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DIGITALIZING PAPER DOCUMENTATION – ON THE EXAMPLE OF AN EARLY CELTIC SETTLEMENT ALTDORF „AM FRIEDHOF" IN GERMANY, IN THE PROGRAM ARCVIEW[1]

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Abstract: *Changing paper documentation into digital one, guarantees easy access and transmission of information about archaeological sites and helps in creating new, more accurate data, which was not possible previously[3]. An Archaeological Information System (abbreviation AIS) created from the digitized paper documentation should be easy put to use, enables quick and effective management of previously collected materials, and should allow the comparison of analysis, description of features and inventory of artifacts[4]. Digitalization should also permit the visualization of the results in an understandable and interesting way.*

The documentation presented here comes from site Altdorf „Am Friedhof" in Germany and was made in traditional way. During excavation archaeologist discovered an early Celtic settlement, along with numerous deposits of daub, bone and pottery[5]. All finds were documented in three dimensions, which allowed the use of GIS during interpretation of the results. This paper presents, point by point, the steps of computing a paper documentation to a digital one, and then creating an Archaeological Information System of the archaeological site.

Rezumat: *Autoarea prezintă documentaţia arheologică din aşezarea celtică Altdorf "Am Friedhof", utilizând GIS în interpretarea rezultatelor. Articolul ilustrează paşii parcurşi de la documentaţia primară până la crearea unui Sistem Informaţonal Arheologic al aşezării.*

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[1] This topic was subject to a paper presented, in a similar form, at the 39th Annual Meeting of the CAA: Revive the Past, held in Bejing, China during 12th-16th April 2011.

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[3] GILLINGS, WHEATLEY 2002, 3.

[4] MIAŁDUŃ, MIRKOWSKA, RĄCZKOWSKI 2005, 193.

[5] ENGELRDHARD, KOBYLIŃSKI, KRASNODĘBSKI 1993, 85-6..

STAGE ONE: DOCUMENTATION

The first stage of the digitalization process revolves around gathering comprehensive information regarding the site along and making sure there is proper documentation.

Firstly one ought to familiarize himself with the information regarding the history of the site. It is important to keep in mind that the site could have been excavated over long periods of time. Moreover different researchers might have been using different methods of documentation. Information regarding the methods used to excavate the site is crucial. One should distinguish which particular piece of data was documented and in what way. Moreover, one ought to read any previous publications about the site. Those are often the source of interpretations of the research data. Reviewing the documentation is also necessary in order to make out all the data to be digitalized in upcoming stages. After collecting all the relevant information one may ascertain what will be used and in what way. At the end of this stage it is possible to go ahead and plan the data base.

The site Altdorf "am Friedhof" is located near Munich in southern Bavaria, Germany. A complex of 3 houses from the Early Iron Age was discovered there. The site was dated at about 450 B.C – the transition between the late Hallstatt and Early La Téne period.

Excavations first started in 1992 as a rescue excavation, due to the expansion of a nearby cemetery. The work was carried out by the Warsaw Academy of Science's, Archaeology and Ethnology Institute and the Bayerishes Landesamt für Denkmalpflege. Zbigniew Kobyliński and Doctor Bernd Engelhardt administered the project which continued until 1995[6].

The site's first layer was 1,5 m thick and consisted of redeposited loess formed by a collapsed terrace forming the slope, under which the site was located. As it turns out, this is what helped preserve the

[6] ENGELRDHARD, KOBYLIŃSKI, KRASNODĘBSKI 1993, 85-86.

archaeological layers. Under the loess the archeologists encountered the settlement layer. In it features such as post holes pits, ovens and fire places were discovered. Finds included deposits of burnt daub and numerous deposits of pottery and animal bones, which were crushed but well preserved. The site was transcribed into a system of Cartesian coordinates, corresponding to geographic directions. The exploration was carried out with the use of wide area and stratigraphic methods. All the mentioned artifacts were documented in 3 dimensions. The exceptions were the deposits of solid daub, which were documented in 3D and square meters[7].

In this study, the AIS was restricted to features documentation from 1994 and 1995, due to the great amount of deposits and limited time one had to may disposal (fig. 1).

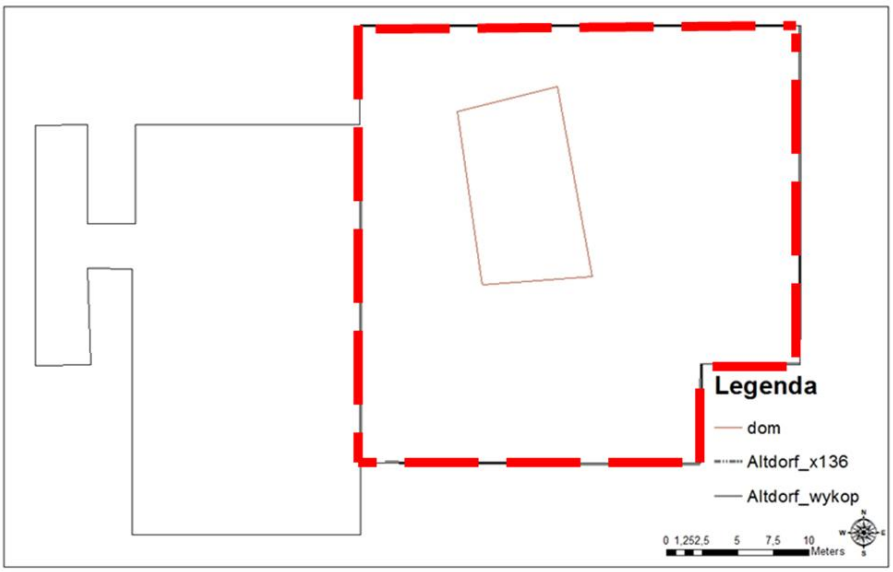

Figure 1. Area of digitized documentation

The paper documentation was composed of secondary data – drawings, made on sheets of paper about 2,1 meter per 90 cm. The following was documented: color drawings of the features, a general plan of the features and solid daub. They scales used were 1:20 and 1:10. The

[7] KOBYLIŃSKI, KRASNODĘBSKI, WACH 1999, 278.

tabular data contained inventories of: bones, pottery, daub and special finds. It lists data such as: inventory number, trench number, x,y and z (height) coordinates, a description of layers, number of fragments, date, place of storage and comments[8].

After gathering the aforementioned data one planed data base, which would be used during the creation of AIS. Due to the type of data in this particular case it was decided to create a hybrid raster - vector GIS. Features were depicted as polygons, ceramics, bones and special finds were points and deposits of daub became polygons and points. The colors of the point representations were chosen in accordance with the colors used on the site in order to distinguish the appearance of depositions. Consequently the following color-codes were established: green for pottery, yellow for bones, blue for special finds and orange for daub.

STAGE TWO: DIGITALIZATION

Stage II was the digitalization, which began with scanning followed by preliminary raster data processing and the creation of tabular data.

In the example- site Altdorf „Am Friedhof", a manual scanning technique was adopted due to the size of the sheets of paper on which the features were documented. The resolution of the raster was 600 dpi. The preliminary data processing, included cutting and straightening of rasters. This was required due to the adopted manual scanning technique and the possibility of errors resulting from an inaccurate application of paper into the scanner[9]. In the end, a raster ready for vectorization was created.

Tabular data was created by rewriting inventories into a computer spreadsheet. Only the most important information was copied into the Excel format. This included: inventory numbers, trench numbers, x, y and z coordinates, numbers of fragments and comments.

[8] KOBYLIŃSKI, KRASNODĘBSKI, WACH 1999, 279.
[9] MANIA 2009, 16.

STAGE THREE: PROGRAM

During stage III a program was chosen. This was performed on the basis of requirements, needs and the range of information entered into AIS. In the AIS of Altdorf mostly raster (paper maps), vector and tabular data was used. Upon consideration, the program ArcView 9.3 was chosen to create the AIS.

STAGE FOUR: CREATION OF ARCHAEOLOGICAL INFORMATION SYSTEM

The final, stage IV was the creation of AIS. This stage was divided into steps. The first step was to establish a uniform naming pattern for the database. Afterwards the georeferencing and vectorization were carried out. An optional step was to create a 2, 5 dimension visualization of the site.

The vocabulary was uniformed to ensure clarity during review of large quantities of files. Names were divided into different categories of data: points, polygons, rasters and analysis. Also a dictionary of abbreviation was created to help other users understand the database.

Later all rasters were georeferenced - transcribed in correct coordinates, as noted in the documentation. This formed the base for vectorization. The vectorization of polygons was done manually while the points were generated automatically. In this step it was important to remember about possible generalizations (one had to choose the degree of the raster's zoom).

After the conclusion of those IV stages an Archaeological Information System was produced (fig. 2). The AIS of Altdorf "Am Friedhof" contained: vectors (a point representation of artifacts and a polygon representation of features), a raster of features (on the base of vectors), and a raster of the general plans in a scale of 1:100. Next a planigrafy was made, all documented artifacts were depicted on a plan of the site. One could identify any point and any polygon.

A visualization in 2,5 dimension was an optional choice. It was made on the base of the raster, where the height (z values) of the features was depicted. This data was vectorized as points and the height was

added to them as an attribute. Thus a TIN of every single feature was made. The TINs together with the 2,5 dimension point representation of artifacts constituted the visualization of the site.

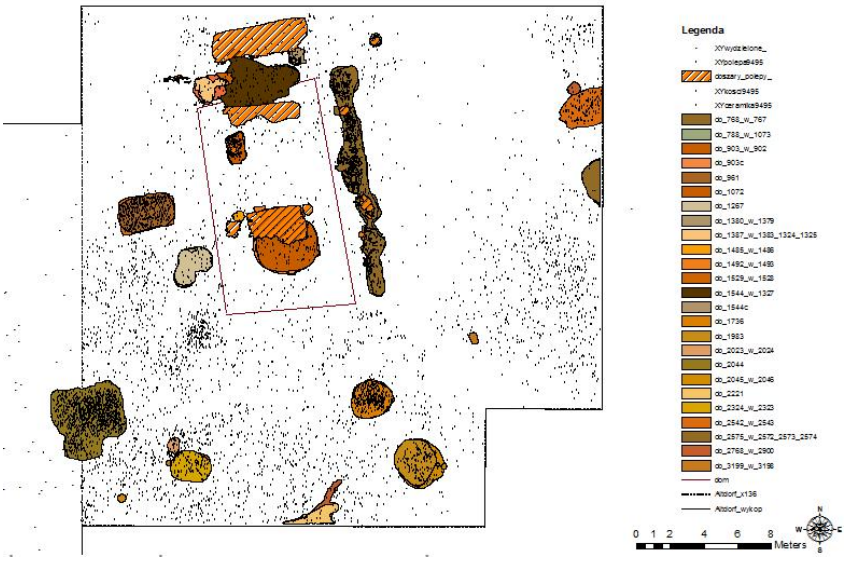

Figure 2. Archaeological Information System of Altdorf "Am Friedhof"

CONCLUSIONS

What is the benefit of the proposed steps of paper documents digitalization? In a nut shell: an Archaeological Information System, which is basically a digital copy of the documentation, allows for easy access to the data, visualization and analysis. The AIS of the site contains all information from the analog documentation and it is a computer version of planigraphy. Moreover, in the event that the original paper documentation is damaged or destroyed, the digital copy can serve as a backup, securing the preservation of the knowledge gathered from the site. AIS makes easy access to the data possible and allows for fast sharing of the information via server, email or CD. Physical distance is no longer a factor. Visualizations help to illustrate the results of research in ways considered interesting and understandable to society at large. Most importantly, analysis gives us the possibility of obtaining new information

from a site that no longer exists. As we will demonstrate in the next paragraphs.

ANALYSIS

The first analytic tool employed in my work was average nearest neighbor analysis (abbreviation ANN). The result of this analysis – distance – helped in the creation of a buffer, which showed locations in which the amounts of artifacts were the same height as features[10]. Buffers for bone distribution were also created which showed a clear area outside features, were a number of artifacts exist, but this information was very general. In the case of the second largest artifact collection, ceramics, this area is highlighted again, but it lacks details.

Next, only the artifacts inside features were selected (fig. 3). Then, the average nearest neighbor distance was calculated again. The assumption was, that the spatial relation between artifacts inside the feature and those found outside them, could point out places were probable features could have existed, but did not show up in the soil during excavation. For bones and ceramics, the result of the average nearest neighbor analysis was exactly the same.

[10] CONOLLY, LAKE 2006, 77-80.

Figure 3. Artifacts selected inside features

In the next step, a buffer was created, using AAN result. Once again the same area outside the features appears in both bones and ceramics buffers (fig. 4).

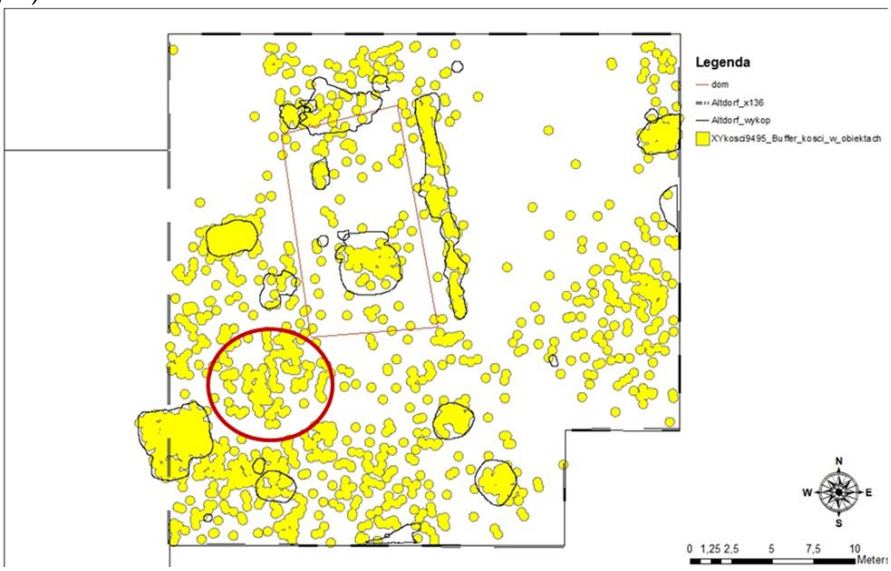

Figure 4. Buffer of bones

For a more detail results another analysis was done – density analysis. The analysis of both the bones and the pottery the same the same areas outside of the archaeologically located features appeared. Thanks to the density analysis one could even see boarders of the new features (fig. 5).

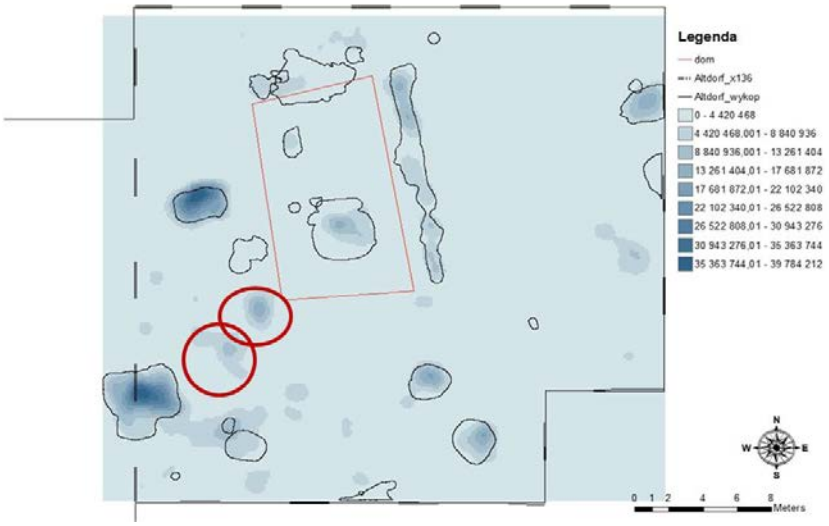

Figure 5. Bones' density analysis

Thus the process of documentation digitalization and its analysis has produced unexpected new information about a site, i.e. indicating the presence of features which had not been visible on the basis of soil color and texture recorded during the excavation.

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