult ones, in its attempts to develop fast and cheap 'desktop' approaches to the mapping of Stone Age settlements*" (Grøn, 2018: 192), Grøn came to the conclusion that *"it will be of immense importance to clarify whether predictive modelling has a future in archaeology – albeit in a probably somewhat costlier version. If not, it is time to focus on, and invest in, the development of viable alternatives*" (Grøn, 2018: 198). In their recent assessment of survey practices in development-led archaeology in the Netherlands Peeters *et al.* (2017) noted that survey strategies not only "*largely build on the known archaeological record through predictive models*" (Peeters *et al.*, 2017: 8), but also that "*underrepresented zones and regions are simply not investigated*" (Peeters *et al.*, 2017: 8). Although Peeters and colleagues acknowledge the existence of specific problems related to different forms of predictive modelling and its role in setting up research strategies within development-led archaeology, this type of modelling should in their view not be abandoned. They argue that fieldwork should instead be used as a form of model validation, contributing to archaeological theory building (Peeters *et al.*, 2017: 210). They therefore not only urge to make model expectations more explicit, but also to establish to what extent these explicit expectations actually fit the results, taking into account the "*absence of the expected*" and the "*presence of the unexpected*" (Peeters *et al.*, 2017: 9, 210) as well as its implications for the strategy, methodology and overall planning and budget and changes therein. This can avoid that prehistoric remains are systematically discovered only as 'by-catch' during other survey (or excavation) activities, as currently is still too often the case, also in Flanders.

With the rise of development-led archaeology and the increasing involvement of commercial units in auger survey practises, in a time when no consensus on methodological standards was available, previously unexplored topographical contexts came into the focus of archaeological survey. Instead of assigning these less familiar locations an 'unknown potential' requiring further investigation, they are often argued to have a 'low' potential and are consequently excluded from any survey at all. As a result, the nature of the lithic record at these locations has received much less consideration and remains poorly understood. Already more than thirty years ago, Shott (1985: 458) advised against such a biased survey approach: "*It bears emphasizing that the practise of more intensive sampling in areas of suspected high site density is not recommended. It runs the risk of skewing survey results toward those areas, which can only reinforce what are often simplistic or mistaken notions concerning a location's potential. In fact, the interests of more representative survey results would dictate the reverse of this practice. Areas of suspected low site density should be more intensively surveyed*". The combination of simplistic, but largely untested assumptions on past human behaviour, the preference for survey areas with high expectations, and the ignorance of many other areas with lower expectations inhibit a correct assessment of the archaeological record. Moreover, it creates a highly biased view of this record, affecting the validity and representativeness of our knowledge on prehistoric land use practises. It remains a daunting task to understand how the currently known part of the prehistoric record relates to its unknown counterpart or to the former part of the record that has already been destroyed without proper documentation. The extent to which the known record forms a representative sample of the total record is crucial when developing adequate survey sampling strategies. This relates to what is known in the literature on sampling theory as the 'sampling-paradox' (e. g. Mueller, 1975; Schiffer *et al.*, 1978; Shott, 2004; Bailey, 2008). Generally the known sample of available archaeological evidence grows in size, regardless of how the evidence was unearthed, and in the course of this process it also may change in character. How can we then be sure that the known sample, regardless of how (well) it is documented, is not inadequate and too small to inform us on prehistoric behaviour? How representative is the known record in relation to the nature and composition of the total population of physical remains from this time period? Expressed differently, how big and how typical is our known sample? Such questions have hardly been explored in detail in survey practices in Flanders.

Soil formation and preservation -often (fairly) easy to observe and interpret by archaeologists in the case of sandy podzol soils- remain important criteria to decide for auger survey. Yet, the timing, speed and duration of sedimentation processes, soil formation and erosion processes bear no direct link with the processes of artefact deposition and displacement, and often merely indicate the absence of recent disturbances of the top of the soil profile. Intact soil profiles do not necessarily correspond to well-preserved prehistoric records (although this most often will be the case); whereas on the other hand, disturbed soil profiles may still contain (reasonably) well preserved records. Obtaining a correct understanding of the nature, timing, speed and duration of these complex processes and their mutual interaction therefore forms an essential part of each survey project.

Despite its marginal position, auger survey was shown to display a large methodological variation, both through time and space. While this paper mainly focussed on survey trajectory, auger grid lay-out, auger devices and treatment of collected soil samples, this variation can be observed in many of the other listed variables as well, raising questions of consistency, mutual comparability and reliability of survey results. The variation in the nature of survey trajectories –i.e. in the number and order of phases and the position of auger sampling relative to the other phases- was one of the most surprising results, with the most appropriate sequence of 'desktop assessment > field assessment of local topography and soil preservation > survey and assessment of find distributions > survey and assessment of soil features' being only one of a myriad of applied combinations. A possible explanation for the observed increase in the number of phases within survey designs during more recent times might relate to the fact that earlier surveys were mostly done by universities or the Flemish government and were often part of scientific projects that specifically focussed on auger survey of the prehistoric record, while during more recent times auger surveys were mostly done by companies as part of development-led projects and became increasingly integrated in larger trajectories that also investigated the more recent archaeological record in addition to (clustered) artefact distributions from prehistoric times. While auger survey is generally considered the most appropriate strategy to search for the buried (prehistoric) clustered artefact distributions and to assess soil preservation, many of these remains are still brought to the surface fortuitously -and too late in the trajectory- as a 'by-catch' by means of other, less appropriate and often more destructive approaches such as mechanical trial-trenching or open-area excavations. While in some cases such fortuitous discoveries of artefacts and/or intact soil profiles still resulted in an auger survey (of partly disturbed records), such fortuitous discoveries should be abandoned in favour of more appropriate survey-attempts.

Grid lay-outs with a resolution of ca. 10 m predominate but variation in grid pattern is actually much larger than would appear at first sight from the written accounts as the same terminology is applied to different distances and configurations between auger points. This variation in grid pattern and interval, partly hidden in the reports, can have profound effects on the number of auger points (and corresponding sampled volume) for a given area. Furthermore, this variation turns a meaningful comparison between projects and their results into a rather awkward exercise. Also conspicuous in recent surveys, given the widespread use of GPS-equipment, is the near absence of more efficient equilateral triangular configurations in favour of the omnipresent isosceles or even rectangular or square-shaped grid lay-outs. We also noted that grid resolution was more intensive during earlier years than it is in more recent years. The trend towards a more frequent use of 10 m intervals at the expense of 5 m intervals -particularly since 2011- is remarkable, given that around the same time several studies appeared which argued for an intensification of auger sampling practices in order not to systematically overlook large parts of the prehistoric record (e. g. Bats, 2007; Crombé & Verhegge, 2015; De Clercq *et al.*, 2011, 2012; Noens, 2014; Noens & Van Baelen, 2014; Noens *et al.*, 2013; Verhagen *et al.*, 2011, 2013). Another questionable practice in auger survey is that further assessment of discovered remains most often focuses only on the immediate surroundings of (some of) the 'positive' auger samples, leaving not only the 'negative' (and some 'positive') zones entirely unexplored, but also missing an opportunity -in light of future archaeological surveys and the further development of the discipline- to assess the true meaning of these apparently 'empty zones', which are now simply treated as if they reflect the true absence of archaeological remains. Only subsequent assessments will allow us to investigate these issues.

Edelman devices predominate throughout the entire period while mechanical auger devices (much more expensive and with significantly smaller diameters) were only introduced after the turn of the millennium, but overall still hold a marginal position and are mostly limited to deeply buried contexts. Much regional variation was observed in auger diameter. Particularly during the first decade of auger survey in Flanders, the Campine area of north-eastern Flanders was characterized by an exclusive use of larger diameters (≥ 15 cm). In contrast, many of the past surveys in Sandy Flanders and the Polders in the north-western part of Flanders were executed with a maximum diameter of 12 cm. In all of the regions, the use of diameters below 10 cm is rare. Sieving has been the dominant strategy to process the collected soil samples, albeit in different forms. Given that the Campine area, Sandy Flanders and the Polders are dominated by sandy soils, sediment-type cannot be invoked as an explanation for the observed differences in mesh width and in the use of water for sieving between the Campine area and the other two regions (i. e. 98 % of dry-sieving on meshes ≥ 3 mm in the former area *versus* 89 % and 94 % of wet-sieving on meshes ≤ 2 mm in the latter areas). Other explanations, including different research traditions, must account for these differences in diameter and sieving procedures. Meshes of 1 mm are furthermore frequently applied with wet-sieving. Interestingly, its role has diminished in the last few years in favour of 2 mm meshes which prior to 2015 have been in use only sporadically. This increasing use of 2 mm meshes at the expense of 1 mm meshes is probably related to the introduction of the CGP in development-led practises which set 2 mm meshes as a minimum.

Current Flemish legislation stipulates that archaeological survey is only required under certain well-described conditions. As a result, it deals with a small part of the soil disturbance processes currently induced by modern human activities and leaves a large part of the unknown record prone to undocumented disturbance or destruction. At least since the early 1980s around one third of the land surface of Flanders consists of active arable lands (https://statbel.fgov.be). Given the impact of agriculture it is interesting to observe that many of these ploughed parcels and agricultural practises are largely ignored in the archaeological legislation decision making processes and do not require any archaeological interventions at all. The nature of 'disturbed surface sites', the value attached to them and the question of how to deal with them in an adequate manner are important, legitimate and pressing questions in the context of archaeological heritage management and development-led archaeology as is illustrated by urgent calls from scholars in Flanders -and the Netherlands- to pay more attention to this often neglected part of the record (De Bie *et al.*, 2014; Deeben, 1999; Groenewoudt, 1994; Smit, 2010; Verhart, 2006; Vermeersch, 1994).

Development-led archaeology and the implementation of the new legislation resulted in a rise of the number of (desktop-)survey campaigns, including a more widespread use

-but by no means full implementation- of auger sampling. At the same time, it also led to a diversification of its practitioners and an increase in methodological variation. Given these new trends, the need to develop, evaluate and implement adequate standards that guarantee a minimum quality and inter-project comparability has become an urgent matter. In order to fulfil these needs, AOE has imposed a set of quality norms and protocols, describing what needs to be done if the responsible (field) archaeologist chooses to incorporate auger sampling into his/her survey strategy. These Flemish quality norms for auger survey seem to have been inspired by their Dutch counterparts (see Meylemans & Vander Beken, 2008; Tol *et al.*, 2004, 2006, 2012; Verhagen, 2013; Verhagen & Tol, 2004; Verhagen *et al.*, 2011, 2013) which in turn rely heavily on American studies on the use and utility of statistical models in subsurface sampling to detect archaeological sites (e. g. Drew, 1979; Kintigh, 1988; Krakker *et al.*, 1983; Lightfoot, 1986, 1989; Lovis, 1976; Lynch, 1980; McManamon, 1984; Nance, 1979, 1981, 1983; Nance & Ball, 1986, 1989; Shott 1985, 1989; Stein, 1986, 1991; Stone, 1981). More than a decade after the introduction of auger survey in Dutch survey practises, funds were invested -mainly by the National Heritage Agency- to evaluate and refine the proposed survey strategies through a number of studies, some of which included empirical data collected in Flanders (de Boer & Lesparre-de Waal, 2012; Hamburg *et al.*, 2014; Hissel & van Londen, 2004; Tol *et al.*, 2004, 2006, 2012; Verhagen *et al.*, 2011, 2013). These assessments resulted in revisions and refinements of the original guidelines (Tol *et al.*, 2012). While the original version of the Dutch auger guideline was based on a limited amount of data on artefact distribution in prehistoric sites, it was recognized that more empirical data were required to compare the theoretical assumptions with field data and to assess the effectiveness of the proposed strategies (Verhagen *et al.*, 2011, 2013). Verhagen *et al.* (2011, 2013) concluded that the original guidelines were partly founded on inaccurate statistical models and erroneous assumptions and also departed from too optimistic discovery probabilities. They therefore argued for more intensive strategies: "*in order to discover Palaeolithic and Mesolithic sites with sufficient reliability, we will have to apply more intensive survey strategies than have been recommended up to now*" (Verhagen *et al.*, 2013: 240). At the same time they emphasized the urgent need for new empirical data in order to evaluate and refine current auger strategies and/or develop better ones. In addition, they stressed that our current knowledge of relevant site characteristics needs improvement, that the number of large scale and accurate excavations is still too limited, and that the variability in excavation approaches is too large to arrive at useful data for a thorough evaluation of the existing strategies. However, the quality and representativeness of some of the Flemish and Dutch excavation data from their dataset, as well as several methodical aspects of their own analyses have also been criticized (e. g. Crombé & Verhegge, 2015; Smith, 2013; Smith & Hogestijn, 2013; Wansleeben & Laan, 2012; Hamburg *et al.*, 2014). These on-going disagreements on the usefulness of the chosen datasets, on the often ambiguous manner in which archaeological sites are excavated, defined and delineated, and on the applicability of the applied statistics underlying auger practices indicate that much caution is still needed in the interpretation and usefulness of the guidelines that result from these studies.

To date, the Flemish norms and protocols for auger survey are not (yet) accompanied by such a set of guidelines and as a result, considerable room is left for methodological variation and inconsistent practises. According to the current version of the norm, a survey trajectory does not require a multi-phased character. Furthermore, the use of an isosceles triangular grid of 10 x 12 m in combination with an auger diameter of 10 cm and sieving over 2 mm meshes is deemed sufficient to detect in a reliable and cost-efficient manner 'prehistoric artefact sites'. The use of 15 cm augers (CGP v1.0) or 12 cm augers (CGP v2.0) for second-phase auger surveys has recently also been reduced to 10 cm augers in the most recent version of the CGP (v3.0). Sieving over larger meshes or cutting of the sediment instead of sieving is also considered acceptable if the sediments do 'not lend themselves' for sieving over fine meshes. In this regard, it is interesting to re-emphasize the case of Holsbeek–Rotselaarsebaan where the surveyors choose the crumble the clayey soil samples collected during the auger survey (and failed to find any archaeological remains, Sevenants *et al.*, 2010), while little or no difficulties were encountered in sieving much larger volumes of the same clayey sediments over 2 mm meshes during a subsequent small-scale excavation, after these first had been soaked in water for several hours (Van Baelen & Vanmontfort, 2011). Thus, even clayey sediments, however rarely encountered and sampled during augers survey, indeed are suitable to sieving over small meshes, albeit not at the same speed of sandy deposits. The systematic use of fine-grained observation methods to detect and recover archaeological remains from the collected soil samples (e. g. wet sieving over ≤ 2 mm meshes) forms the main reason for the superiority of auger sampling to detect artefact distributions when compared to other survey-approaches. Simply cutting down in this basic strategic choice has no doubt important consequences for the significance of the survey outcome.

The amount of sampled and inspected soil volume primarily relates to the spacing, lay-out and size of the auger points. Four decades ago, long before auger sampling was introduced in Flanders, Schiffer *et al.* (1978: 8) argued that "[t]*echniques which expose only a small area, such as boring and coring, yield on the average few artefacts and often miss sites*". In auger survey, the collected and inspected samples always represent a very limited portion of the total survey area, regardless of grid lay-out, auger type and auger diameter. When applying the CGP-recommended combination of grid lay-out and auger diameter in a 1 ha area, only a maximum of 0,008 % of this area is actually sampled. This figure increases nearly five times (0,038 %) when a 5 m equilateral grid lay-out is used and nearly 19 times (0,151 %) when this latter grid is used in combination with a 20 cm auger. These latter two approaches, however, are no longer applied in Flemish auger survey. Nevertheless, sampled volumes in all these cases remain very low, especially when compared to mechanical trial trenching which exposes on average 12 % of the entire surface (Haneca *et al.*, 2016, 2017). Some of the most important inherent characteristics of (clustered) artefact distributions are the small dimensions of the clusters, the differential artefact densities within these clusters, the large amount of zones devoid of any artefacts even in the densest part of clusters and the rapidly decaying find densities from the centre towards the edges of the clusters (Noens, 2014; Noens *et al.*, 2013). Furthermore, artefacts smaller than 3 mm often account for nearly 70 % of the recovered artefacts within clusters when sieved over 2 mm meshes (putting the notion of 'high density' as expressed by numbers instead of volume also into a different perspective, Noens *et al.*, 2013). When confronting these major characteristics with the CGP-recommendations it becomes hard to disagree with the above quote from Schiffer *et al.* or with Plog *et al.* (1978: 390) finding that "*unless the intensity of a survey is high many sites will be missed-not simply atypical or very small sites, but typical and relatively large sites*". Therefore, the need to apply intensive approaches for visual inspection of soil samples, instead of sieving over large meshes or simply cutting/crumbling of the sediment, cannot be overemphasized.

In the prevailing context of commercial, development-led archaeology, surveys often take place under considerable time pressures and financial constraints. Project planning in such circumstances inevitably involves the allocation of scarce resources and it becomes challenging to design a survey in a reliable and cost-efficient manner, as in each survey project choices have to be made. But even under these circumstances, choices have to rely on a transparent, explicit and well-substantiated trade-off between extent, costs and reliability of the survey, a consideration that often leads to a compromise. A few years ago, De Clercq *et al.* (2012: 44) argued that auger sampling is well-suited for the detection of discrete, low-density find scatters, provided that basic strategic choices are being made concerning grid interval and sieving meshes, and that we remain aware not to reduce the costs too such an extent that the survey becomes ineffective. Unfortunately, their observation that "[a]*ll too often within Malta research, the reduction of costs is more important than sound results and archaeologists neglect or cut down on what should be basic strategic choices in augering survey (e. g. grid size, sieving technique)*" is still valid today. It seems that the Flemish archaeological community has focused too much on cost-reduction and at the same time has been less concerned by the question of how best to design cost-effective survey strategies. The related question of how to evaluate and improve the effectiveness of currently applied survey strategies received even less scrutiny, despite some critical thoughts on the merits and shortcomings of current survey practices and some preliminary attempts to evaluate and increase auger survey-effectiveness, either based on statistical approaches and/or empirical datasets (e. g. Bats, 2007; Crombé & Verhegge, 2015; De Clercq *et al*., 2011, 2012; Noens, 2014; Noens & Van Baelen, 2014; Noens *et al*., 2013; Ryssaert *et al*., 2007; Verhagen *et al*., 2011, 2013). Financial considerations, in the development-led circuit too often a more important issue than the actual cost-benefit debate, will increase as both the demands of reliability and the lateral extent and depth of survey areas increase. This tension between costs and reliability -and thus quality- of surveys, which is particularly pertinent for larger survey areas, remains a challenging aspect to deal with in the search for the prehistoric material record. In this regard, a statement put forward by Shott (1985: 467) over three decades ago, is worth repeating once more: "[t]*he costs of surveys* [...] *should follow from their goals, not place limits on what they can accomplish. If such increases* [in costs] *are needed to produce more reliable results, then we should be prepared to accept them*". Stressing the importance of a good survey design and a balance between costs and benefits, Banning (2002: 24), too, sees it as a waste of resources when surveys do not meet their goals: "*Although ensuring a high level of data quality may be costly, it would also be wasteful to spend time and money on a survey whose results fail to accomplish basic goals* [...] [I]*t often pays to minimize the costs as long as the survey can accomplish its goals and does not compromise the archaeological evidence*" (Banning, 2002: 24).

The intensity of subsurface surveys thus has a strong bearing on its effectiveness to detect buried remains (Plog *et al.,* 1978; Way, 2017a, 2017b). Increasing intensity will not only result in higher discovery rates, but will also lead to a more reliable view on the absence of remains in the surveyed area. Survey evaluation, including explicit assessments of methodological shortcomings, inherent biases and successes at detecting archaeological remains of interest, is an important step in a survey design, one that is required to draw confident conclusions from the surveys' result (Banning, 2002: 25, 217-228). Yet this step is often overlooked in Flemish survey practices. Low discovery rates or the entire lack of any remains in auger samples do not necessarily reflect the absence of artefact distributions in the survey area, but instead can (and often arguably do) mirror a failure to detect materials as a result of survey limitations, sampling bias or flawed methodologies. How likely is it that the applied sampling procedures failed to detect particular kinds of artefact distributions? How to recognize and compensate for this potential misinterpretation? Which proportion was discovered? And which survey intensity is required to achieve (more) adequate discovery levels? Such questions are often simply ignored. Furthermore, survey includes more than just finding archaeological remains. Another important task often seems to be neglected by its practitioners in Flanders. As recently noted by Banning *et al.* (2017) "*the ability to characterize the existing materials correctly in terms of their type, density, and distribution*" is only part of the story and the reputable and professional status of survey practices also depend on "*their ability to convince us that spaces in which they report a lack of archaeological materials are actually devoid of such materials*". Both aspects -i. e. finding archaeological remains but also showing in a reliable way that areas lack such remains- should be fundamental cornerstones of any archaeological survey, particularly in the case of development-led archaeological contexts.

Despite a general consensus on minimal procedures in auger survey, many methodological aspects remain unexplored and disagreements exist on the practicalities of these procedures. While the utility of auger sampling procedures to detect clustered occurrences of material residues in areas of low visibility is currently no longer being questioned in Flanders as a viable approach, it still largely remains to be explored how effective this sampling approach actually is, expressed in terms of what part of the record under study is likely to be missed and what the inherent biases in survey designs are. A number of recent evaluation studies have re-opened the debate on the suitability of auger survey for systematically detecting and assessing some parts of the buried lithic record (i. e. Verhagen *et al.*, 2011, 2013; Noens & Van Baelen, 2014; Crombé & Verhegge, 2015; see also Bats *et al.*, 2004), although so far no viable survey alternatives have been proposed to investigate these more obscure parts of the record. These recent arguments echo similar concerns that were made during the early years of test-pit sampling in the U.S. (e. g. Schiffer *et al.*, 1978; Plog *et al.*, 1978; Thomas, 1986; Zeidler, 1995) and recently also in Australia (Way, 2017a; 2017b). It became clear in recent years that most of the auger surveys in Flanders might be overlooking a considerable part of the artefact distributions, instead of systematically exposing it. These include small and/or low density artefact clusters as well as highly-clustered or non-clustered artefact distributions. A similar point has previously been made by Zeidler (1995: 64-65), who noted that while "*subsurface testing is admittedly not a very effective technique for intersecting and detecting small sites* [...] *with low artifact densities distributed in highly clustered fashion, even in these cases the technique permits reasonable estimation of the probability of not finding them, and is thus preferable to unsystematic search techniques, or worse yet, total avoidance*".

The shortcomings in current auger survey practises from Flanders are undesirable as these can -and probably do- introduce large and uncorrectable biases in our knowledge of the prehistoric past. Not only does it create a biased view of the occupational history in many areas, it probably also results in the large-scale undocumented destruction of this record. While all this seems to imply that our auger survey efforts need to be intensified and/or more viable alternatives need to be developed, it also became clear from the first evaluation studies on auger sampling that there is an urgent need for more reliable empirical (archaeological and experimental) data to evaluate the existing approaches and to search for more appropriate one(s). Our current knowledge of relevant survey-characteristics of artefact distributions is prone for improvement, the number of large-scale, detailed archaeological surveys and excavations is still too limited, and the variability in approaches too large, to arrive at useful data allowing a thorough evaluation of the existing strategies. Furthermore, little factual data is currently gathered on the influence of each variable, as well as their combination. The reliability of our knowledge of the inherent characteristics of the material record to a large extent depends on the procedures we use to excavate it. Despite a large number of excavated datasets in Flanders, the variation in these characteristics of the record remains poorly understood. As a result, it is nearly impossible to accurately predict these characteristics prior to the survey and it remains a haphazard enterprise to develop (the most) optimal survey strategies. Further evaluation is thus urgently needed to determine exactly how reliable it is for detecting (the variation in) artefact distributions and how its reliability can be improved, viewed from a cost-benefit perspective and taking into account the inherent variation in artefact distribution patterns.

It is widely accepted nowadays by both scientists and heritage managers that the part of the archaeological record on Flemish soils that consist of portable material remains scattered at and below the present-day surface not only is very difficult to detect in an adequate manner, but also requires particular approaches that are different from those used to detect non-portable material remains. It is also recognized -at least among prehistorians- that the prehistoric record is often treated inappropriately or -worse- simply ignored in development-led archaeological investigations, leading to a destruction of a unique archaeological resource without proper assessment. Pressures on the soil archives in the densely populated area of Flanders are high and large parts of it are rapidly disappearing -either documented or undocumented- due to the high number of intrusive land development activities taking place. The prehistoric record, including both its surface and subsurface components, is not immune to this eminent threat. On the contrary, its unobtrusive nature and poorly known character makes it even more prone to undocumented destruction than is the case with many other parts of the archaeological soil archive. Viewed within this context, the need to develop, apply, evaluate and refine appropriate survey designs in order to expose and assess it in a more systematic way, has become of more urgent concern than ever before. Well over 70 years ago, amateur archaeologist Stroobant (1947) -at the age of 85- noted that "*le temps n'est pas loin où il sera trop tard, et où des constatations scientifiques seront impossibles*". More recently, Vermeersch (1994) added to this that "*in the near future no Epi-Palaeolithic or Mesolithic sites will survive*", and only a decade ago Verhart (2007) argued that "*destruction looms, and we must hurry*". No more time should be wasted, otherwise these prophecies expressed by these Flemish and Dutch prehistorians with regard to (the surface component of) the prehistoric record might turn into an undesirable reality for the entire prehistoric record in Flanders.

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Bibliography

https://loket.onroerenderfgoed.be/archeologie/notas/archeologienotas/ (consulted 03/03/2018).

https://statbel.fgov.be/nl/themas/leefmilieu/grond/ (consulted 20/02/2018).

BAILEY, G., 2008. Time Perspectivism: Origins and Consequences. In: Holdaway S. J. & Wandsnider L., *Time in archaeology: time perspectivism revisited*, University of Utah Press, Salt Lake City: 13-30.

BANNING E. B., 2002. *Archaeological survey*. New York.

BANNING E. B., HAWKINS A. L., STEWART S. T., HITCHINGS P. & EDWARDS S., 2017. Quality Assurance in Archaeological Survey. *Journal of Archaeological Method and Theory*, 24(2): 466-488.

BATS M., 2007. The Flemish Wetlands. An archaeological survey of the valley of the river Scheldt. In: Barber J., Clark M., Cressey M. *et al.* (ed.), *Archaeology from the Wetlands: recent perspectives. Proceedings of the 11th WARP conference, Edinburgh 2005*, Edinburgh: 93-100.

BORREMANS M. (ed.), 2015. *Geologie van Vlaanderen*. Academia Press, Gent.

CORRY S., 2011. *Tribal peoples for tomorrow's world*. Freeman Press.

CROMBÉ P. & MEGANCK M., 1996. Results of an auger survey research at the Early Mesolithic site of Verrebroek "Dok" (East-Flanders, Belgium). *Notae Praehistoricae*, 16: 101-115.

CROMBÉ P. & VERHEGGE J., 2015. In search of sealed Palaeolithic and Mesolithic sites using core sampling: the impact of grid size, meshes and auger diameter on discovery probability. *Journal of Archaeological Science*, 53: 445-458.

DE BIE M., VAN GILS M. & D. DE WILDE D., 2014. A pain in the plough zone. On the value and decline of Final Palaeolithic and Mesolithic sites in the Campine region (Belgium). In: Meylemans E., Poesen J. & In't Ven I. (ed.), *The archaeology of erosion, the erosion of archaeology. Proceedings of the Brussels Conference, April 28-30 2008*, Brussels: 37-54.

DE BOER G. H. & LESPARRE-DE WAAL M. S., 2012. *Size doesn't matter. Naar een verbeterde waarderingsmethodiek voor afgedekte steentijdvindplaatsen in de gemeente Almere. Pilot Avegaar 200 mm*. RAAP Archeologisch Adviesbureau, RAAP-rapport, 2564, Weesp.

DE CLERCQ W., BATS M., LALOO P., SERGANT J. & CROMBÉ P., 2011. 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: Blancquaert G., Malrain F., Stäuble H. & Vanmoerkerke J. (ed.), *Understanding the past: a matter of surface-area. Acts of the XIIIth Session of the EAA Congress, Zadar 2007*, Oxford: 73-89.

DE CLERCQ W., BATS M., BOURGEOIS J., CROMBÉ P., DE MULDER G., DE REU J., HERREMANS D., LALOO P., LOMBAERT L., PLETS G., SERGANT J. & STICHELBAUT B., 2012. Developer-led archaeology in Flanders: an overview of practices and results in the period 1990-2010. In: Webley L., Vander Linden M., Haselgrove C. & Bradley R. (ed.), *Development-led Archaeology in Northwest Europe. Proceedings of a round table at the University of Leicester, 19th-21th November 2009*, Oxford: 29-55.

DEEBEN J., 1999. The known and the unknown: the relation between archaeological surface samples and the original Palaeolithic and Mesolithic assemblages. *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek*, 43: 9-32.

DREW L., 1979. Pattern drilling exploration: optimum pattern types and hole spacings when searching for elliptical shaped targets. *Mathematical Geology*, 11(2): 223-254.

GOODRUM M. R., 2013. The study of prehistoric artefacts in national context. Belgian archaeologists and the problem of ancient stone implements. *Bulletin of the History of Archaeology*, 23(2): 1-11.

GROENEWOUDT B. J., 1994. *Prospectie, waardering en selectie van archeologische vindplaatsen: een beleidsgerichte verkenning van middelen en mogelijkheden*. Amersfoort.

GRØN O., 2018. Some problems with modelling the positions of prehistoric hunter-gatherer settlements on the basis of landscape topography. *Journal of Archaeological Science: Reports*, 20: 192-199.

HANECA K., DEBRUYNE S., VANHOUTTE S. & ERVYNCK A., 2016. *Archeologisch vooronder-*

zoek met proefsleuven. Op zoek naar een optimale strategie. Brussel.

HANECA K., DEBRUYNE S., VANHOUTTE S., ERVYNCK A., VERMEYEN M. & VERHAGEN P., 2017. Simulating Trial Trenches for Archaeological Prospection: Assessing the Variability in Intersection Rates. *Archaeological Prospection*, 24(3): 195-210.

HAMBURG T. A., TOL J., DE MOOR J. & LAMMERS-KEIJSERS Y., 2014. *Afgedekt verleden. Opsporing, waardering en selectie van prehistorische archeologische vindplaatsen in Flevoland. Programma Kennisontwikkeling Archeologie Hanzelijn (Thema 1B)*. Archeologisch Onderzoek Leiden BV, Archol-rapport, 244 & Earth Integrated Archaeology rapporten, 49, Leiden/Amersfoort.

HISSEL M. & VAN LONDEN H. (eds), 2004. *De kwaliteit van de waarneming. Een vergelijking van boormethoden voor archeologisch inventariserend onderzoek*. Amsterdam.

HISSEL M., VAN LONDEN H., TIGGELMAN, L. & VAN DEEN K., 2005. Een oog voor de archeoloog. De waarde van boormethoden uit de geotechniek voor de archeologie. *Geotechniek*: 30-35.

KINTIGH K. W., 1988. The effectiveness of subsurface testing: a simulation approach. American Antiquity 53(4): 686-707.

KRAKKER J. L., SHOTT M. J. & WELCH P. D., 1983. Design and evaluation of shovel-test sampling in regional archaeological survey. *Journal of Field Archaeology*, 10(4): 469-480.

LIGHTFOOT K. G., 1986. Regional surveys in the Eastern United States. The strengths and weaknesses of implementing subsurface testing programs. *American Antiquity*, 51(3): 484-504.

LIGHTFOOT K. G., 1989. A defence of shovel-test sampling: a reply to Shott. *American Antiquity*, 54(2): 413-416.

LOVIS Jr. W. A., 1976. Quarter sections and forests: an example of probability sampling in the Northeastern Woodlands. *American Antiquity*, 41(3): 364-372.

LYNCH B. M., 1980. Site artifact density and the effectiveness of shovel probes. *Current Anthropology*, 21(4): 516-517.

MCMANAMON F. P., 1984. Discovering sites unseen. *Advances in Archaeological Method and Theory*, 7: 223-292.

MEIJS E. P. M., VAN PEER P. & DE WARRIMONT J.-P., 2014. Geomorphologic context and proposed chronostratigraphic position of Lower Palaeolithic artefacts from the Op de Schans pit near Kesselt (Belgium) to the west of Maastricht. *Netherlands Journal of Geosciences - Geologie en Mijnbouw*, 91(1-2): 137-157.

MEYLEMANS E. & VANDER BEKEN T., 2008. *Onderzoeksbalans: methoden en technieken*. Versie 1, Brussel.

MUELLER J. W. 1975. *Sampling in Archaeology*. University of Arizona Press, Tucson.

NANCE J. D., 1979. Regional subsampling and statistical inference in forested habitats. *American Antiquity*, 44: 172-176.

NANCE J. D., 1981. Statistical Fact and Archaeological Faith: Two Models in Small-Sites Sampling. *Journal of Field Archaeology*, 8(2): 151-165.

NANCE J. D., 1983. Regional Sampling in Archaeological Survey: The Statistical Perspective. *Advances in archaeological method and theory*, 6: 289-356.

NANCE J. D. & BALL B. F., 1986. No surprises? The reliability and validity of test pit sampling. *American Antiquity*, 51(3): 457-483.

NANCE J. D. & BALL B. F., 1989. A Shot in the Dark: Shott's comments on Nance and Ball. *American Antiquity*, 54(2): 405-412.

NOENS G., 2014. Gerichte prospectie naar (prehistorische) vondstclusters II: enkele opmerkingen omtrent de mogelijke invloed van opgravingsmethoden op de perceptie van vorm, omvang en densiteit van vondstclusters. *Notae Praehistoricae*, 34: 51-63.

NOENS G. & VAN BAELEN A., 2014. Gerichte prospectie naar (prehistorische) vondstclusters I: enkele boorsimulaties gericht op een evaluatie van de onderlinge afstand tussen boorpunten binnen een driehoeksraster. *Notae Praehistoricae*, 34: 27-50.

NOENS G., BATS M., VAN BAELEN A. & CROMBÉ P., 2013. Archeologische (lithische) indicatoren met geringe afmetingen en hun rol bij het opsporen van afgedekte prehistorische vindplaatsen: experimentele en archeologische observaties. *Notae Praehistoricae*, 33: 193-215.

PEETERS J. H. M., RAEMAEKERS D. C. M., DEVRIENDT I., HOEBE P. W., NIEKUS M. J. L. T., NOBLES G. R. & SCHEPERS M., 2017. *Paradise lost? Insights into the early prehistory of the Netherlands from development-led archaeology*. Cultural Heritage Agency of the Netherland, Nederlandse Archeologische Rapporten, 062, Amersfoort.

PLOG S., PLOG F. & WAIT W., 1978. Decision Making in Modern Surveys. *Advances in Archaeological Method and Theory*, 1: 383-421.

RYSSAERT C., PERDAEN Y., DE MAEYER W., LALOO P., DE CLERCQ W. & CROMBÉ P., 2007. Searching the stone age in the harbour of Ghent. How to combine test trenching and stone age archaeology. *Notae Praehistoricae*, 27: 69-74.

SCHIFFER M. B., SULLIVAN A. P. & KLINGER T. C., 1978. The design of archaeological surveys. *World Archaeology*, 10(1): 1-28.

SEVENANTS W., 2010. *Archeologische prospectie & begeleiding te Holsbeek-Rotselaarsebaan*. Erps-Kwerps.

SHOTT M. J., 1985. Shovel-test sampling as a site discovery technique: a case study from Michigan. *Journal of Field Archaeology*, 12(4): 457-468.

SHOTT M. J., 1989. Shovel-test sampling in archaeological survey: comments on Nance and Ball, and Lightfoot. *American Antiquity*, 54(2): 396-404.

SHOTT M. J., 2004. Representativity of the Midwestern Paleoindian sample. *North American Archaeologist*, 25(2): 189-212.

SMIT B. I., 2010. *Valuable flints. Research strategies for the study of early prehistoric remains from the Pleistocene soils of the Northern Netherlands*. PhD dissertation, Groningen.

SMITH W., 2013. *Een integrale opsporingsformule voor prospectief booronderzoek*. Almere.

SMITH W. & HOGESTIJN J. W. H., 2013. *De invloed van variatie in vondstdichtheden op de vindkans van vuursteenvindplaatsen. Poissonverdeling versus de negatief binomiale verdeling*. Almere.

STEIN J. K., 1986. Coring archaeological sites. *American Antiquity*, 51(3): 505-527.

STEIN J. K., 1991. Coring in CRM and archaeology: a reminder. *American Antiquity*, 56(1): 138-142.

STONE G. D., 1981. On artifact density and shovel probes. *Current Anthropology*, 22: 182-183.

STROOBANT L., 1947. Contribution à l'étude de la préhistoire campinoise. Fond de hutte de quartzite de Wommersom à Bolck-Les-Merxplas. *Bulletin de la Société Royale Belge d'Anthropologie et de Préhistoire*, 58: 20-24.

THOMAS P., 1986. Discerning some spatial characteristics of small, short-term, single occupation sites: implications for New England archaeology. *Man in the Northeast*, 31: 99-121.

TOL A. J., VERHAGEN J. W. H. P., BORSBOOM A. & VERBRUGGEN M., 2004. *Prospectief boren. Een studie naar de betrouwbaarheid en toepasbaarheid van booronderzoek in de prospectiearcheologie*. Amsterdam.

TOL A. J., VERHAGEN J. W. H. P. & VERBRUGGEN M., 2006. *Leidraad inventariserend veldonderzoek; Deel: karterend booronderzoek*. Versie 1.0, Gouda.

TOL A. J., VERHAGEN J. W. H. P. & VERBRUGGEN M., 2012. *Leidraad inventariserend veldonderzoek; Deel: karterend booronderzoek*. Versie 2.0, Gouda.

VAN BAELEN A., 2017. *The Lower to Middle Palaeolithic Transition in Northwestern Europe. Evidence from Kesselt-Op de Schans*. Leuven.

VAN BAELEN A. & RYSSAERT C., 2011. The early Middle Palaeolithic of Belgium. Le Paléolithique Moyen en Belgique. In : TOUSSAINT M., DI MODICA K. & PIRSON S. (ed.), *Le Paléolithique moyen en Belgique. Mélanges Marguerite Ulrix-Closset*, Bulletin de la Société belge d'études Géologiques et Archéologiques 'Les Chercheurs de la Wallonie' (hors-série, n° 4) & Études et Recherches archéologiques de l'Université de Liège (ERAUL, 128), Liège : 197-213.

VAN BAELEN A. & VANMONTFORT B., 2011. Evaluatie van een mesolithische vindplaats te Holsbeek-Rotselaarsebaan 2 (B). Opgravingscamapagne 2011. *Notae Praehistoricae*, 31: 87-99.

VAN ZIJVERDEN W. & DE MOOR J., 2014. *Het groot profielenboek. Fysische geografie voor archeologen*. Leiden.

VERHAGEN J. W. H. P., 2013. Site discovery and evaluation through minimal interventions: core sampling, test pits and trial trenches. In: Corsi C., Slapsak B. & Vermeulen F. (ed.), *Good practice in archaeological diagnostics*, New York: 209-225.

VERHAGEN J. W. H. P. & TOL A. J., 2004. Establishing optimal core sampling strategies: theory, simulation and practical implications. In: Fischer Ausserer A., Börner W., Goriany M. & Karlhuber-Vöckl L. (ed.), [*Enter the past*]: *the E-way into the four dimensions of cultural heritage: CAA 2003: computer applications and quantitative methods in archaeology: proceedings of the 31th conference, Vienna, Austria, April 2003*, Oxford: 416-419.

VERHAGEN J. W. H. P., RENSINK E., BATS M. & CROMBÉ P., 2011. *Optimale strategieën voor het opsporen van Steentijdvindplaatsen met behulp van booronderzoek. Een statistisch perspectief*. Rapportage Archeologische Monumentenzorg (RAM). Amersfoort.

VERHAGEN J. W. H. P., RENSINK E., BATS M. & CROMBÉ P., 2013. Establishing discovery probabilities of lithic artefacts in Palaeolithic and Mesolithic sites with core sampling. *Journal of Archaeological Science*, 40: 240-247.

VERHART L., 2006. From prospecting to conservation: the past and future of the Early Mesolithic Vlootbeek valley region (the Netherlands). In: Rensink E. & Peeters H. (ed.), *Preserving the Early Past. Investigation, selection and preservation of Palaeolithic and Mesolithic sites and landscapes*, Amersfoort: 55-64.

VERHART L., 2007. Als een roepende in de woestijn? Enkele gedachten over steentijdonderzoek in Limburg. *Archeologie in Limburg*, 105: 16-23.

VERHEGGE J., VANHECKE M., VAN DEN WIJNGAERT M. & CROMBÉ P., 2016. Geotechniek & Archeologische prospectie: een overzicht van mechanische boor- en elektrische sondeer- technieken voor archeologie. *Notae Praehistoricae*, 36: 203-209.

VERMEERSCH P. M., 1994. Increasing Destruction of prehistoric Settlements in Flanders. In: Koschik H. (ed.), *Aspekte Europaïscher Denkmalpflege*, Rheinland-Verlag, Köln: 17-28.

WANSLEEBEN M. & LAAN W., 2012. The archaeological practice of discovering stone age sites. *Analecta Praehistorica Leidensia*,43/44: 254-261.

WAY A. M., 2017a. The Design, Application and Evaluation of an Effective Subsurface Sampling Strategy: Detecting Holocene Knapping Floors in Southeastern Australia. *Journal of Field Archaeology*, 42(3): 187-197.

WAY A. M., 2017b. Test-pitting and the detection of sub-surface sites: an example from Lake George, NSW. *Australian Archaeology*, 83(1-2): 32-41.

ZEIDLER J. A., 1995. *Archaeological inventory survey standards and cost-estimation guidelines for the Department of Defence*. Construction Engineering Research Laboratories, US Army Corps of Engineers, Champaign IL.

Abstract

In 1996, auger sampling was introduced into archaeological survey practices in Flanders as a means to detect prehistoric artefact distributions. Nowadays, it has come to be viewed as the most practical, reliable, effective and cost-efficient approach currently at our disposal to discover clustered artefact distributions in low-visibility areas where the remains are either (deeply) buried by younger deposits or covered by vegetation. Since its introduction over two decades ago, it has been applied to more than 230 different locations as part of at least 90 different survey-projects but, nevertheless, still holds a marginal position in Flemish developer-led archaeology compared to other survey-approaches used to detect archaeological soil features. Based on an extensive inventory of auger survey projects between 1996 and the end of 2017, this paper provides an overview and discussion of its methodological variation, focussing on grid lay-out, auger devices, treatment of collected soil samples and the place auger sampling occupies within the survey trajectories.

Keywords: Flanders, (prehistoric) find distributions, survey, augering.

Samenvatting

Sinds 1996 wordt in Vlaanderen archeologisch booronderzoek aangewend voor de prospectie naar prehistorische artefactspreidingen. Vandaag de dag wordt deze aanpak algemeen aanzien als de meest praktische, betrouwbare, effectieve en kosten-efficiënte benadering voor het detecteren van geclusterde vondstspreidingen in afgedekte contexten. Hoewel deze benadering reeds werd toegepast tenminste 230 locaties in het kader van tenminste 90 verschillende projecten, blijft het een randfenomeen in de hedendaagse preventieve archeologiesector, in tegenstelling tot andere prospectiebenaderingen die meer geschikt zijn voor het detecteren van bodemsporen in plaats van geclusterde artefactspreidingen. Op basis van een uitvoerige inventaris van archeologisch booronderzoek dat in Vlaanderen werd uitgevoerd tussen 1996 en het einde van 2017, probeert dit artikel een kritisch overzicht te bieden van de chronologische en regionale variatie in toegepaste methodieken, met nadruk op het boorraster, de booruitrusting, de behandeling en inspectie van bodemmonsters en de plaats die het booronderzoek inneemt in de prospectietrajecten.

Trefwoorden: Vlaanderen, prehistorische vondstspreiding prospectie, archeologische boringen.

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