CAA
2017

Espen Uleberg and Mieko Matsumoto
http://dx.doi.org/10.15496/publikation-43233

Display Matters? Enhanced Visualisation of Norwegian Neolithic Landscapes

Espen Uleberg
Museum of Cultural History
University of Oslo
espen.uleberg@khm.uio.no

Mieko Matsumoto
Museum of Cultural History
University of Oslo
mieko.matsumoto
@khm.uio.no

Abstract

The paper explores enhanced visualisation of site distribution, with the purpose of understanding shifts in landscape preferences from Middle to Late Neolithic in East Norway. It includes single finds and artefacts from excavations, and the criteria are spatiotemporal accuracy related to the scale of analysis. The representativity of the dataset is evaluated. The artefacts are seen as a Poincaré set that describes the nonlinear system of movement and tasks in the prehistoric landscape. This gives a different approach to the study of site distributions that are results of single events performed in a continuous time and space. This Poincaré set is visualised as find densities in landscape subregions. Archaeological periods are used as temporal scale levels, while landscape subregions, defined through a holistic landscape categorisation, are applied as the spatial scale level.

Keywords: landscape categorisation, taskscape, nonlinear systems, MUSIT database, map-based EDA

Introduction

This study is an extension of the project Dynamic Distributions (Matsumoto and Uleberg 2015a; Uleberg and Matsumoto 2015; Uleberg and Matsumoto 2016), which investigated changing relations between humans and landscape during the Stone Age in East Norway. The elements in the analysis are archaeological single finds and landscape regions. The lithic finds are from the collection at the Museum of Cultural History (Kulturhistorisk Museum, hereafter KHM) at the University of Oslo. The datasets are published through MUSIT (MUSeum IT), at www.unimus.no. The landscape regions are based on a holistic landscape categorisation (Puschmann 1998).

Dynamic Distributions analysed the find distribution at different temporal and spatial scales. The scales correlated with different spatiotemporal aggregations of archaeological material projected onto varying aggregations of landscape regions. The site distribution visualised changes in landscape preferences over time. This combination of archaeological single finds with varying aggregations of landscape regions has contributed to a different approach to archaeological distribution maps.

The present article extends the analyses from Dynamic Distributions by focusing on sites as well as single finds dated to the Middle and Late Neolithic from seven counties in East Norway (Figure 1). The sites and single finds are results of events that took place in a time–space continuum, and are analysed as a 3D Poincaré set (Uleberg 2004). The points in this set are aggregated and visualised as distributions in the holistically defined landscape regions (Puschmann 1998).

The MUSIT Database

The current analysis is based on KHM's open data published through MUSIT, which is a cooperative initiative created by the Norwegian university museums (Matsumoto and Uleberg 2015a; Uleberg and Matsumoto 2009). The MUSIT database is event

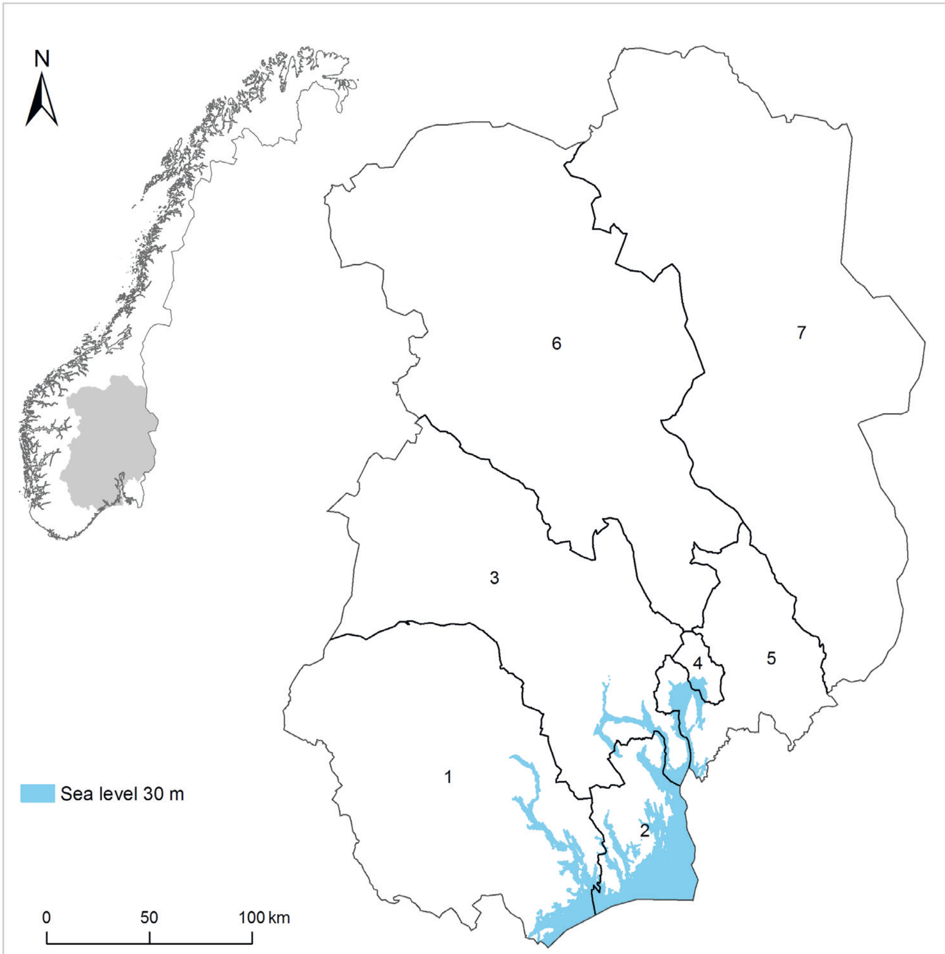

Figure 1. Seven counties in East Norway: 1. Telemark, 2. Vestfold, 3. Buskerud, 4. Oslo, 5. Akershus, 6. Oppland, 7. Hedmark.

based and developed in line with the CIDOC-CRM concept (Jordal, Uleberg & Hauge 2012: 256). The artefact catalogues, published and handwritten, have been digitised and converted to the MUSIT database. Original terminology for place names, artefacts, and raw materials have been kept as old classification events, and new, updated terms are consecutively added as new events.

The archaeological museum in Oslo, Universitetets Oldsaksamling, was founded as part of the University in 1829 and is now part of KHM. KHM is responsible for archaeological excavations in East Norway, and archaeological finds from this area are curated by this museum and registered in the MUSIT database (Matsumoto and Uleberg 2015b). The majority are georeferenced to a cadastral unit, but some have exact site coordinates. Given the long history of the collection, it is natural that some finds can only be georeferenced to wider areas like a parish or municipality. Metadata to describe the accuracy of the provenance are recorded in the database, and different sets of artefacts can be selected for analysis at different scales (Uleberg and Matsumoto 2015). The applied set of metadata is in accordance with the Norwegian standard for georeferenced information, SOSI (Kartverket 2016). The precision levels that are used in this paper are the equivalents of site and cadastral unit.

Representativity

The finds included in this analysis are georeferenced with an accuracy of cadastral unit or site. The question of representativity should address whether the visualisation includes a sufficient number of sites to capture the variation in tasks performed in the landscape during the Stone Age.

Generally in Norway, Stone Age finds have been abundant close to the coast and in the high mountains, but scarce in the intermediate woodlands and valleys. This pattern could be a result of modern activity rather than a reflection of Stone Age taskscapes. Single finds dominated the artefact assemblage from the seven counties presented here (Figure 1) as late as 1940, and many of them were accidentally found during farming. However, a study comparing the number of single finds with area of farmland in municipalities in Vestfold and southern Buskerud could not demonstrate a covariation between these two factors. This indicates that the distribution map is not only a reflection of modern farming. The number of surveyed and excavated sites increased from the late 1950s onwards as the development of hydroelectric power in the mountains led to the discovery of numerous sites near lakes and rivers (Glørstad 2002; Glørstad 2006; Indrelid 2006). From the 1980s there have been larger development projects producing new knowledge about the intermediary zone (Boaz 1998; Stene 2010), and in recent years the construction of modern infrastructure have provided more knowledge about Stone Age landscape use around the Oslo Fjord (Damlien and Solheim 2017; Glørstad 2004; Jaksland and Persson 2014; Melvold and Persson 2014; Reitan and Persson 2014; Solheim 2017; Solheim and Persson 2018).

The archaeological surveys included in the development plans related to hydroelectric power in Norway from the late 1950s marked a beginning of systematic archaeological surveying, and today all development plans involve documentation of cultural remains from all eras. The national systematic archaeological surveys from the 1960s were mainly concentrated on Iron Age sites, but also included Stone Age sites. This development is reflected in the Stone Age collection, as new accessions are more and more dominated by finds made more systematically by archaeologists. However, the surveyed areas are generally not chosen by archaeologists' research interests, but determined by developers' interests and concerns (Indrelid 2006: 21).

This selection of areas can be seen as detriment to the archaeological research, but construction work also sends archaeologists into areas that otherwise would not be studied. Surveys in the initial phase of road and railway planning are carried out within rather wide corridors, and from an archaeological point of view this can be seen as an arbitrary path through the landscape. However, the survey methodology will be influenced by the expectations and research interests of the archaeologists doing the survey. As an example, digging of test pits will be used more frequently in surveys concentrating on Stone Age sites than when the focal point is remains from the Iron Age or later (Prescott 1995: 38–43).

An example of this can be found in the surveys in the Oslo fjord area. The Ice Age ends around 12,000 BP, and the subsequent isostatic uplift has given the fortunate situation that height above sea level is related to archaeological periods. The earlier coastal sites are always at a higher altitude than the later. The shoreline at the end of the Ice Age is now at a height of 220 m a.s.l. in the inner Oslo fjord. The isostatic rebound was strongest shortly after the Ice Age when the shore displacement curve for Vestfold indicates a 30 m rebound within 400 years, which gives an annual average of as much as 7.5 cm (Jaksland 2014: 16–17). The changes during the Neolithic were more gradual. A sea level of around 30 m higher than the present can be used as an approximation for the situation around the Middle and Late Neolithic in the inner part of the Oslo fjord.

Recently, a site at 193 m a.s.l. in Akershus dated to 11,000 BP was excavated due to a new railway line in the area (Eymundsson and Mjærum 2015). Parts of the new highway through southern Vestfold were planned further away from the coast and at a higher altitude than the existing road, and the surveyed transect cut through previously unknown Early Mesolithic sites between 95 and 125 m a.s.l. In calendar years, this is equivalent to the period around 11,200 BP to around 10,800 BP (Jaksland 2014: 16–17). Further north in Vestfold, nine Middle Mesolithic sites were excavated where the highway corridor passed through landscapes between 49 and 70 m a.s.l. (Damlien 2013: 8–15). All these sites are interpreted as coastal sites that are now in forested areas. Corridors at lower altitudes have given more knowledge of Neolithic occupational sites. The Svinesund project (2000–2003) excavated sites in Østfold east of the Oslo fjord between 55 and 28 m a.s.l, equivalent to a shore line dating between 6300 BC (Late Mesolithic) and 2800 BC (Middle Neolithic).

Shorelines should, however, only be used as a *post quem* dating method. A site at 90–93 m a.s.l. in southern Vestfold was interpreted as a Mesolithic site during the survey, but diagnostic artefacts and C14 dates from the excavation revealed that it could be dated to Late Neolithic or Late Neolithic/Bronze Age and interpreted as a forest hunting camp (Jaksland

and Kræmer 2012: 226–227). The Svinesund project also excavated sites that were at a distance from the coast when they were inhabited. These sites corroborate that the Late Neolithic (2350–1700 BC) is a period with more sites further from the coast and generally in areas well suited for agriculture or pastoralism (Glørstad 2012).

All of these sites were found during surveying connected to modern development. It can be argued that the combined modern archaeological surveys and collected stray finds give a reasonably good representation of the distribution of prehistoric human activity in the landscape. The archaeological survey follows transects through the landscape determined by modern planning, and the strategy will be determined by expectations based on previous archaeological knowledge. It is, however, necessary to aggregate the archaeological material in ways that make it possible to visualise spatial analyses that can elucidate connections with different landscape types.

Landscape Categorisation

Spatial analysis of archaeological finds has been done in relation to a number of geological, geographical, and topographical variables. The purpose has often been predictive archaeology, and sites have been analysed in relation to variables like slope, soil types, and distance to water. This kind of analyses is sensitive to the scale of the geographic data, and in many cases it can only use finds that are georeferenced with high accuracy. A more holistic approach combines a set of distinct variables in the definition of landscape areas and this allows an inclusion of finds with lower accuracy. This approach can also reflect how the landscape is understood and created by people living and moving in it.

The Norwegian Institute of Land Inventory (NIJOS) developed a landscape reference system for Norway based on a method from the US Forestry Service and adapted in collaboration with the Institute of Landscape Architecture at the Norwegian Agricultural University (NLH). The landscape system is described at three different geographical scales: agricultural region, landscape region, and subregion. The three-dimensional content and the interaction between cultural and natural factors are important. This classification represents a multidisciplinary understanding and holistic evaluation of the landscapes. The description of the landscape character is based on six components: major landform, geological composition, water and waterways, vegetation patterns, agricultural areas, and buildings and technical installations. The final division into subregions was done in meetings with representatives from county departments for cultural heritage and agriculture and nature conservation. The outcome was a division into 45 landscape regions and 444 subregions. The borders of the subregions were defined from maps of the scale 1:250 000 (Puschmann 1998). Of the 444 subregions, 175 are within KHM's museum district. The map scale level is important to understand the accuracy of the borders, and to decide which accuracy levels in the archaeological material that can be analysed in reference to the subregions (Uleberg and Matsumoto 2016).

Landscape categorisations based on this system have earlier demonstrated that Puschmann's regions are quite useful for archaeological studies. Solheim (2012) has created broad categories based on Puschmann while Matsumoto and Uleberg (Matsumoto and Uleberg 2015a; Uleberg and Matsumoto 2015; Uleberg and Matsumoto 2016) have created different intermediate categories to find patterns in site distribution at different scale levels. This paper will use Puschmann's subregions to explore how the transition from Middle to Late Neolithic society is reflected in the archaeological sites in the landscape.

Experienced and Created Landscapes

The purpose of archaeological surveying is to register traces of human activities in a landscape. Each activity or sequence of activities can be described as events, an action taking place at a certain place and a certain time involving a single person or a group of people. The traces are grouped as sites, and in the case of Stone Age sites, the area is defined through a combination of topographic features and positive test pits.

Each event exists within a defined part of a spatiotemporal continuum. The archaeological notion of a site invites a delimiting aspect of an event. This is of course necessary when the event is registered as an entry in a database and a Geographical Information System (GIS). This reflects the general understanding of space, where we give names to cities, valleys, and a range of other defined parts of the continuous landscape around us to be able to refer to them. Anyhow, points on a map tend to direct our understanding towards limited, secluded spaces (Welinder 1988).

Probably the practical aspects of the site have kept it a widely used concept in spite of some aspects of it being criticised several times (e.g., Clarke 1972). One suggestion has been to replace the site by the concept of an archaeological landscape. Landscape archaeology employs spatial relationships of artefacts and features to understand how the landscape was used (Crumley and Marquardt 1990; Wagstaff 1987). The archaeological landscape can be defined as a surface within a certain timespan, an approach that can give a better understanding of the totality of human behaviour. An analysis without initially defined sites can give a more accurate definition of artefact clusters and can include off-site elements like cultural residues and paleoenvironmental data (Zvelebil, Green & Macklin 1992). Landscape archaeology could in this way achieve a more objectified description of human interaction with landscape. This effort to objectify the relationship between humans and landscape is also evident when the model is expressed in terms of organisms moving across a landscape (Stafford and Hajic 1992). This highly functional view of archaeological landscapes contrasts with the phenomenological view where all elements are endowed with meaning and deliberately placed in the landscape (Tilley 1994).

The landscape experience is different for people with different intentions. A study of pastoralists and fishermen in North Norway has shown how these two groups look for different traits and features and register different details in the landscape surrounding them (Meløe 1989). Pastoralists look for signs telling them when the grazing in the mountains can start, while fishermen look for signs indicating where the richest catches can be made. A good dwelling site for a pastoralist has good grazing conditions where the animals can be controlled and protected. A good dwelling site for a hunter/gatherer can be a place near animal trails. These different ways of understanding the landscape are then reflected in how the sites are placed in the landscape (Uleberg 2003; Uleberg and Matsumoto 2007).

Landscape archaeology has turned away from natural science to a view inspired by the humanities. The landscape is perceived, experienced, created, and transformed by people performing tasks. Tim Ingold set focus on this aspect of humans' relation to space by introducing the term taskscape (Ingold 1993). The concept of taskscape leads us to look for the active relation between humans and the time and space they live in; however, Ingold has later stated that he prefers the term landscape because of the connotations it has (Ingold 2017: 26).

A taskscape is created through the tasks performed by people in a space. Tasks are generally repetitive and can be described as cyclic, recurring events. Different tasks will have different duration, repetitiveness, and different spatial distribution. A task can result in objects that can be found during an archaeological survey, but not all tasks will leave tangible traces. An example of a task is the production of expedient stone tools. This is a task, an event, which is of short duration, can be recurring several times at the same place, and even be part of a larger event like a seasonal hunting of migrating reindeer. A place where a wide range of different tasks are performed can be identified as a habitation site, while a place with specialised tasks can be described as a butcher site, or simply a wood-procurement site. The term off-site can be used for a place where several independent but recurring tasks have been performed (Binford 1980). Places with recurring events have been described as persistent places (Schlanger 1992) but can better be seen as attractors; places where the artefacts are tangible evidence of the tasks performed there (Uleberg 2003; Uleberg and Matsumoto 2007).

Attractors in Nonlinear Systems

The taskscape is created by the combined trajectories of all tasks of short and long duration. These interwoven trajectories are an extremely complicated nonlinear system with minute variations that are irrational, accidental, historical, and specific (Spencer-Wood 2013: 5). This will probably be a better modelling of actual human behaviour than the equilibrium, slow change and rational behaviour that system theory otherwise presupposes. Nonlinear systems theory gives an opportunity to introduce sudden change without the influence of external factors. This is a property of the self-contained system that can shift between order and chaos without external influence.

Change can be triggered by small deviations inherent in the system and make it oscillate to chaos. The self-contained system can also go from chaos to a new equilibrium as a result of internal mechanisms (Luhmann 1992).

One way to approach an understanding of interaction and movement is by visualising the system through its attractor. The attractor is the state that the system converges to. A simple, two-dimensional system like a pendulum will eventually come to a stand-still as it has converged to its point-attractor. Nonlinear systems can converge towards much more complicated attractors which are called strange attractors. The strange attractor has a deterministic but totally aperiodical path. The movement converges towards the attractor, but two paths close to each other can diverge and follow different developments. The only way to describe such a system is by observing the trajectory of the strange attractor (McGlade 1995: 119–120).

In the case of past societies, it is not possible to describe the attractor which is how people moved through the landscape or produced artefacts. This attractor can, however, be visualised indirectly; by studying its Poincaré section, a hyperplane intersecting the strange attractor. The Poincaré section can be obtained from an m-dimensional attractor through the intersections of a continuous trajectory with a (m−1)-dimensional surface in the phase space. In our case, m is the 4D time–space continuum and the (m−1) surface is the 3D landscape with its sites and artefacts (Tsonis 1992: 83; Uleberg 2004: 445).

Another aspect of the Poincaré section that makes it applicable to archaeology is that it can be obtained by sampling the system occasionally, and not necessarily continuously (Tsonis 1992: 83). Not all activities will be registered in the archaeological record. The finds in the landscape will be the Poincaré section, and important variables will be landscape and find density that can incorporate a wide range of chronologically defined subsets. It follows that it is not necessary to know all sites in an area to give a valid description of the landscape use system. Such visualisations will feed the map-based Exploratory Data Analyses (EDA) (Andrienko and Andrienko 2006) that we will return to later – giving a new understanding leading to new interpretations followed by renewed clustering and new visualisations.

Turning back to the Stone Age in East Norway, it is rare to find sites with a stratigraphy that makes it possible to discern separate visits to the same site. Each site may have been visited several times with regular or erratic intervals. It is events taking place in the 4D time–space continuum and this material that can be analysed as a 3D-Poincaré set. The Poincaré set includes sites with multiple occupations or visits within a wide time span. It is scalable in the sense that it can be used to understand movements at a site or across regions. This view is possible because the focus is on accumulation at certain places through time and not detailed activities at special occasions (Uleberg 2004).

Map-Based Exploratory Data Analyses

Map-based Exploratory Data Analyses (Andrienko and Andrienko 2006) is an iterative process where results and new insights create new input (Figure 2). Different segments of space and time are defined in a process of aggregation and segmentation where the definition of boundaries is given special attention. This can be referred to as combinations of the Modifiable Areal Unit Problem (MAUP) (Harris 2006) and the Modifiable Temporal Unit Problem (MTUP) (Cheng and Adepeju 2014). The discussion of MAUP addresses the fact that the geographical data are correct at the scale they were prepared for and should not be used at a very different scale. This is actualised as digital data can be studied and combined at any scale in a GIS. The landscape subregions used in this study are constructed for a map scale of 1:250,000, and this must be kept in mind when combining these data with other datasets. They form a continuous space within the outer borders of the study area. Similarly, MTUP addresses the problems of separating different time intervals. Here, the temporal scale levels have been set as broad archaeological time periods, and MTUP must be considered to avoid a misleading combination of wide and narrow timespans. Certain patterns and covariances will be visible only at certain scales, and this will determine the questions that can be posed. The analysis can be too detailed for a pattern to be recognized or too large so that more detailed and important associations are lost. The scale of explanation must relate to

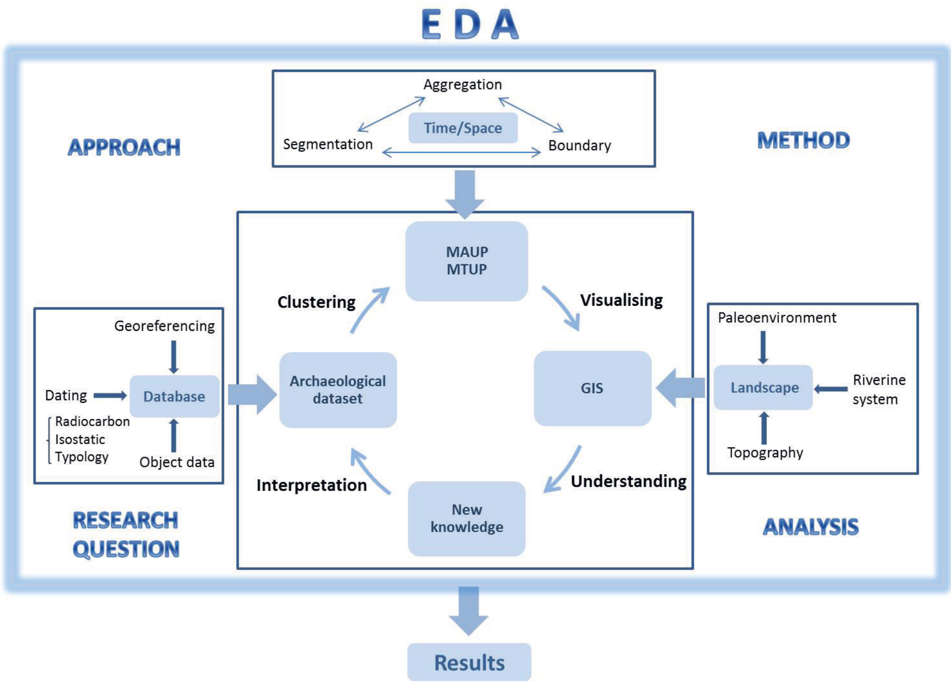

Figure 2. Exploratory Data Analyses (EDA) using the MUSIT database and landscape analyses.

the scale of observation (Harris 2006; Holdaway and Wandsnider 2006; Uleberg and Matsumoto 2015).

The map-based Exploratory Data Analysis starts with the general knowledge that is necessary to interpret the archaeological dataset. The dataset is taken from the database with object information, dating ,and georeferences. The research question guides the clustering in lieu of the MAUP and MTUP. They are both a consideration of segmentation, aggregation, and boundaries of the chosen time/space. The subsequent GIS visualising can include the landscape with elements like topography, riverine systems, and paleoenvironment. This leads to new understanding and new knowledge that starts a new cycle (Figure 2).

In this process, the archaeological dataset is clustered according to the spatiotemporal divisions and visualised with a GIS. It is important that the temporal and spatial scale levels in the analysis correspond with the accuracy of the basic data (Holdaway and Wandsnider 2006). Each archaeological site can be the result of one or several events, each of longer or shorter duration. The archaeological material could be from a series of consecutive or separate events spread out over a longer time span. A site that is the result of many such events cannot be dated precisely. The distribution along the time axis can no longer be seen. The original 4D time–space attractor is projected on the landscape and can only be documented as a distribution map, a 3D-Poincaré set. Diagnostic artefacts at the site could be given a more precise date, but expedient tools and debris can only be traces of events that took place sometime during the period.

The Middle Neolithic–Late Neolithic Transition

The transition from the Middle to the Late Neolithic in Norway is seen as a period of marked and lasting changes in economy, technology, and social organisation. There were several local groups during the Middle Neolithic, and marine activity was an important part of the subsistence economy. Agriculture and pastoralism become more important at the onset of the Late Neolithic, ca 4300 BP, and sites can be found at further distances from the coast. There are even indications of metal prospection (Glørstad 2012; Melheim 2012; Prescott 2009; Prescott 2012; Østmo 2012).

The Scandinavian flint daggers are impressive objects made with the pressure-flaking lithic technology which is a diagnostic treat in the Late Neolithic/

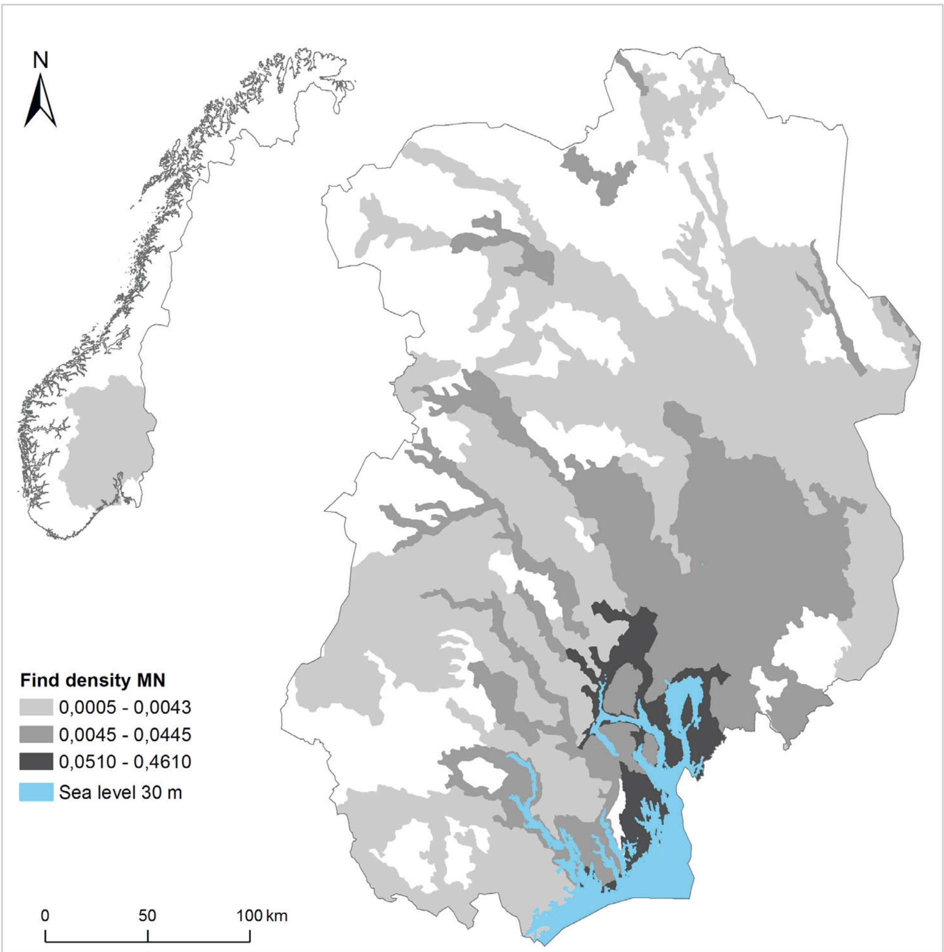

Figure 3. Middle Neolithic (MN) find density in landscape subregions.

Early Bronze Age. Flint daggers were imported to Norway, in some cases as almond-shaped roughouts (mandelflint). Most of the flint daggers are single occurrences, but they can occasionally be found in graves, as evidenced in the few monumental stone cists that occur in Norway (Østmo 2011). The flint daggers belong to a society with a warrior class and reflect the contact with the Bell Beaker Culture (Glørstad 2012; Prescott 2012; Østmo 2012). Flint daggers are categorised in six main types (Lomborg 1973), that have a chronological as well as geographical distribution (Apel 2001; Madsen 1978). The production of the earliest type of flint daggers, Type I, can be located to Jutland in the western part of Denmark. The later types were produced on the isles in Eastern Denmark and in the adjoining part of Sweden (Apel 2001). The early daggers from Jutland shows increased contact across Skagerak and also reached the Oslo fjord further north (Østmo 2012).

The fact that flint daggers have been found as grave goods in stone cists indicates the special status of these artefacts in the Late Neolithic society. Although most of them are single finds without a reliable context, it is reasonable to assume that they were deposited at meaningful places in the landscape, places that had been chosen for a grave or an offering. The daggers also signal that the surrounding landscape was controlled by people with power and status as well as contacts that enabled them to own such a precious object (Apel 2001; Østmo 2011: 166–167).

The daggers of type I and II made in the first 400 years of the Late Neolithic have parallels in bronze daggers in Western Europe and the British Isles. The daggers of type III, IV and V were made during the last 250 years of the period and have parallels in the Unetice culture in Middle Europe, especially in Moravia and Bohemia. The production of Scandinavian flint daggers decreased markedly towards the end the period, but the dagger of Lomborg's type VI

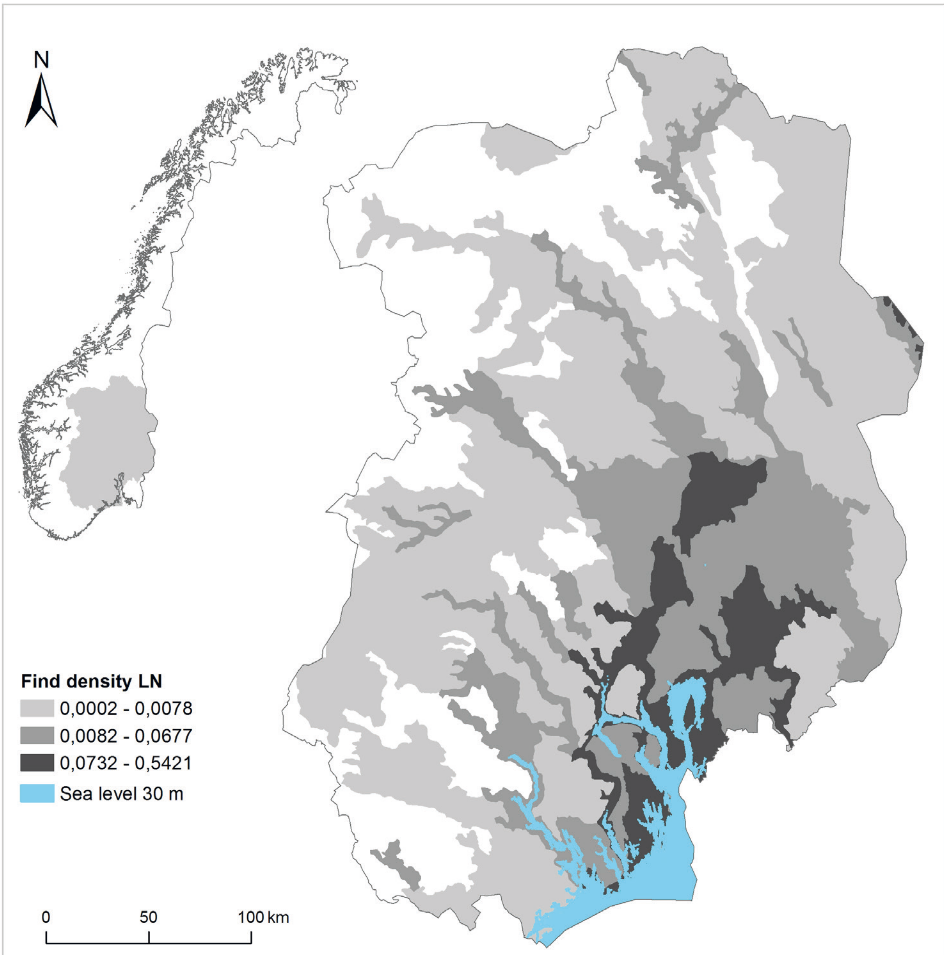

Figure 4. Late Neolithic (LN) find density in landscape subregions.

continued into the early part of the Bronze Age (Apel 2001: 259–275; Madsen 1978). The flint daggers can safely be presumed to be signs of cultural contacts between Norway and the rest of Europe during the Late Neolithic.

The influence from the Bell Beaker Culture is also evident in the two metal objects in this study area. They are flanged axes that can be dated to Late Neolithic I (4300–3900 BP). One (C25254)[1] was found in a river close to the Oslo fjord in a high-density subregion, the other (C7978) at the innermost part of a narrow fjord adjacent to a high concentration subregion. This appearance already in the first part of the period could indicate that metal had a wider role than just being exotic items of high value. Such finds in more peripheral areas may even be seen in a metal prospection context (Melheim 2012).

1 Individual objects or sets of objects are numbered with the prefix 'C' in KHM's catalogue.

Methods and Results: The Visualised Distribution

The general dating of the sites in the MUSIT database refers to archaeological periods. The dating can be based on typology, technology, C14-dating, or shore line curves. In addition, a more specific or even different archaeological period can be indicated by single artefacts from a site. The finds include artefacts from sites dated to the Middle or Late Neolithic as well as single artefacts typologically dated to these periods. Puschmann's landscape subregions are chosen as the spatial scale level. The corresponding accuracy level for the georeferenced finds is site or cadastral unit. With these limitations, 837 Middle Neolithic and 1812 Late Neolithic artefacts are used in the current analysis.

The maps show the archaeological finds divided in three classes. The values that create the classes are calculated by dividing the number of points in

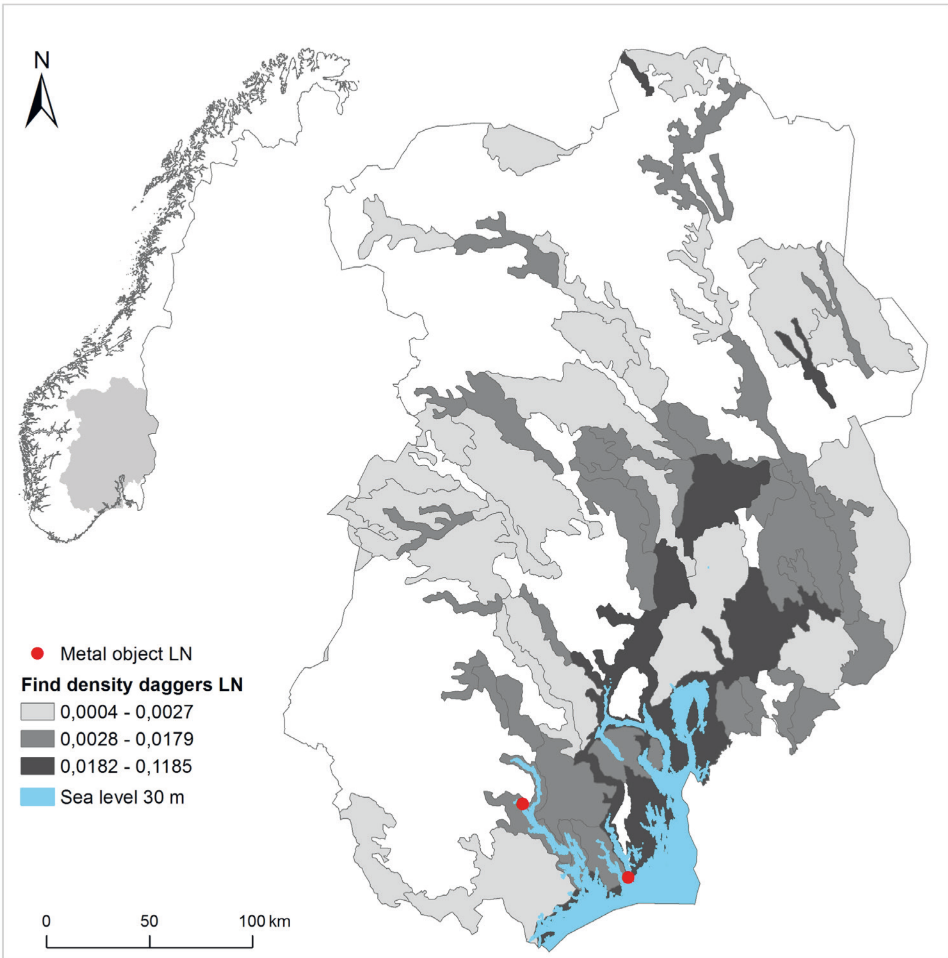

Figure 5. Late Neolithic (LN) metal objects and flint dagger find density in landscape subregions.

the Poincaré set by total area in each subregion with a sea level 30 m higher than the present. The total area includes lakes and rivers. The class breaks are calculated as geometric intervals. The geometric intervals are defined by an ArcGIS algorithm designed for continuous data. It creates geometric intervals by minimising the square sum of element per class. The geometric coefficient for the classes in this dataset is 10.

The map (Figure 3) shows that subregions with the highest concentration of Middle Neolithic finds are concentrated to the narrow areas around the Oslo fjord. In addition, there are areas with intermediate find concentrations along the larger river systems, especially to the north.

The map of Late Neolithic finds (Figure 4) presents a continuity in the concentration around the Oslo fjord.

Our preceding studies of axes, sickles, and daggers have indicated that the development from the Middle to the Late Neolithic is an intensification and expansion into the interior areas (Uleberg and Matsumoto 2016). A comparison of Figures 3 and 4 indicates a higher concentration of activity in the landscapes best suited for agriculture. The interior areas with intermediate concentration shift from one period to the next. The interior areas northwards from the coast are along the river systems, and it should be noticed that the inland areas with highest Late Neolithic concentrations are on clayish or Silurian soils which are especially well suited for pastoralism. There are a few areas with higher concentrations far from the fjord that can be related to metal prospecting.

Flint daggers and metal objects are prestige objects that indicate a stratified society. The two metal objects are found at the Oslo fjord, but not in the area with the highest concentration of finds. The distribution of flint daggers as densities and the two Late Neolithic metal objects as points (Figure 5) have the same high-density areas as the overall Late Neolithic finds, but fewer intermediate areas. This indicates that groups in the best agricultural areas had contacts that gave them access to such prestige objects. This visualisation of the find distribution supports the claim that the activity in the Late Neolithic was more concentrated on agricultural activity (Glørstad 2012).

Landscapes Created Through Events

The analysis of the existing dataset has enhanced aspects of the transition from Middle to Late Neolithic in East Norway; the interior areas become more inhabited, and landscapes with better conditions for agriculture, also at a distance from the coast, have a higher frequency of more prestige artefacts.

This visualisation is based on the idea that all artefacts can be seen as points on a Poincaré map that describes the underlying nonlinear system. In this way, all artefacts which meet the criteria for dating and provenance precision are included in the analyses. It makes it possible to include both excavated material and finds with less precise provenance. The artefacts have been aggregated according to predefined landscape areas, and the difference between the Middle Neolithic and Late Neolithic can be seen as a movement into the interior areas that favours the landscapes best suited for agriculture.

This paper has analysed wide time categories, as the Middle and Late Neolithic have been treated as units. Future work could look at finer chronological divisions and also include more paleoenvironmental information. The Norwegian Late Neolithic is a period with increasing cultural contact with other parts of Europe. The most distinctive artefacts, the flint daggers, are imported as finished products or next step could be to analyse the spatial distribution of these artefacts at more fine-grained temporal scales and understand more of the landscapes created through these actions.

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