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HIGH-RESOLUTION STUDY AND RASTER INTERPOLATION OF EARLY NEOLITHIC PIT FEATURES AT MĂGURA 'BUDUIASCA', TELEORMAN COUNTY, SOUTHERN ROMANIA

Steve MILLS

Abstract: *The Southern Romania Archaeological Project (SRAP) conducted high-resolution total station spatial surveys of early Neolithic (5800-5600 cal. BC) sub-surface pit features at Măgura 'Buduiasca', Teleorman County, southern Romania in 2003 and 2004. The spatial data from these surveys were imported into the project Geographic Information System (GIS) and used to interpolate a raster surface of excavated and surveyed pit features. This provides a powerful, dynamic, resource for team members to visualise the three dimensional spatial relationships within and between pit features during the post-excavation phase. Ongoing GIS integration of geo-referenced photographs and plan drawings, and the wide range of additional spatial data derived from the excavation and post-excavation phases of the project (e.g. the distribution and character of associated material culture and dating and environmental samples), provides a multi-layered, flexible and navigable computer-based environment that considerably enhances the SRAP's aim to address questions of the chronology, form and function of early Neolithic pit features. It is hoped that the wider adoption of high-resolution methodologies, as used by the SRAP at Măgura 'Buduiasca', will invigorate research into this important period of prehistory in the lower Danube region.*

Rezumat: *În cadrul Southern Romania Archaeological Project (SRAP), au fost realizate, în anii 2003 și 2004, ridicări topografice de înaltă rezoluție ale gropilor neolitice timpurii (5800-5600 a. Chr.) descoperite la Măgura 'Buduiasca', județul Teleorman. Datele obținute au fost importate într-o bază GIS (Sistem Informatic Geografic) și folosite pentru a interpola o suprafață rasterizată a gropilor cercetate. Metoda asigură o soluție eficientă și dinamică ce permite membrilor echipei să vizualizeze în regim tridimensional relațiile spațiale din cadrul gropilor și dintre acestea, în etapa ulterioară săpăturilor arheologice. Integrarea continuă în baza GIS a unor fotografii, a unor planuri georeferențiate și a unei game largi de date spațiale suplimentare obținute în timpul săpăturilor și în fazele ulterioare ale proiectului (de exemplu distribuția și caracteristicile materialelor arheologice asociate sau probele pentru datări și probele de sol) asigură o bază de date digitală flexibilă și accesibilă pe mai multe niveluri, care mărește considerabil obiectivele SRAP privitoare la probleme de cronologie, morfologie și funcționalitate a gropilor din neoliticul timpuriu. Se speră ca adoptarea pe scară largă a unor metodologii de înaltă rezoluție, precum cea folosită la Măgura 'Buduiasca', va întări cercetarea acestei importante perioade a preistoriei în zona Dunării de Jos.*

Keywords: *Neolithic; pit features; micro-survey; GIS; raster surface.*

Cuvinte cheie: *neolitic; gropi; topografie; GIS; suprafață raster.*

1. Introduction

This paper reports on the high-resolution spatial survey and GIS employed by the Southern Romania Archaeological Project (SRAP) to further understanding of early Neolithic sub-surface pit features at Măgura 'Buduiasca', Teleorman County, southern Romania. The aim of research is to collect quantifiable data to critically address questions of relative chronology, form and function of pit features and to renew interest in the study of the early Neolithic in the lower Danube region (Bailey et al. forthcoming). Associated material culture, supported by new radiocarbon dates, indicates that pit features excavated thus far date to between 5800-5600 cal. BC, conventionally attributed to Criș and Dudești local ceramic cultures. Systematic, context sensitive, excavation of all archaeological features and associated material culture, alongside detailed spatial recording, enables more informed definition of pit features and deposits. Within the larger context of SRAP research, an outline of the spatial survey methodology and procedures for data collection and analyses is presented. Preliminary results based on high-resolution spatial recording and GIS representations of pit features are given. The ability to create a raster surface, that can be manipulated, integrated with other spatial data and navigated in three dimensions within a GIS, considerably enhances visualisation of the spatial relationships within and between pit features complementing that possible with the more traditional representations based on plan drawings and photographs. Research of this kind, using new and improved techniques, is critical to advance interpretations of land use and social practice during the early Neolithic. As research continues, knowledge of the location and distribution of early Neolithic sites in the lower Danube regions is increasing. To better understand this patterning requires

continued and vigorous questioning of the significance of the distribution and kind of Neolithic material culture encountered, and for pit features, their role (e.g. were they used as dwellings or rubbish deposits, or both?) and their chronology (e.g. were they used repeatedly or only once?). By synchronising the questions asked to investigate the early Neolithic phase, with those more commonly applied to the middle and late Neolithic phases, and by expanding and refining the techniques used (including the use of GIS), studies of this kind will advance research into this important period of prehistory in southern Romania and in the lower Danube region more generally.

2. SRAP study area and research context

The SRAP 10 km x 10 km study area is located in the Teleorman River Valley in the Romanian Plain 85 km southwest of Bucureşti and 6km northeast of the modern town of Alexandria (figure 1). The Teleorman River, a major left bank tributary of the Danube, rises in the Carpathians and is joined by the Claniţa River from the east in the Lăceni-Măgura reach. The Holocene valley floor is approximately 2km wide and the slightly sinuous, single channel contemporary river, situated in the central part of the valley floor, is incised up to 5 m below late-glacial and Holocene alluvial fills (Nuemann & Haită 1999; Tomescu 1999; Howard & Macklin 2001; Howard et al. 2004). During the 1980's a system of linear drainage channels were cut into the western side of the valley floor. These channels, approximately 2.0m deep and 3.0m wide, have exposed sides containing early 5th millennium BC middle Neolithic material culture and evidence of local geomorphology. Recognising the significance of this data, alongside the established studies of later 5th millenium BC late Neolithic tell settlements in the study area (Spiru 1996; Andreescu et al. 1999; 2000), a systematic research programme investigating relationships between sequences of environmental data and Neolithic material culture at a landscape scale began in 1998 (Andreescu & Bailey 1999; 2002; 2003; 2004; Andreescu et al. 2002; Bailey et al. 1999; 2000; 2001; 2002; 2003; 2004).

Research in the field employs a step-by-step logical methodology. Systematic geo-referenced field walking across the landscape identifies prehistoric activity areas on the basis of material culture (ceramics, worked stone and building material) on the surface (Mills 1999a). This is followed by surface collection of material culture to obtain quantifiable data on distribution and densities (Mills 1999b) and then by a programme of strategic excavations and post-excavation analyses. Concordant with this is a programme of archaeobotanical, archaeozoological, geomorphological and sedimentological sampling to elucidate the local environmental sequence.

The presence of early Neolithic, Criş and Dudeşti, ceramics on the surface at Măgura-Buduiasca were first identified by a local Măgura school teacher, Floarea Florea, and subsequently by the ceramics specialist of the Teleorman County Museum, Pavel Mirea, following sequences of engineering works (road-construction, irrigation pipe layering and fibre-optic cabling). Adopting the systematic field methodology outlined above, in 2001 the SRAP confirmed and spatially defined this surface scatter east of Măgura village (figure 2). An early Neolithic presence in the study area is of much significance. Firstly, it extends the chronological sequence of known Neolithic activity in the Lăceni-Măgura reach enabling long-term changes in landscape use and social practice to be investigated within a practicable study area. Secondly, it provides the opportunity to apply the SRAP field methodology to a phase of prehistory that is not well understood in Teleorman County, enabling both field techniques and archaeological interpretations to be improved. The remainder of this paper provides an outline of the survey methodologies applied to, and preliminary results obtained from, investigations at Măgura-Buduiasca.

3. Măgura-Buduiasca landscape context and archaeology

Măgura 'Buduiasca' (site datum: UTM zone 35 X: 372258.52, Y: 4875366.34, Z: 56.79 masl; Lat: 44° 01' 13", Long: 25° 24' 22") is located on the eastern edge of the Teleorman River Valley on a low terrace approximately 5-10 m above the main valley floor at 50-60 masl, approximately 750 metres north of the Teleorman River and 500 metres east of Măgura village. One kilometre to the northeast the main eastern valley terrace rises to 90 masl. The low terrace zone is under cultivation in a strip system consisting of vines, maize and melons with some strips of herbs and grass.

Systematic surface collection together with GPS geo-referenced find spots in 2001 identified an area 900m east-west by 350 m north-south exhibiting Criş and Dudeşti material culture. A programme of small-scale 1x2 m excavations was conducted in 2001 and 2002 to determine the presence and character of any Neolithic sub-surface material culture and features associated with the surface scatter. These were successful in demonstrating that the surface scatter was associated with

sub-surface Neolithic layers and that the area near site datum had not suffered from disturbance as a consequence of deep ploughing. Assemblages of Criş and Dudeşti ceramics (van As et al. 2004; Mirea 2005; Thissen 2005) together with animal bone and some building material were identified in pit-like depressions at a depth of between 60-150 cm below surface. While the 2001 and 2002 excavations successfully identified sub-surface Neolithic material culture and features, the area excavated was not sufficient to determine the morphology of any given feature in its entirety or the stratigraphical and chronological relationships between features. To provide this level of information, larger open-area excavations were conducted in 2003 and 2004 (figure 3).

4. 2003/4 Excavations

4.1 Sondages

In 2003 an open-area 8.3x8.3m trench, labelled Sondage 10, was excavated. This was divided into four areas (labelled 10A, 10B, 10C and 10D) separated by 30cm baulks. The four areas were excavated following a 1x1m grid system in units of varying depth from 20cm-5cm dependent on the presence or absence and character of the archaeology encountered. Sub-surface pit-features were identified in areas 10A and 10D where they cut into the calcareous sub-soil at a depth of between 140 and 290 cm below surface.

In 2004 four open-area 6x6m trenches, labelled Sondages 19, 20, 21 and 22, were excavated. These were excavated using the same 1x1m grid system of units adopted in previous years. Sub-surface pit-features were identified in all four sondages at depths ranging between 90 and 240 cm below surface.

To improve understanding of pit features, it was important to record them in as much detail as was practicably possible while in the field. Where pit features cut into the calcareous sub-soil, the fill was entirely excavated by 5 cm or 10 cm, 1x1 m units to maintain spatial control. The larger pit features (in sondages 10A, 10D and 19) had vertical control established by the use of baulks. After all fill was excavated and baulks removed, all pit features were photographed, and plan and section drawings made where appropriate.

Given the nature of the soil in the study area, pit features were only recognisable and spatially definable when they included cuts into the calcareous sub-soil. Assemblages of material culture (ceramics, bone, worked stone, charcoal, and plant remains) above this subsoil may have been associated with pit cuts that are no longer visible to the eye during the excavation process. The presence of pit features above the sub-soil may be determined following post-excavation analyses of collected micromorphological samples. Assemblages of material culture above the sub-soil were thus equally subject to high-resolution excavation and survey and then drawn and photographed to aid in the identification of pit features in the post-excavation phase.

An essential aim of the SRAP is the high-resolution spatial survey and recording of the excavated pit features and assemblages of material culture.

4.2 Spatial survey

For all spatial surveys in the field, the co-ordinate system used is Universal Transverse Mercator (UTM) zone 35T based on the World Geodetic System (WGS) 84 ellipsoid. This enables small-scale total station site surveys to be integrated with larger-scale landscape based Global Positioning System (GPS) surveys. In 2000 the project purchased a digitised version (.bill file format) of the 1971 1:50,000 Russian map of Teleorman County geo-referenced to UTM. Using GIS it is thus possible to integrate this local base mapping and to digitise vectors layers derived from it (e.g. contours, spot heights, rivers, vegetation cover, villages/towns and roads) with the project total station and GPS surveys to investigate variation in the spatial distribution of Neolithic activity areas in the study area.

At Măgura 'Buduiasca' there are no local equivalents to a triangulation point or benchmark within practicable daily working distance of the site. Therefore the Măgura 'Buduiasca' site datum (labelled T3E02) was selected to establish the main site benchmark and a series of GPS readings were taken at this point during the course of fieldwork in both the 2003 and 2004 seasons. These GPS readings were taken on different days and at different times of day to allow for variation in satellite geometry. The GPS device used was a Garmin 12XL hand-held unit. All the GPS readings were then combined and the average UTM X and UTM Y co-ordinates taken as the location of T3E02. The elevation of T3E02 was not based on GPS readings, this was not deemed to be sufficiently accurate (a survey grade GPS receiver was not available at the time). The elevation of T3E02 was determined by

reference to total station survey to the summit of an Iron Age burial mound 1 km from the site that has a concrete spot height marker referenced on the Russian mapping.

Once the main site benchmark was tied into the UTM co-ordinate system, all subsequent total station survey readings could be transformed into the same co-ordinate system in readiness for use in the GIS. This was achieved using a Microsoft Excel spreadsheet set-up to calculate reduced heights and to combine total station northings and eastings with the known UTM co-ordinates and elevation of T3E02. A series of control points were selected in suitable locations near the 2003 and 2004 excavations and spatially referenced relative to T3E02 using the total station. The total station was then set-up on these additional control points to survey the excavations as required.

The site survey included: the surface extent of all excavation trenches; excavation units and depths; the spatial extent and depth of assemblages of material culture (ceramics, worked stone, animal and human bones, building material and hearth fragments); and single point spatial references for special finds, radiocarbon dating samples, ceramic residue samples, micromorphology samples, environmental samples, human bone isotope samples, and faunal bone isotope samples (associated with the human bones). Recording the spatial detail for all these archaeological artefacts allows for full integration in a GIS considerably enhancing reconstruction, interpretation and dissemination in the post-excavation phase.

Given that it was critical that the descriptive information associated with each surveyed point was recorded – whether it was a radiocarbon dating sample or an excavation unit depth – pre-made survey recording sheets were used and all information hand written in the field. While a data logger may have speeded up the process of data collection in the field, it was considered essential that as much descriptive information as possible was recorded for all surveyed points to enable them to be successfully and uniquely referenced and selected in the GIS during the post-excavation phase. Thus it was considered essential to have a hand written account of all surveyed points.

4.2.1 Micro-survey

A high-resolution total station micro-survey of sub-surface pits features was then conducted in sondages 10A and 10D in 2003 and 19, 20, 21 and 22 in 2004. The aim of these micro-surveys was to record vertical and horizontal spatial variation within and between pit features in as much detail as possible enabling two and three-dimensional representation using GIS during the post-excavation phase.

The surveys were co-ordinated by use of parallel strings laid out across the sondages and spaced 20 cm apart, each string having markers spaced at 20cm intervals along their length. The choice of 20 cm spacing was made for reasons of time. While a spacing of 10cm or less would have produced a higher-resolution survey, the increased number of survey points required would have demanded a substantial, additional investment in resources beyond that practicable during the 2003/04 fieldwork seasons. Total station readings (X, Y and Z) were taken at each 20cm marker along each string and the process repeated for each parallel string in turn. Thus for a 6m x 6m sondage, a maximum of 961 readings was possible (31 readings along each string where the 0cm and 600cm markers are included). In practice, however, the number of readings taken was less than the theoretical maximum for each sondage due to the presence of excavation baulks and the fact that pit features were not contiguous across the surface of all sondages. For logistical reasons, where pit features were not contiguous (as in sondages 20, 21 and 22), the micro-survey was targeted and limited to areas that exhibited pit features. In addition to the systematic micro-surveys, distinct linear features within pits (ridges or ledges) and pit edge tops and bottoms were surveyed to refine the detail.

After the surveys were completed, all total station readings were entered into the master spreadsheet on a survey-by-survey basis to automate the process of calculating reduced levels and for converting total station X, Y and Z values into UTM co-ordinates and elevations. As part of the spreadsheet data entry process, each total station survey point was attributed with a unique numeric ID, and with the appropriate descriptive information as documented on the survey record sheets completed in the field. When all the data had been entered into the spreadsheet and checked for input and calculation errors, the data from all the surveys were combined into one database file to allow easy input into the GIS project.

5. GIS raster representations of pit features

The SRAP GIS project began in 1998 as a data management system to organise, manage and present geo-referenced topographic and archaeological datasets (Mills 2001). The purpose of the

GIS project is to integrate different datasets into one computer-based system that can be used to show the spatial relationships between different geographic features and the distribution of archaeological material in the study area. As the SRAP has progressed, generating more and different kinds of spatial data during each subsequent year of fieldwork, so the GIS has been updated accordingly. The GIS is used to articulate different combinations of spatial datasets to document the progress of the project, to generate maps that show the relationships between Holocene landforms and changes in prehistoric land use through time and to aid planning future phases of the project.

Based at the Cardiff School of History and Archaeology, Cardiff University, the GIS project was first established using Environmental Systems Research Institute (ESRI) ArcInfo version 3.3 and ArcView version 3.1 software running on a Microsoft Windows 95 platform. It has subsequently migrated to using ESRI ArcGIS Desktop ArcView 9.1 software running on a Microsoft Windows XP Professional platform.

The first step in generating two and three dimensional representations of pit features was to import the database file of all micro-survey points into the GIS project and to display it with existing polygon shapefiles (an ESRI GIS file format) of the sondages to confirm that all points were correctly located. Any points observed to be incorrectly located, due to data-entry errors, were then referenced back to the master spreadsheet and original site record sheets and corrected as necessary. The corrected database file of micro-survey points thus provided the necessary sample point data required to generate raster surfaces representing the survey of pit features. A raster surface is a digital model of a continuous variable (in this instance elevation/depth) across space created out of a grid of cells or pixels. Each cell in the grid is attributed an elevation value based on the site survey which can then be colour coded such that cells with similar elevation values have similar colours. Other examples of the raster model include digital and satellite images such as the familiar JPEG and TIFF format files.

To enable greater control over the creation of raster surfaces, the database file of micro-survey points was queried to isolate sample points from each sondage respectively. The results of these queries allowed the sample points to be exported to individual point shapefiles for each of the sondages 10A, 10D, 19, 20, 21 and 22.

Using the Spatial Analyst extension in ArcGIS 9.1, each point shapefile for each sondage was interpolated to a raster using the Inverse Distance Weighted method (IDW – an interpolation function) based on the Z (elevation) value of the sample points. The IDW interpolation function predicts the values of cells in the raster at locations that lack sampled data based on their linear distance from sampled data – the survey points themselves. For purposes of data integrity, the Spatial Analyst extension environment was set to ensure that the rasters generated were limited to the area of the original surveys to prevent extension beyond the sample point data. For consistency, the same IDW settings were used for each raster generated (power: 2; search radius: variable; search radius number of points: 12; output cell size: 10cm). These settings allowed for the variation in the location of the sample point data between those derived from the equally spaced micro-survey points and those derived from the variably spaced surveys of linear features within pits and pit edge tops and bottoms. To refine the interpolation, barrier polylines (an ESRI GIS file format) were created based on the survey of linear features (ridges, ledges, pit edge tops and bottoms) where steep changes in elevation occur within and between pits. These barrier polylines limited the search radius for input sample points thereby sharpening the resulting rasters generated, providing a more realistic representation of the original pit features.

This procedure produced six raster surfaces, each of which contained a range of Z values specific to the sondage and pit features it represented. In order that the surfaces representing pit features from the different sondages could be compared in respect of elevation/depth, the six raster surfaces were merged using the Arc Toolbox mosaic tool. This procedure generated a single raster surface representing all pit features surveyed with a uniform range of Z values.

Using Z values in metres above sea level (masl) relative to the site datum T3E02 (56.79 masl), rather than as depths below surface, allows the raster to be displayed using the same elevation range used by other geo-referenced layers in the project GIS. This therefore displays the raster of pit features below the modern land surface level. By generating raster surfaces with Z values based on metres above sea level and relative to the site datum, the representations of pit features and prehistoric land surfaces -based on studies of the local geomorphology- can be displayed in the same elevation units and the relationships between them investigated spatially and temporally.

6. Results and discussion

6.1 Raster surface

The raster surface representing the survey of pit features is shown in plan in figure 4. The labels for the pit features refer to the numeric coding system used during excavations and the post-excavation phase to uniquely identify pit features and their associated assemblages of material culture. The blank areas in the raster surface in sondage 19 represent the location of excavation control baulks that were still in place when the micro-survey was conducted. (Feature 36 is a later Iron Age animal burial pit cut into the Neolithic features).

The figure clearly shows the complicated spatial arrangement of pit features and the varying depths to which pit features cut into the sub-soil. The raster surface also shows the variability in density of pit features, with sondage 19 in particular exhibiting the greatest number.

Understanding the spatial configuration of pit features, both spatially and temporally, is a critical aim of the SRAP. The raster surface provides an essential record of these features that can be drawn upon by the project team when investigating questions of chronology, form and function in the post-excavation phase. While plan and section drawings and photographs made in the field of the pit features are of immense value for recording two dimensional relationships, it is only through the process of micro-survey and subsequent raster surface generation that the three dimensional spatial relationships between all the pit features excavated can be dynamically visualised in the GIS. Furthermore, ongoing integration in the GIS allows plan drawings and photographs to be draped over the raster surface thereby further enhancing its visualisation value.

Figure 5 shows an example of a three dimensional (or more appropriately labelled 2.5 dimensional as three dimensions cannot be truly represented on a flat screen) representation of the raster surface of pit features for sondages 19, 20, 21, and 22 generated using ESRI ArcGIS 9.1 ArcScene. The ability to visualise and navigate in three dimensions around and through the raster surface is a powerful means for team members to investigate the spatial relationships between the pit features. Not only does it provide a useful aide-mémoire for those present during the excavation phase, and valuable insight for those specialists involved in the post-excavation phase not present during the excavations, it enables team members to better understand the horizontal and vertical relationships between pit features that were not necessarily evident during the excavation phase and that would not have been recorded in either drawings or photographs. This is particularly important given that the excavation of the individual sondages and pit features was executed over a two-year period and at different rates in any given year. This functionality in the GIS is essential to research that aims to critically address questions of the temporal sequence of development and use of pit features and the potential similarities and differences in their function interpreted through variation in form and associated material culture.

6.2 GIS integration of excavation and post-excavation data

The raster surface of pit features provides a starting point for GIS integration of the wide range of excavation and post-excavation analyses data generated as the SRAP progresses. Based on survey data collected in the field, point, line and polygon shapefiles of excavation units and samples (as detailed above) have been generated and can be readily displayed in the GIS alongside the raster surface. Figure 6 shows, for example, the spatial relationship between the raster surface of pit features in sondage 19 and radiocarbon dating samples collected during the 2004 excavation season. As the post-excavation phase progresses, analyses data resulting from material culture studies (for example categories, counts, weights, sizes and patterns of breakage of ceramics, animal and human bone, building material and hearth fragments) will be entered into the tables of the shapefiles of excavation units. This will permit investigation and presentation of the spatial distribution of all, or different, categories of the material culture excavated and analysed in relation to the raster surface of pit features. The integration of these data in the GIS will greatly assist team members during the interpretation phase of the project, particularly in respect of better understanding spatial and temporal patterns of deposition and post-deposition within and between pit features. Complemented by GIS integration of the forthcoming results from ceramic residue, environmental, human and animal bone isotope, micromorphology and radio-carbon dating samples, the project will have a powerful spatial database with which to address questions of the temporal sequence and function of pit features.

It is acknowledged that the raster surface is limited to representing those pit features that cut into the sub-soil and could thus be the subject of micro-survey. It is likely that Neolithic activity identified by assemblages of material culture stratigraphically nearer the modern land surface, were potentially associated with pit features that were not cut to a depth reaching the sub-soil and thus not

identified during the excavation phase. Conversely, it is also essential that assemblages of material that may not have been within, or that were removed, from pit features, can be securely identified. To address these issues demands that a range of techniques is employed including geomorphology, micromorphology and palaeobotany. This emphasises the critical methodological point that the micro-survey and resulting raster surface is not considered by the SRAP, at this stage, to be a definitive representation of all Neolithic pit features. Only intensive post-excavation analyses of all material culture and samples recovered during excavation and their subsequent integration can result in more informed interpretations. By recognising that applying new and multidisciplinary techniques, including GIS, is necessary in determining how archaeologists identify, excavate, represent and interpret pit features, and by explicitly acknowledging the potential limitations in any one technique, the SRAP is advancing the methodologies used in the study of the early Neolithic in the lower Danube region. The use of GIS in the project therefore plays an important role in challenging assumptions into the role of pit features during the Neolithic period and the methodologies archaeologists employ to address this question.

Future SRAP research aims for the full GIS integration of the spatial data produced during the excavation and post-excavation phases, and to deposit and archive this data (through, for example, an online GIS interface) to make it accessible to a wider audience and to ensure digital preservation.

7. Conclusion

This paper has promoted the SRAP procedure for, and the value of, conducting micro-surveys and producing a GIS raster surface of Neolithic pit features at Măgura 'Buduiasca', Teleorman County, southern Romania. It is argued that a high-resolution spatial excavation, followed by GIS integration of the wide range of spatial data produced by SRAP, is critical for improving the recording, representation and interpretation of early Neolithic pit features. It is hoped that new and continued studies of this kind, that address issues of resolution, and that challenge the theoretical and methodological assumptions of research, will re-new interest, and drive forward, the study of this important period in the prehistory of the lower Danube region. Only through a willingness to adopt and adapt, new and existing techniques, can archaeologists approach questions to do with the distribution, chronology, form and function of pit features in a more informed manner. The procedures outlined above, emphasising the integral role of GIS, are offered as one way that this aim can be fruitfully progressed.

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Although presented as a single-authored paper, this work represents the significant contribution of many of the core SRAP team members without whom this research would not be possible. In particular the author gratefully acknowledges the continued input and support of Douglass Bailey, Radian Andreescu, Pavel Mirea and Laurens Thissen. In addition, the author wishes to acknowledge and thank those SRAP team members, particularly Cardiff University archaeology undergraduate and postgraduate students, who assisted during the site surveys and with data entry.

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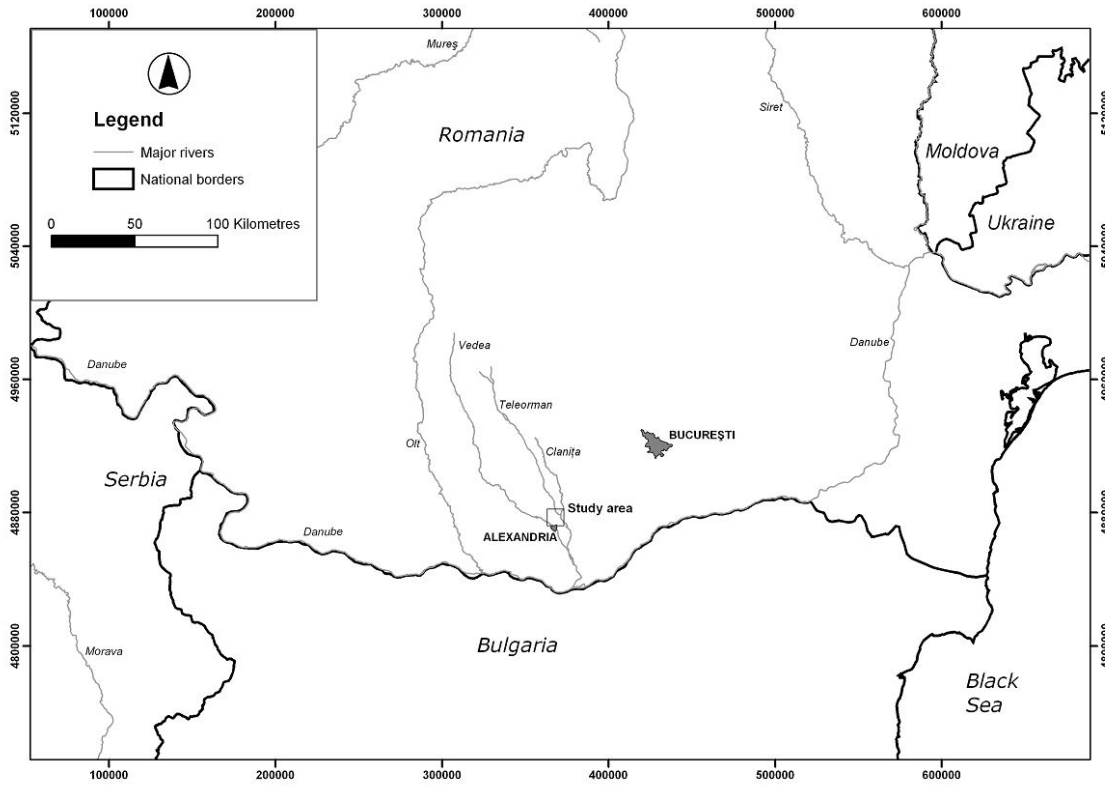


Figure 1. Location of the SRAP study area.
Amplasare zonei studiate de către SRAP.

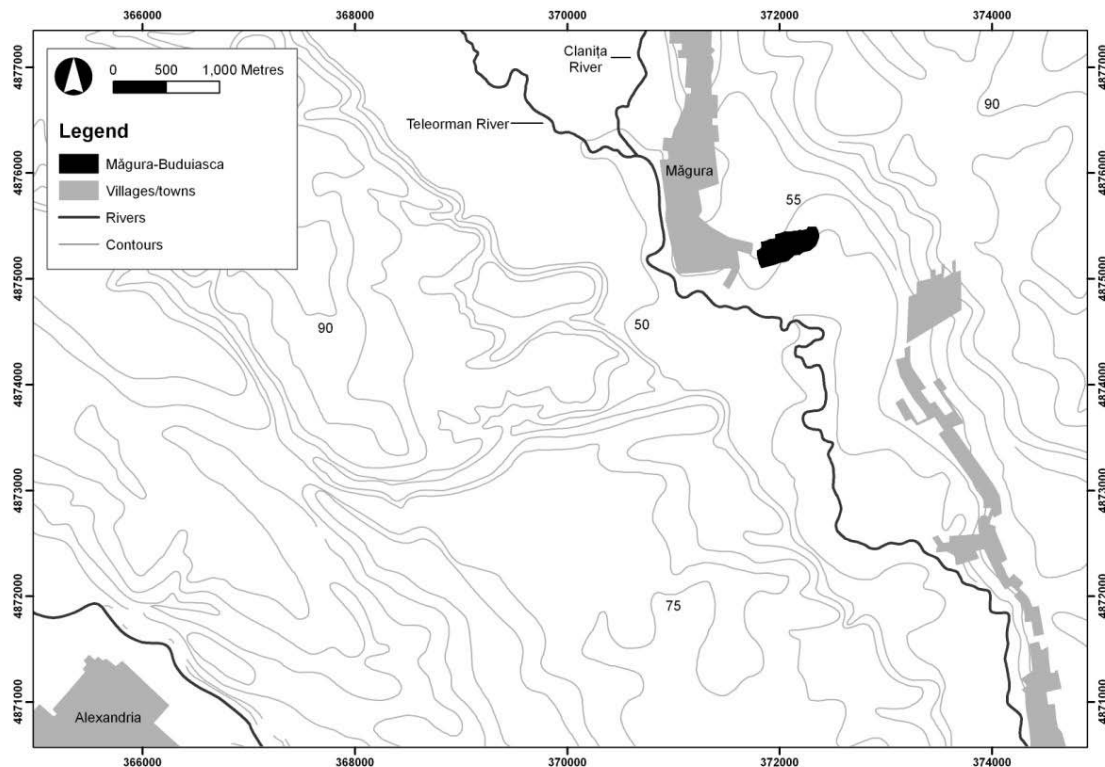


Figure 2. Location of Măgura 'Buduiasca'.
Amplasarea sitului de la Măgura 'Buduiasca'.

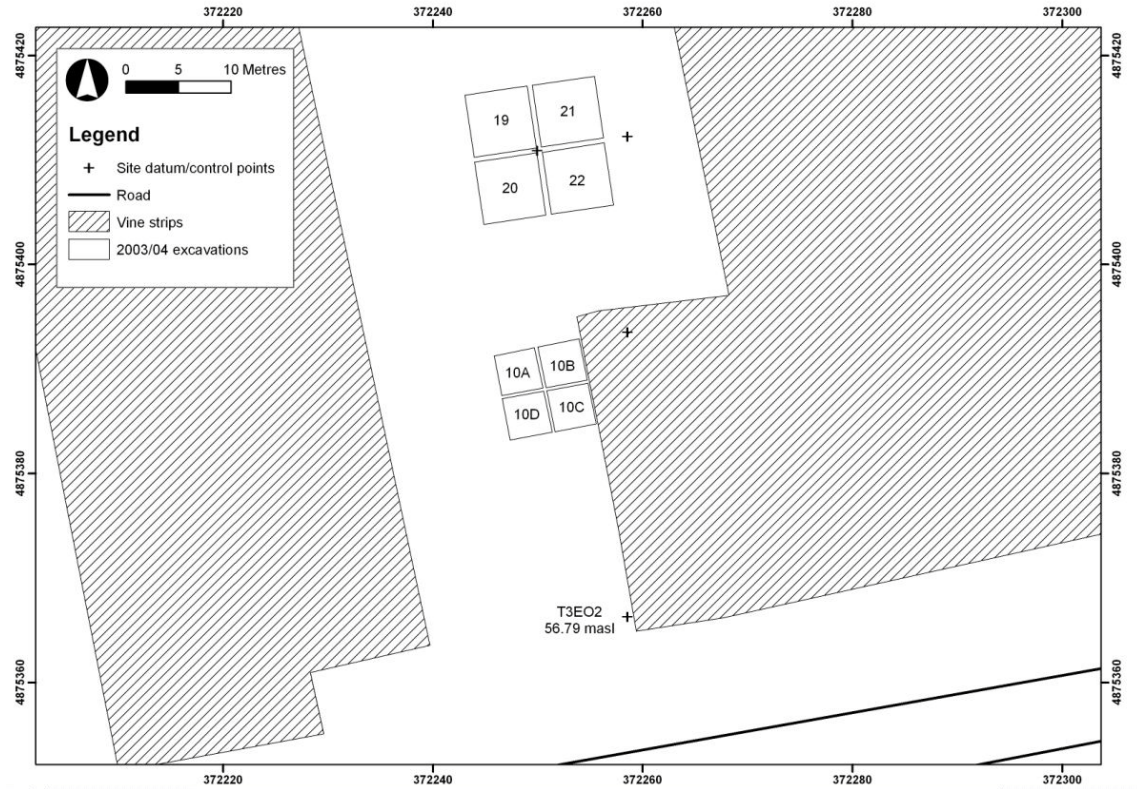


Figure 3. The 2003/04 Măgura 'Buduiasca' open-area excavations.
Suprafața excavată la Măgura 'Buduiasca' în anii 2003 și 2004.

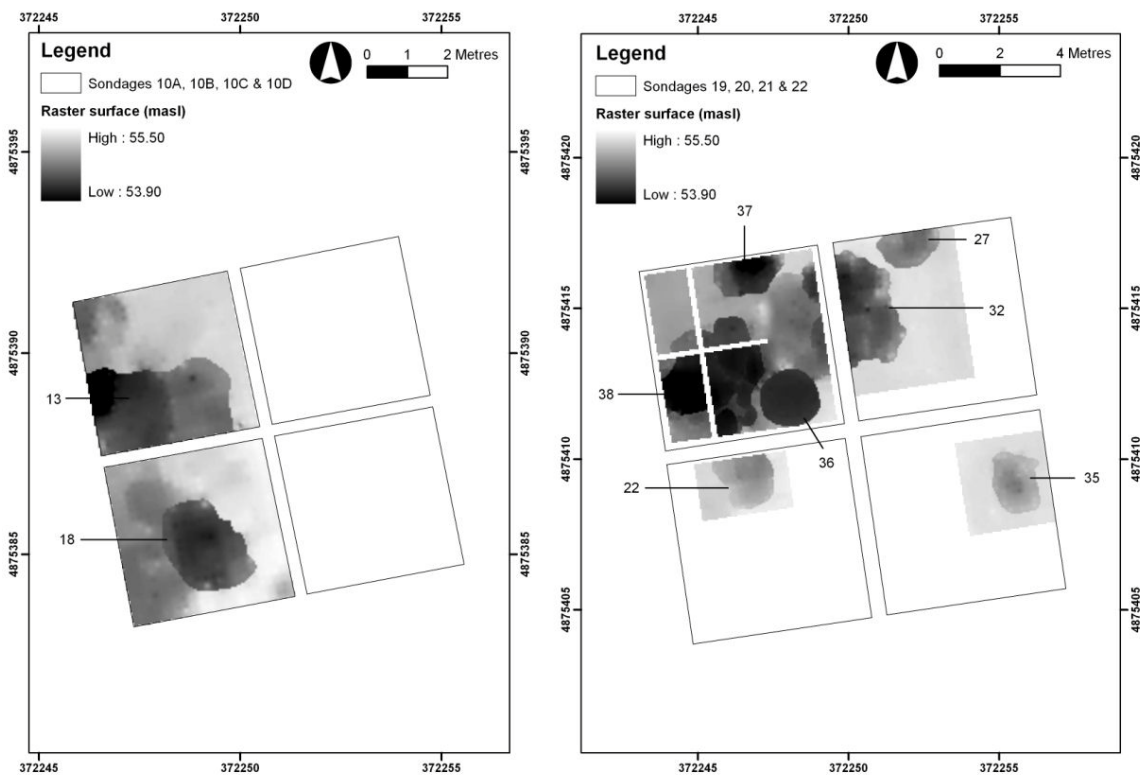


Figure 4. Raster surface representing the survey of pit features shown in plan.
Suprafața rasterizată a gropilor indicate în plan.

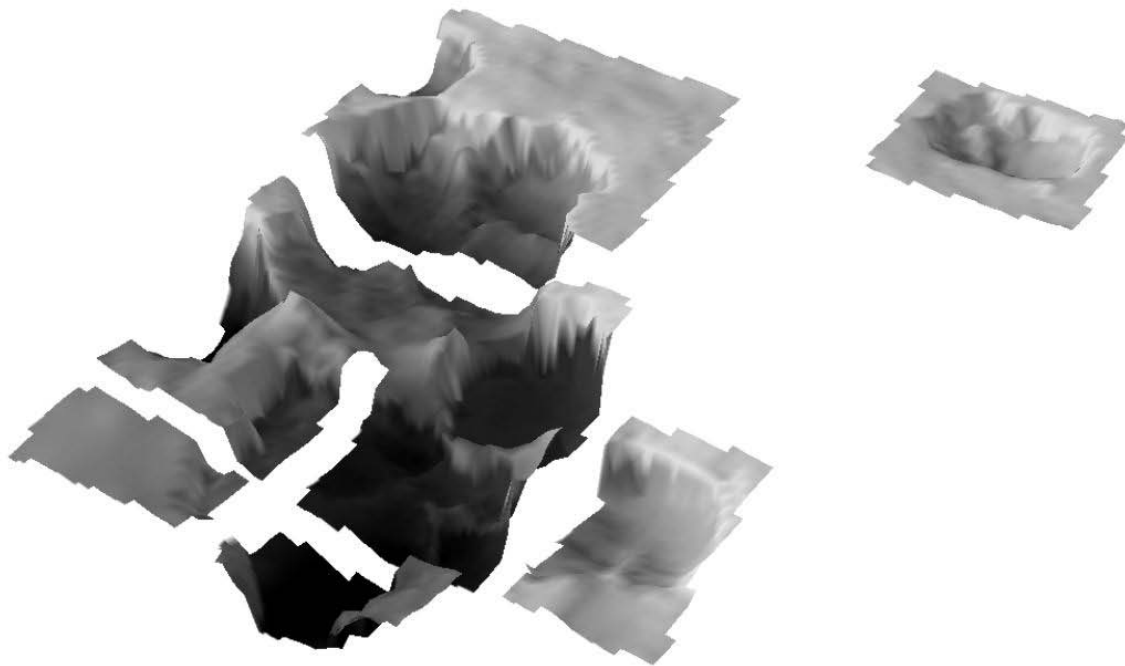


Figure 5. 3D view of the raster surface of pit features for sondages 19, 20, 21 and 22.
Imagine 3D a suprafeței rasterizate a gropilor din sondajele 19, 20, 21 și 22.

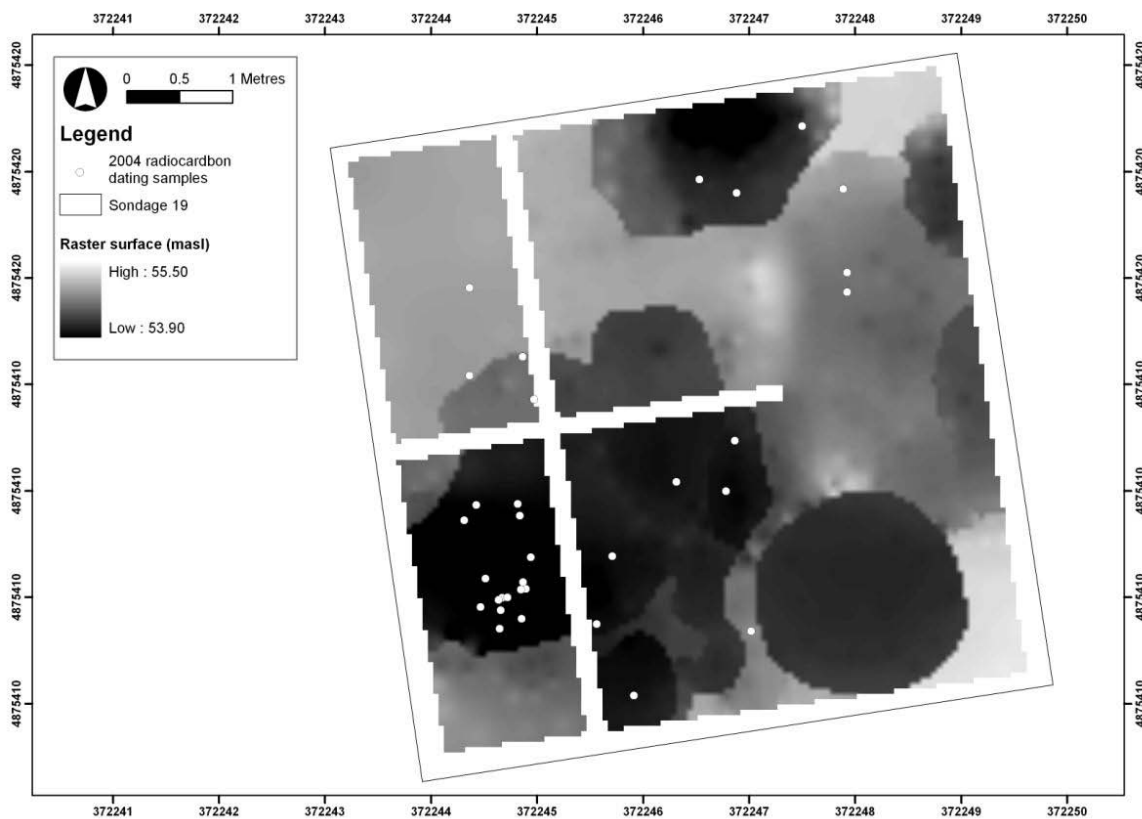


Figure 6. Raster surface of sondage 19 pit features with radiocarbon dating samples.
Suprafața rasterizată a gropilor din sondajul 19 cu indicarea probelor pentru datarea cu radiocarbon.

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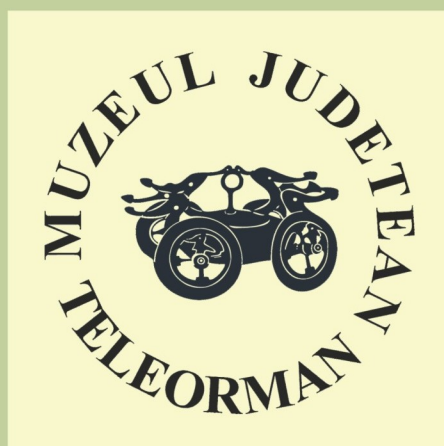
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