Tumulus Culture Burial Mounds in the Landscape - Krotoszyn Forest Area: the Beginnings of a New Project.

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Abstract:

The project presented in this paper is concerned with the funeral rite of the Tumulus cultural community located on the border of Silesia and Greater Poland. Detailed multi-disciplinary analyses have been applied to a unique slice of the Bronze Age cultural landscape preserved within the cover of a 100-year old oak forest known as the Krotoszyn Forest. Preliminary research carried out by the author (rescue excavations, non-invasive prospection and airborne laser scanning) revealed the existence of 120 barrows, which are likely to be associated with the dominance of the Tumulus Culture in areas of south-west Poland. The information obtained by previous studies was included in the spatial database available to the author. It provides basic information on the location, state of preservation and the amount of burial mounds in the area of the Krotoszyn Forest. The main aim of the project is to carry out multi-dimensional spatial analysis in order to capture the relationship between the variables governing the environment and Tumulus Culture burials. The methodological approach adopted by the project consists of the GIS analysis of data obtained from the airborne laser scanning, palaeoenvironmental studies and the application of geophysical prospection.

Introduction

The project aims to study the relation between the ritual activities of the Tumulus Culture (TC) prehistoric communities and their surrounding landscape. The chronological frame of the TC can be defined as the period circa mid-second millennium BC, i.e. 1550–1300 BC (Gediga, 1978; Gedl, 1975; Kostrzewski, 1924; Lasak, 2001; Müller & Lohrke, 2009). This period is directly connected with the growth and predominance of TC – a taxonomic unit identified in vast areas stretching westward to the Rhine valley and eastward to the arc of the Carpathians and along the south-north axis over the territories from the border of the European Lowland to the Alpine foreland. Compared with the preceding archaeological cultures included in the common name of Central European Early Bronze civilisation, TC is to be considered as a new socio-cultural entity characterised by changes in forms and ornamental patterns of bronze objects, less frequently of ceramics (fig. 1) (Gedl, 1985; Harding, 2000; recently for Polish territories: Cwaliński & Niebieszczański, 2012). Most importantly, however, we are dealing with a noticeable transformation of the Bronze cultures’ worldview, which was taking place throughout the TC ecumene – the barrow funerary ritual. The barrows, too, are the only TC-related category of sources...
that allows its deeper analysis.

Study Area

The region in which we are planning to carry out the project’s research objectives is the Krotoszyn Forest. This is a swathe of territory of circa 3600 ha and the largest compact concentration of oak trees in Europe. Happily, for the last 150 years this place has remained untouched and thus the ancient forest has preserved numerous archaeological objects, mainly barrows, which constitute an almost unaltered element of the Bronze Age cultural landscape. The circumstance is absolutely unique, as the introduction of machinery in agrotechnology [steam ploughing in the nineteenth century, combustion tractors in the twentieth] led to a considerable reduction and devastation of the cultural landscape. The degree of the preservation of cultural elements within the ancient forest allows considering Krotoszyn Forest as the best possible area for achieving the research objectives set down by the project.

The application of a whole package of modern non-invasive procedures, to wit: spatial analyses in a geographic information system (GIS) environment of the digital elevation model (DEM) obtained during a pilot study in the form of airborne laser scanning (LiDAR/ALS) and geophysical prospection will help to make the most of the informative potential of Krotoszyn Forest.

History of the Research

The barrow cemetery in Smoszew and the neighbouring burial sites located in the borderland between Silesia and Greater Poland (Krotoszyn Forest) are a major element of the TC sites’ network in Poland. The necropolis in question is one of the 20 recognised and adequately published TC burial sites in south-west Poland in the whole literature on the subject. Within the body of the registered cemeteries it is remarkable for its high number of barrows concentrated over a relatively small area, the graves’ exceptional state of preservation and the exhaustive documentation of archaeological research carried out over the last hundred years (fig. 2). Early amateurish explorations were done
circa 1891 (Jaeger & Pospieszny, 2011a: 435). Large-scale excavations supervised by J. Kostrzewski and Z. Zakrzewski begun in 1923 (Blajer, 2001: 334; Kostrzewski, 1924: 259-60; Jaeger & Pospieszny, 2011a: 436). Subsequent research took place in the 1960s, under the leadership of local archaeologists – D. Kosinski and Z. Pieczyński from the Poznań Archaeological Museum (Kosiński, 1975:79). In 2007 a team of researchers from Adam Mickiewicz University, Poznań, and Christian-Albrechts Universität, Kiel, started working on a new project aimed at the identification, documentation and multi-dimensional analysis of the artefacts that make up the Bronze Age cultural landscape of Krotoszyn Forest. The excavations were supported by scholars from the universities at Göteborg (Sweden), Aarhus (Denmark), Toruń and Szczecin (Poland). In 2008, based upon the results of a non-invasive survey (geomagnetic prospection and electrical resistance), the project expanded to include the excavation of barrow no. 15 (site Smoszew 1). During the three-year excavation this feature was comprehensively surveyed. Archaeologists were joined by palaeobotanists, geomorphologists and petrologists. Altogether, it was possible to precisely define the barrow’s construction type, from its stone elements to the composition of the soil used at the site (Kneisel et al, 2010). In spring 2012, as part of the project, the entire area of Krotoszyn Forest was covered by a LiDAR/ALS survey financed by the National Heritage Institute. This was the first LiDAR survey in the Silesia-Greater Poland borderland. It resulted in the point cloud from which the digital surface

Fig. 2. Archival photo (1916) of a burial mound on which amateur excavations were probably carried out in the nineteenth century [collection of the Poznań Archaeological Museum - Archives].
model (DSM) and the digital elevation model (DEM) were generated. The density of measurement was 4 points per 1 m² and type of registration Full-Waveform. ALS point cloud was subject to prior filtering and classification (Doneus & Briese, 2006: 101-102). Cleansing of the point cloud was made by filtering out extreme values of altitude. Afterwards classification was made using TerraScan software, Terra Solid package, with manual amendments. Points reflecting modern vegetation were removed on the basis of the point classification, those classified as surface were retained to produce the DEM. Assisted by spatial geomorphometric analyses, it was possible to single out ter-
rain forms corresponding to the barrows from the Middle Bronze Age cemeteries earlier discovered within the Krotoszyn Forest compound. The obtained DEM was processed in SAGA GIS 2.0.7 software. In order to detect archaeological features the following tools were used: analytical hillshading and terrain geomorphometry (Slope, and Slope height, Normalised height). Contrary to slope height analysis, which shows the deviation level of the “convex” form of the terrain in frames of the model’s surface trend calculated on the basis of the slope, normalised height analysis shows the relative position of the inclination based on ridge lines. The values are calculated in a range between zero and one, where one is the top line and zero the line of channel. Results were verified in the field, with the approximate number of potential barrows within the entire forest area increasing to 120. The information collected was the starting point for the construction of the spatial database containing general information about the location and size of particular objects together with their photographic records. Six clusters of barrows are visible at a glance. Those can be identified as cemeteries (fig. 3). A characteristic feature of those cemeteries is that three of them – bigger in terms of area and number of barrows – are located on the north-south axis, while three smaller cemeteries are placed along the east-west line. Those observed alignments probably reflect the original spatial relation between the location of the cemeteries and the main rivers in the region.

Methodology

The theoretical basis of the project is the concept of landscape archaeology. In general terms it is used to characterise areas of archaeological research, to analyse mutual relations between sites and/or landscape/space and to build models explaining the observed variables (Chapman, 2006). Landscape archaeology tackles the problems of interaction occurring between humans and their environment. On the one hand it concentrates on the reconstruction of the prehistoric community’s adaptation to its surroundings and, on the other, on the process of modifying the natural environment to the needs of human groups. Both types of relations have led to the formation of a specific landscape with a distinct cultural mark.

Methodological assumptions of the project involve the use of GIS. Standard GIS software allows managing, editing and analysing two types of graphics: vector and raster. The system is used to perform advanced spatial analyses and data (and metadata) unification using GIS standards.

The analyses were divided in two scales: macro, covering the whole Krotoszyn Forest region, and micro, concerning particular cemeteries and single barrows.

Research Plans

In regards to the planned fieldwork, during the first phase we intend to explore the inner structure of the isolated representative group of 25 barrows by non-invasive methods to discover specific stone or wooden elements familiar from previously explored TC mounds. The non-invasive studies aimed at defining the original sizes of the barrows on the basis of the diameter of the surrounding stone circles, using magnetometric prospection. The investigation of archaeological objects with their own landscape forms (barrows) is always conducted according to a standard procedure. The prospection is done on a study area of 20 x 20 m or 10 x 10 m in size. Observations of gradient changes in the vertical component of
magnetic intensity employed the Bartington Fluxgate Grad 601-1 magnetometer with 0.1 nT (nano Tesels) accuracy, at a distance of 0.25 m along the measurement cross-sections at 0.5 m interval. To increase the quality of measurements, they were taken in parallel mode (the device is moved only in one direction throughout the registration). It must be emphasised that the efficacy of the method for discovering the inner structure of barrows was proved in preceding research at Smoszew 1 site. Most stones and erratic boulders are magnetic. Furthermore, at each instance its results will be checked by drillings with gimlet bits or drillers. Apart from the ground truthing of magnetometer results, the drillings will be aimed at getting potential samples with material intended for \(^{14}\)C dating. Geological drillings will also help to produce synthetic lithostratigraphic cross-sections of the barrows. The plan includes a layout of the drillings network every 1.5 m along a single profile section, with the assumed mean radius of 7.5 m for a barrow. Since the heterogeneity of cultural forms can alter the density, the depth of drillings has not been arbitrarily defined. The layout of the holes will also be set by the parameters defined by the results of the geophysical prospection, which indicate the maximum reach of anthropogenic forms. Furthermore, natural stratigraphic and lithological sequences as close as possible to the barrows will be surveyed to achieve a contextual perspective of their inner structure. Fieldwork will provide the following data: a lithological description including granularity (fraction definition), colour, macroscopic description of mineral composition, stratigraphy and the presence of organic material fit for radiocarbon dating. The selected samples will be subjected to micromorphological analyses in laboratory conditions, i.e. the mineral-petrographic composition together with sieving for higher precision of the fraction division, organic matter content and the presence of components indicative of human activity (phosphorus, various oxides, and also pH).

The preliminary archival research for materials from older excavations in barrows of the TC ecumene will be developed in parallel to fieldwork in Krotosyn Forest. The information obtained will be valuable for the comparative analysis of funerary objects located in the Krotosyn area and the comprehensive funerary ritual of the TC in central Europe.

Following completion of the analyses, work will focus on the definition of those environmental preferences that influenced the location of the barrows in their landscape context, using the DEM obtained for the entire area of the Krotosyn Forest following LiDAR scanning (fig. 4). The density of airborne laser scanning was four points per square metre, which is a highly detailed terrain representation needed for further spatial analyses (Doneus et al, 2008: 884). The scanning was done in Full Waveform echo registration, today a benchmark for forested areas (Doneus et al, 2008: 883; Doneus & Briese, 2006: 100-101).

The algorithm calculating the topographic position index (TPI) will be applied to define the basic landforms in the area under discussion (De Reu et al, 2011). The TPI automatically classifies terrain forms. This makes it possible to generate landscape maps showing the main elements of the terrain’s relief (Kasprzak & Traczyk 2010: 36).

The aspect analysis defines the direction of the slope inclination relative to the directions of the earth. It is a significant factor in ecological modelling, since, through this analysis, it is possible to define the amount of solar radiation reaching the site (Urbański, 2008: 159).

Hydrological analyses in the vicinity of the sites will include the analysis of the topology of the drainage network, here understood in its geomorphological or palaeogeographical meaning as a local hydrological trend independent of modern meteorological conditions and water relations (Jasiewicz, 2010: 91). The analysis aims at modeling water flow over the DEM (Jasiewicz & Hildebrandt-Radke, 2009: 2099). As water flow analysis outputs a hypothetical model, soil drillings will be done to verify its results. The survey and palaeoenvironmental reconstruction will mainly focus on the description of the hydrographical situation in the area during the Middle Bronze Age. The documentation of cross-sections obtained from
drillings with, possibly, their radiocarbon dates, will enable a reconstruction of the river network which might have influenced the structure of TC sites. The preliminary assumption for starting this type of research is the well surveyed geomorphological situation of site 1 in Smoszew and other TC cemeteries from the Silesia-Greater Poland borderland, where the presence of water bodies close to burial grounds can be observed (Cwaliński & Niebiesczankański, 2012). By plotting the course of fossil valleys or glacial gouges later used by surface waters, it will be possible to establish their chronological relations with the relevant Bronze cultural features.

Palynological analysis is a highly useful method for studying forest areas and the degree of man’s interference with the landscape (Jankuhn, 2004: 63-67). The acquisition of palynological cross-sections for the Silesia-Greater Poland borderland has already been planned for in the aforesmen-
tioned project by Adam Mickiewicz University, Poznań, and Christian-Albrechts Universität, Kiel.

Next stage of the research will include views-hed analysis of the barrows. The main assumption that justifies this analysis is extracting information about the degree of prominence of the mounds of the barrows in the terrain and their mutual space-perceptive relations against the field-of-view attainable from a particular location in the landscape (Lake, Woodman & Mithen, 1998; Lagerås, 2005; Llobera, 1996). Drawing on the terrain model data, cells or areas that can be observed from one or more vantage points will be identified (GIS software). In the case of Krotoszyn Forest the cumulative viewsshed (CV) and/or inter viewshed (IV) seem the most informative. CV is used for a grouping of sites in order to estimate the number of visible sites for every DEM cell. The image obtained shows the best exposed areas in terms of their visibility. IV refers to visibility from/to two sites, which consequently outputs information about the visibility relations between barrows. This allows a systematic and quantified perspective in presenting the relationship between the spatial distribution of the objects and their visual relationship as revealed by the above analytical results.

The spatial relations between the barrows within each cemetery will be determined by kernel density estimation (KDE). This in turn will help to produce the spatial map of barrows distribution within the cemeteries. In the case of the non-parametric KDE, generation of the attributes for each raster cell within the circle is done by means of the mathematical function known as the kernel (Wheatley & Gillings, 2002: 166). Archaeology most often uses the Gaussian function, since it calculates the frequency of occurrence of events in space. Thus the results will be presented as a continuum, as opposed to a common analysis where the results are shown at random. Density is calculated after summing up all estimates of events occurring within a given cell. The process is repeated for each DEM cell. In effect, the principles behind the spatial layout of barrows within the cemeteries will be captured. The application of KDE makes it possible to discern a structure imperceptible at first glance and so easy to omit in the investigations (Krišťuf, Praumová & Švejcar, 2011). The analysis will also take into account the sizes of particular barrows and their chronological classification. All results will be used in comparative analysis as the basis for deducing the potential differentiation of the funerary ritual spatial structures within the confines of the chronological period under scrutiny (Krišťuf & Švejcar, 2012).

The next step will involve correspondence analysis (CA) to estimate the degree of relationship between the variables typical of a barrow construction, i.e. size, inner structure, building materials as well as the time factor (completing the CA with chronology data, ^14C dates included). The results of CA will help to determine the sequence of selection among specific construction elements and, consequently, distinguish among the particular construction types used to erect the barrows in the Silesia-Greater Poland borderland. An important advantage of CA is that it does not simply seek correlation of data but reveals the real structure among the data, however irregular (Jensen & Høilund-Nielsen, 1997: 37). It consists in looking for correspondence among objects described by an unlimited set of attributes, both quantitative and qualitative. Its advantage over other statistical analyses lies in its ability to perform a multifaceted analysis of the data depending on the number of axes, and the results are visualised in a multidimensional vector space. CA has been widely used by archaeologists for detailed study of graves and has proved highly successful (e.g. Jensen & Høilund-Nielsen, 1997: 1-2, 29). Pertinent elements that must be included in these analyses include the human remains from burials. However, the limited time period of the project (three years) and its non-invasive character do not allow obtaining representative materials on the basis of...
excavations. The completed preliminary archival research also failed to reveal any anthropological materials whatsoever (bones, teeth) from earlier excavations (Kostrzewski, 1924: 272). This might have been due to the specific conditions in which the burials are deposed (Gedl, 1975: 87; Jaeger & Pospieszny, 2011a: 436). Thus, all relevant information will be obtained from comparative data from other regions of the TC ecumene.

Finally, we will carry out a comparative analysis of results obtained by the barrows’ dispersion analysis in Krotoszyn Forest and plans of the remaining TC barrow cemeteries in Silesia and Greater Poland regions. Furthermore, outcomes of the geophysical investigations will be compared with information concerning the inner construction of the barrows obtained from older excavations. At this stage the factors taken into considera-

Fig. 5. Barrow no. 44. Results of the magnetometric survey with location of geological drilling (graphic: M. Stróżyk).
tion will be materials from preliminary archival research, mainly the documentation of archaeological research in TC cemeteries in Poland over the last century. Comparative analysis will permit referring the Krotoszyn Forest results to a broader cultural context.

Initial Results

In 2014 a first geophysical prospection together with verification drillings was carried out on two trial burial mounds. Barrow 44 is 0.70 m high and 21 m in diameter, while barrow 57 reaches 1.4 m high and 21 m in diameter. In case of the first one, magnetometric survey found a number of anomalies (fig. 5). Several anomalies, which could be interpreted as a stone ring, were observed in the northeastern part of the mound (contour level 132.2 m). In the centre of the mound a single anomaly probably related to the stone kernel or pavement occurred. During drilling (bore K44II) on level 0.50 m below the modern surface of the embankment it was possible to detect stones. One of the anomalies located in the northeastern part could possibly be considered as remains of the grave. It has a size of 2 x 1.5 m. The analysis of the sample obtained from the borehole K44V will allow confirmation of this assumption. In contrast, geophysical prospection on the mound 57 did not show quite as promising results. Some anomalies within this feature were noted; however it is difficult to suggest an unambiguous interpretation. One of the boreholes revealed that this barrow had probably been dug in its centre. Detailed analysis of the terrain model confirmed the presence of a very shallow cut in the middle of the embankment. Soil samples collected during the survey were commissioned for further geochemical analysis.

Conclusions

The aim of the project is to break the all-too-obvious stalemate in the studies of one of the more enigmatic taxonomic units in the prehistory of Polish territories, which clearly is TC (Cwaliński & Niebieszczański, 2012: 235; Gediga, 1978: 137; Jaeger & Pospieszny, 2011a: 435; 2011b: 97-98). Since the now classic works by M. Gedl (1975) and B. Gediga (1978), the quantity of the sources as well as the quality of the publications at our disposal has not much improved. The poor knowledge about the Middle Bronze Age is, basically, a consequence of an insufficient body of fresh data that would meet the rigorous requirements of modern research standards. Recent monographs (Ktosińska, 1997; Blajer, 1999; 2001; Lasak, 2001) were only to a small degree based on state-of-the-art excavation findings. This is the result of the disregard for studies of certain issues, and particularly those concerning absolute dating, the place of funerary objects in the landscape and the inner structure of the barrows. This project will provide a basis for building a model presenting the formation of the spatial layout that ensued from the activities of TC communities. Accumulated information (from single objects to the whole region) will allow isolating the landscape preferences that might have made Bronze communities choose specific settings for their cemeteries and single barrows. Also relevant will be new data concerning the origins of particular strategies of space construction captured within the TC context and the assessment of their potential innovativeness on a broader geographical and cultural scale. The achievement of the project’s aims will thus result in the creation of a model describing the principles that had possibly guided the TC communities from the Silesia-Greater Poland borderland during the construction of ritual sites in the landscape. The model will have prognostic value for areas of similar geographical and cultural circumstances. The project will result in a new methodological model that optimally meets the scientific and conservationist requirements for the exploration of Bronze Age barrows in forested areas. It will significantly enlarge the information pool on the most important and most numerous group of TC sources. The attainment of the project’s objectives will also answer a number of crucial questions concerning TC...
ritual/funerary practices; at the same time, spatial data produced in the digital environment will be subjected to successive analytical phases, which will help evolve GIS methods.

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