

Lauchheim 1986–2016. The Interdisciplinary Analysis and GIS-Mapping of a Prominent Early Medieval Necropolis in Eastern Swabia

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One of the most well-known and largest early medieval necropolises in Western Europe lies near the small town of Lauchheim in Baden-Württemberg, South West Germany. Totalling around 1400 inhumations dating from the 5th–seventh Century AD, it was completely excavated between 1986 and 1996. Due to the high frequency of finds and the fragility of some of the bone material, much use was made of block lifting. Some blocks still remain unopened. The good state of preservation and the juxtaposition of the necropolis with a contemporary settlement, which was also extensively excavated, set the stage for an extensive social-historical analysis of a local early medieval community over two centuries. Analysis of the grave goods and an anthropological appraisal have been combined and structured in a specially designed Database containing over 30,000 individual entries. A GIS Map of the site, arduously piped from the original hand drawings via vectorization software and CAD into Open Source GIS, allows for perspicuous visualization of any combination of anthropological data and/or finds and contributes greatly to the understanding of the development of the necropolis. Since 2008 the Lauchheim Project has been supported by the German Research Council, allowing innovative conservation and documentation methods including complete anthropological examination, 3D computer tomography of the unopened blocks (with sometimes surprising results) and an extensive examination of organic material and textiles.

Key words:

Necropolis, Early Medieval, Database, GIS.

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1. INTRODUCTION

Located at the eastern rim of the Swabian Jura, 80 kilometers east of the Baden-Württemberg capital of Stuttgart, the town of Lauchheim lies on the bank of the River Jagst. In 1986, construction work in the field "Wasserfurche" ("water drain"), a few hundred meters west of the town, revealed burials dating from the seventh century AD (Figs. 1 and 3).

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At that time, no one could foresee that it was only the southeastern corner of a burial site that would prove to be the largest early medieval necropolis of southeastern Germany uncovered so far [Stork 1995]. Between 1986 and 1996 the staff of the Baden-Württemberg Cultural Heritage Department excavated 1305 graves containing a minimum of 1400 individuals. The burials, ranging from the second half of the 5th to the second half of the seventh century AD, were mostly in very good condition. A total of over 30.000 artefacts were unearthed, of which over 20.000 are glass, amber and mineral beads. Many of the artefacts were recovered from blocks with the surrounding soil and containing organic materials. It is not only the size of the site—there are contemporaneous cemeteries with a comparable number of burials [Höke 2016a, p. 55 n. 2]—and the huge number of artefacts that is so special about Lauchheim: the most salient characteristic is the almost complete documentation of a large early medieval cemetery. Less than 5 percent of its original substance has been destroyed. Most cemeteries from this period are either small or incompletely preserved, as is the case with the large necropolises of Altenerding and Straubing in Bavaria [Sage 1984; Geisler 1998]. In contrast, the rectangular Lauchheim cemetery, 175 meters in length and 85 meters in width (approx. 1.5 hectares), revealed most of its original boundaries (Fig. 2). Only the southeastern part is incomplete, due to the initial construction work of 1986.



Fig. 1. Location of Lauchheim, Baden-Württemberg, Germany.

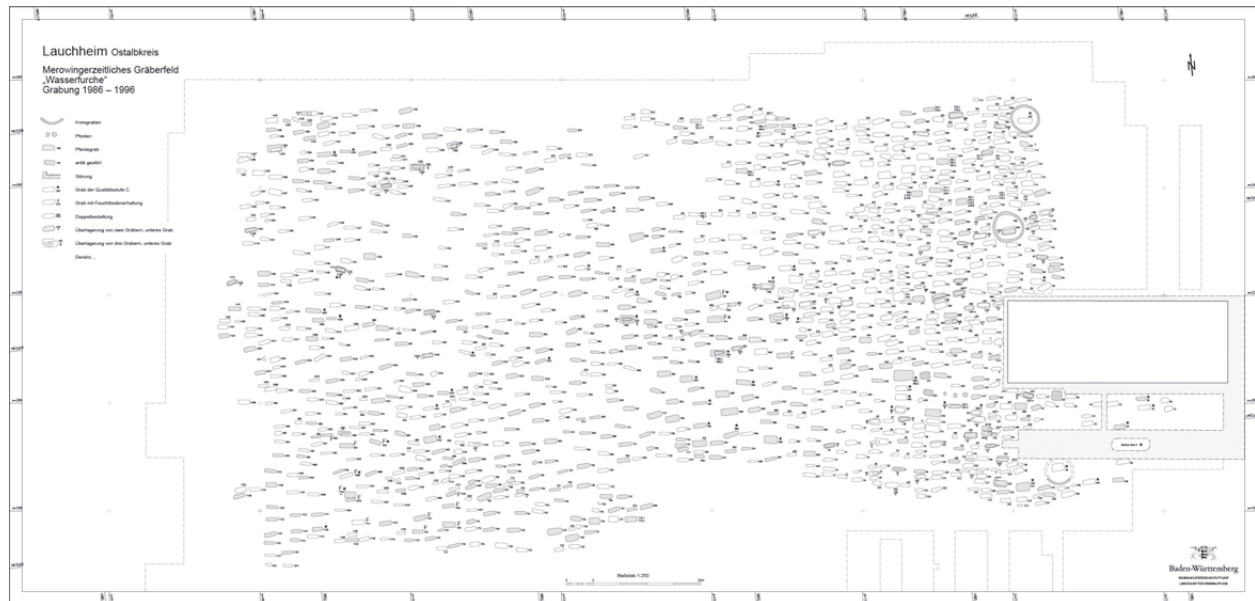


Fig. 2. Lauchheim Wasserfurche, site plan from 1996 (Adobe Illustrator).

It was not until the realization of the German Research Council (Deutsche Forschungsgemeinschaft) Lauchheim project between 2008 and 2015 that the artefacts in their entirety were accessible for scientific analysis [Brather 2016; Gauss 2013; Höke 2016a; Scheschkewitz 2013].

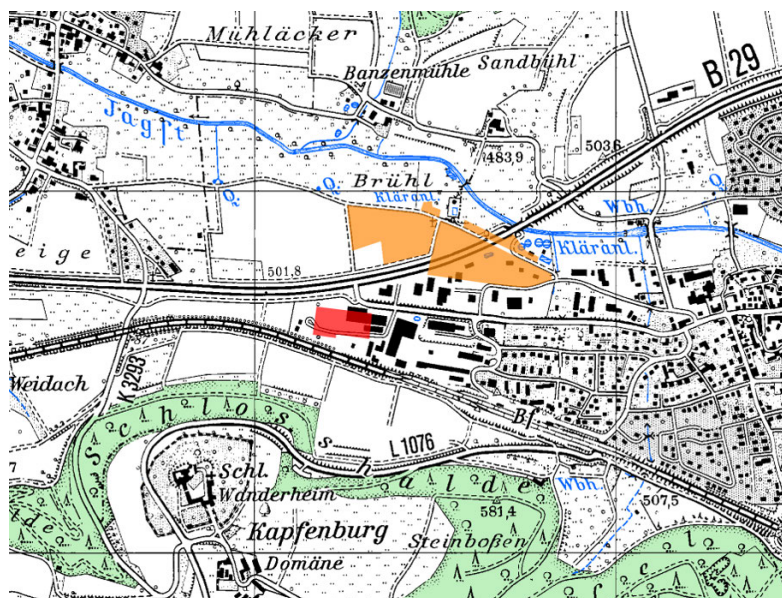


Fig. 3. Topographical map with marking of the Wasserfurche necropolis (red) and the Mittelhofen settlement site (orange).

The main aspects of the project have been:

- artefact conservation
- a large-scale X-ray computed tomography of block excavations and longswords with the goal of "virtual restoration"
- the documentation and analysis of all archaeological textiles and organic remains
- an anthropological examination
- the development and use of a project specific database
- the publication of a printed catalogue

2. "MITTELHOFEN" VILLAGE

The nearby deserted village of "Mittelhofen", a sixth to twelfth century settlement site closer to the river bank, was also excavated between 1989 and 2005 [Stork 1995; Schoenenberg 2014] (Fig. 3). It was, however, not part of the project "Wasserfurche". The assumption that "Mittelhofen" was the place where the "Wasserfurche" dead lived and died in distinctive farmsteads holds great potential for spatial analysis. Another 80 burials were found within these courtyards, most of them from the time after the abandonment of the large cemetery in the late seventh century [Wahl and Stork 2009]. Such shifting of the burial place is a common phenomenon in late Merovingian times [Höke 2016b; Steuer 2004]. Provided that familial associations between the burials within the settlement and the latest ones in the "Wasserfurche" cemetery can be determined by close examination of the grave goods, as well as the skeletal remains, the "Mittelhofen" graves may provide a key for indirect identification of the dwellings of some of the individuals and families buried in the earlier cemetery.

Most likely a correlation of distinctive seventh century "family areas" of the cemetery, which still have to be identified (Fig. 4), with the farmsteads existing at this time, will never be possible, but we have to assume that the spatial and social structure of the settlement may have had some sort of equivalent in the cemetery.

3. ARTEFACT CONSERVATION AND X-RAY COMPUTED TOMOGRAPHY

The large amount of metal artefacts in different stages of corrosion, most of them stored for one to two decades after excavation, imposed special demands on conservation and restoration [Bott et al. 2013]. Efficiency, completion of work within the project timeframe, was as important as thoroughness, with consistent quality, sustainability and meeting scientific demands. Applying concepts of "investigative restoration" and gentle conservation, the surfaces, especially of the iron artefacts, were only freed from corrosion coating as far as it was necessary for the assessment of material, function, shape, measurements and decoration. X-Ray images provided additional details, like damascening patterns, so a complete exposure of the surface was not necessary in most cases. Furthermore, the "restoration window" approach allowed organic overlays on the artefact surfaces, like textiles, leather, wood and plant residues, to be preserved for future examination (see below).

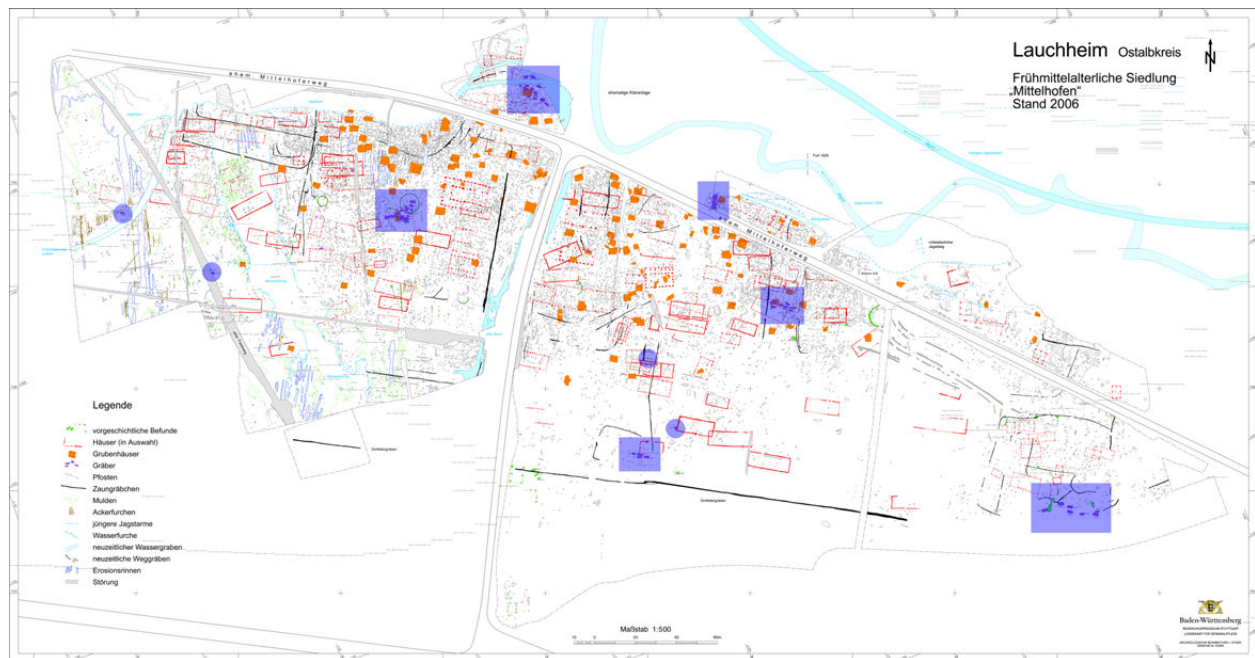


Fig. 4. Lauchheim Mittelhofen, site plan from 2006. Blue rectangles = courtyard burial grounds; blue dots = single burials.

Another pillar of the Lauchheim project is the application of X-ray computed tomography as a method of non-invasive “virtual restoration” of over 300 block excavations [Ebinger-Rist and Stelzner 2013; Stelzner 2016; Stelzner et al. 2016] (Fig. 5). The artefacts remain within the plaster-jacketed blocks. By segmentation, based upon the relative density of the different materials, the objects were isolated and were described and depicted as if excavated; even fragile objects and organic remains, which would have been damaged or destroyed by exposure or by removing them from the surrounding earth were examined using this method. Another important aspect is the possibility of documenting the original artefact alignment within a block excavation and its visualization as a 3D model. Only a few of the Lauchheim block excavations were opened after the CT scan in order to validate the results or because they contained artefacts of special importance. However, the advantages of the non-invasive CT method have to be weighed against the space and infrastructure required for long-term storage of the unopened block excavations.

All of the 106 longswords from the “Wasserfurchen” cemetery have undergone an X-ray computed tomography as well. Only the CT images reveal technical details, like the construction of the hilt or the structure of the pattern-welded blade, which are important for the description and classification of the swords [Stelzner et al. 2016; Lehmann 2016] (Fig. 5).



Fig. 5. Lauchheim Wasserfurche. Left: CT rendering of the content of a block excavation, showing a seax and different tools once stowed in a bag. Right: CT image showing the hilt and a part of the pattern-welded blade of a longsword.

4. TEXTILE ARCHAEOLOGY AND ORGANIC REMAINS

As mentioned above, the identification, documentation and description of all textiles and other organic remains, most of them adhering to metal artefacts, was another goal of the project. As far as early medieval cemeteries are concerned, this has never before been done at this scale: over 8,400 separate layers of organic materials distributed over roughly 900 graves have been recorded. Especially the textiles of different types and quality provide an enhanced view of the burials [Peek 2013; Peek 2015]. However, our intention is not a reconstruction of garments—for which purpose the textile remains are too small and random—but a functional and qualitative differentiation between clothing layers, shrouds and other textiles with funerary context. The other organic materials can give important clues as well. Remnants of leather on metal fittings may help to reconstruct (weapon) belts; plants and their derivatives like moss or straw may indicate a padding of a coffin; and wood was undoubtedly the most frequent material used in early medieval material culture.

5. ANTHROPOLOGY

Anthropological examination of the skeletal remains of Lauchheim “Wasserfurche” has not only resulted in the determination of age and sex, but also gives information about traumata, diseases, age-related degeneration, stress markers, nutrition and distinctive osteological features that may

indicate biological kinship. Anthropology adds another layer of information to the material outfitting of a grave. While grave goods can be the medium of an intentional, if not pretentious, representation of the deceased person [Brather 2008], bioarchaeological data have the potential to obtain an unfiltered picture of the individual's living conditions. The "Wasserfurche" cemetery represents, as far as we know, at least the bigger part of an early medieval local population in a timeframe of two centuries; thus, it can – in contrast to incompletely preserved or smaller cemeteries – provide reliable demographic data for any given period, while changes over time (e.g. life expectancy) become visible. This, of course, requires an examination of every single burial.

6. SPATIAL AND TEMPORAL STRUCTURE OF THE CEMETERY

A preliminary analysis of the graves with datable artefacts resulted in a simplified burial sequence (Fig. 6). A deeper analysis, which is currently in progress, will allow a differentiation of 5–6 phases [according to Friedrich 2016]. The first burials of the late fifth and early sixth century are located in the western part of the area. They do not form distinct rows or clusters. During the sixth century, the larger part of the site contains burials. Beginning in the late sixth century, burials concentrate in the eastern half of the cemetery, growing denser the closer they get to the eastern boundary in the seventh century. The sharp limitation indicates a fence, which separated the cemetery from the surrounding fields. Grave rows become more obvious. During this period, we can distinguish between two powerful families; one of them – located in the southeast – is characterized by very rich burials with Christian traits, the other one is affiliated to the mounds in the northeast and appears somewhat more conservative.

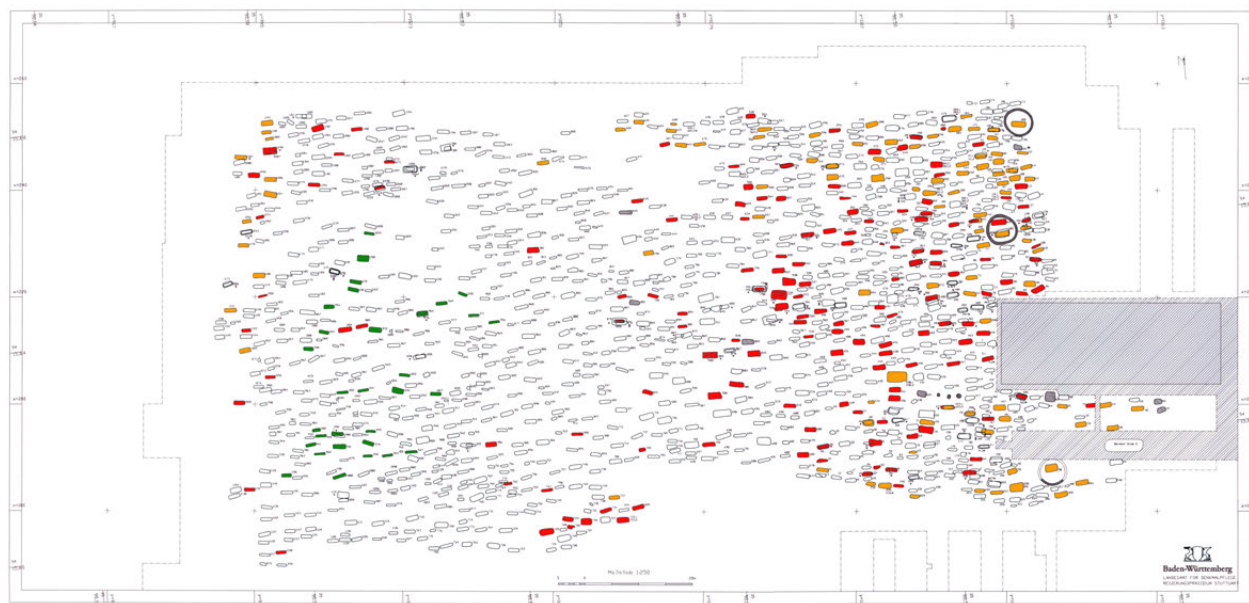


Fig. 6. Lauchheim Wasserfurche, distribution of early and late burials. Green = late 5th to early sixth century; red = late sixth to early seventh century; yellow = seventh century.

At the western rim of the cemetery is another, smaller accumulation of seventh century, but comparatively simple burials. Thus, the spatial structure of the site may reflect the social structure of the community. The concentration in the eastern third of the site may not only be caused by an increasing lack of space, but may also indicate a conscious separation from the older parts of the cemetery. Especially in the cramped eastern part, there are a lot of secondary burials and overlapping of graves, but even in the older areas intentional successional burials can be found. Chronology is mandatory for any other observations; however, it is not yet included in the GIS mappings in this paper owing to pending age determination of many burials.

7. PROJECT DATABASE

The “core” of the Lauchheim project is a specifically designed PostgreSQL database in which all information is pooled. Its modular structure correlates the diversity of the Lauchheim data (Fig. 7). The database incorporates all information derived from field notes and feature drawings, artefact autopsy, the examination of organic remains, scientific studies and so on. The descriptive modules are linked with uploaded images. Ideally, project organization (overall “layout” and workflow) and database structure should be closely related. Thus, the modules “grave description”, “artefact description”, “block excavations/CT”, “textiles/organic remains”, “anthropology” and “images” mirror the division of labor in the project. The textile specialist, for example, mainly used the corresponding module for input, but could access all other modules. The modules and data sets are linked with each other (Fig. 7). Because the sequence of input is not binding (the description of organic parts can be made either before or after the object itself has been described, depending on the status of restoration), coordination of the workflow was essential and the current status of every artefact had to be registered in a separate roster. The Lauchheim database was not designed as an inventory database for archival purposes and, moreover, its conception does not make it a suitable tool for field work. Generally, once input is complete, the database serves as an information or data repository, as a research instrument, and as a basis for a printed catalogue. It is project-specific, but the methodology could be applied to other early medieval cemeteries.

Contextual descriptions have to be extracted and processed from preexisting field notes, drawings and photographs. The database forms include custom-text fields, extensible thesaurus lists and numeric fields. Depending on previous selections, special subforms are accessible (e.g. textiles, beads). Considering the variety of artefacts, materials, function and ornaments this is necessary, in order to find a balance between explicitness and generality in description. Mixing categories and sub-categories (e.g. brooches and plate brooches) and overloading of the thesauri with nearly-the-same terms would impede any comparability and inhibit unambiguous query results.

The database can be used as a research instrument via more or less complex queries. An example: If one wants to isolate all iron belt buckles with plain weave textiles on the topside from undisturbed female burials, the query combines artefact description, grave description, anthropology and textiles. Or, decorative details may be of interest, for example all iron belt fittings with animal style silver damascening; in this case the selection is based on the module artefact description and the sub-module ornaments. The query result lists can be exported as xml-files for additional sorting and filter options (Fig. 8). The attribute tables for the GIS mappings are based on these lists.

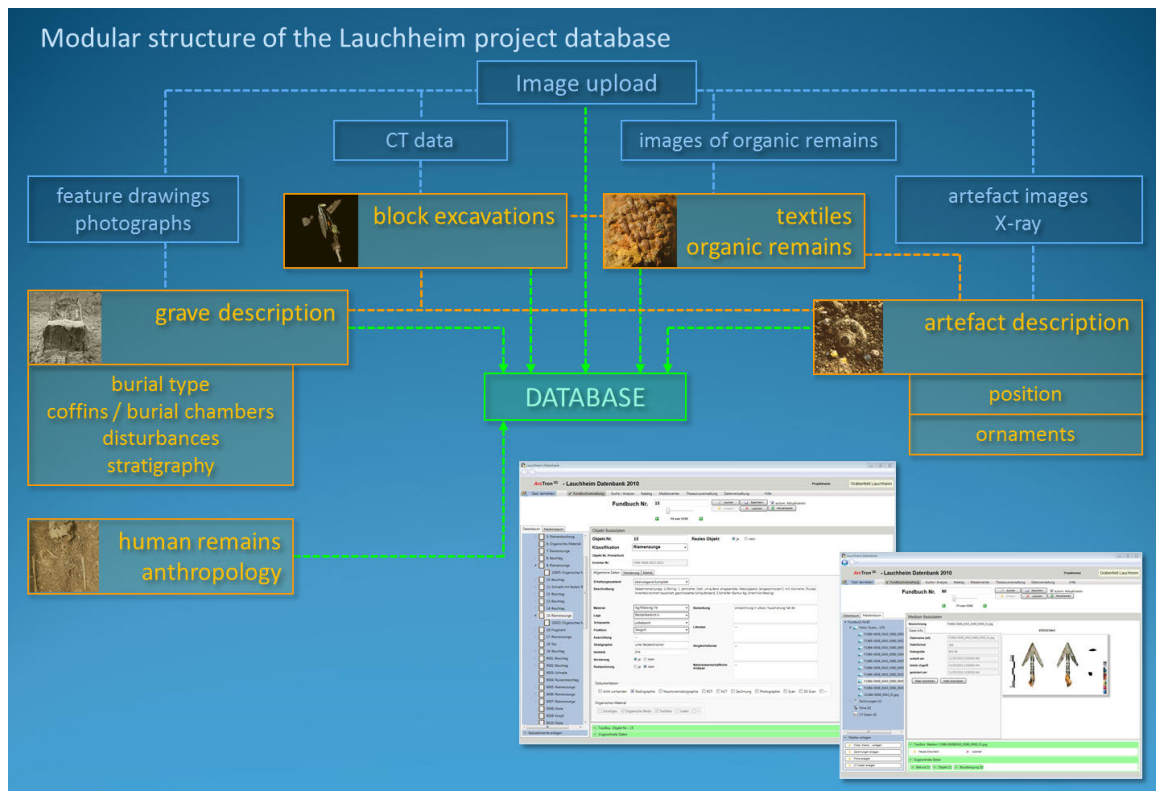


Fig. 7. Structural organization of the Lauchheim project database.

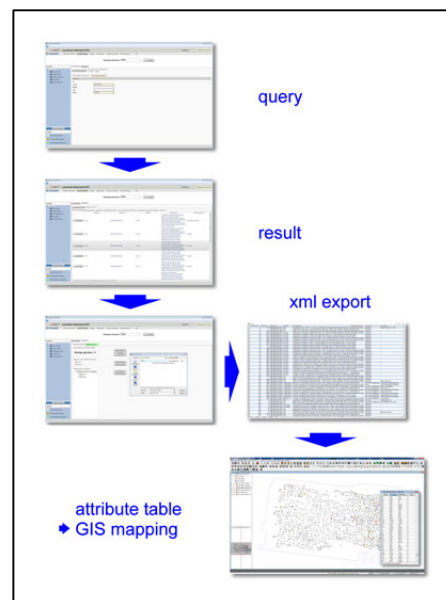


Fig. 8. Database query and data processing in the GIS.

8. SITE PLAN

The production process of the cemetery plan used for the GIS mappings is not that obvious, taking into account that the Lauchheim excavation happened in the pre-digital era of field archaeology. As is usual for an excavation of the late twentieth century, A3 millimeter paper was used for the basic drawn record. At a scale of 1:20 each sheet recorded an area of 7 m x 5 m. Uncovered inhumations and their grave goods were drafted at 1:10, also on A3 sheets – and occasionally blown up to 1:1 for comparison of real details! (Fig. 9, Fig. 10).

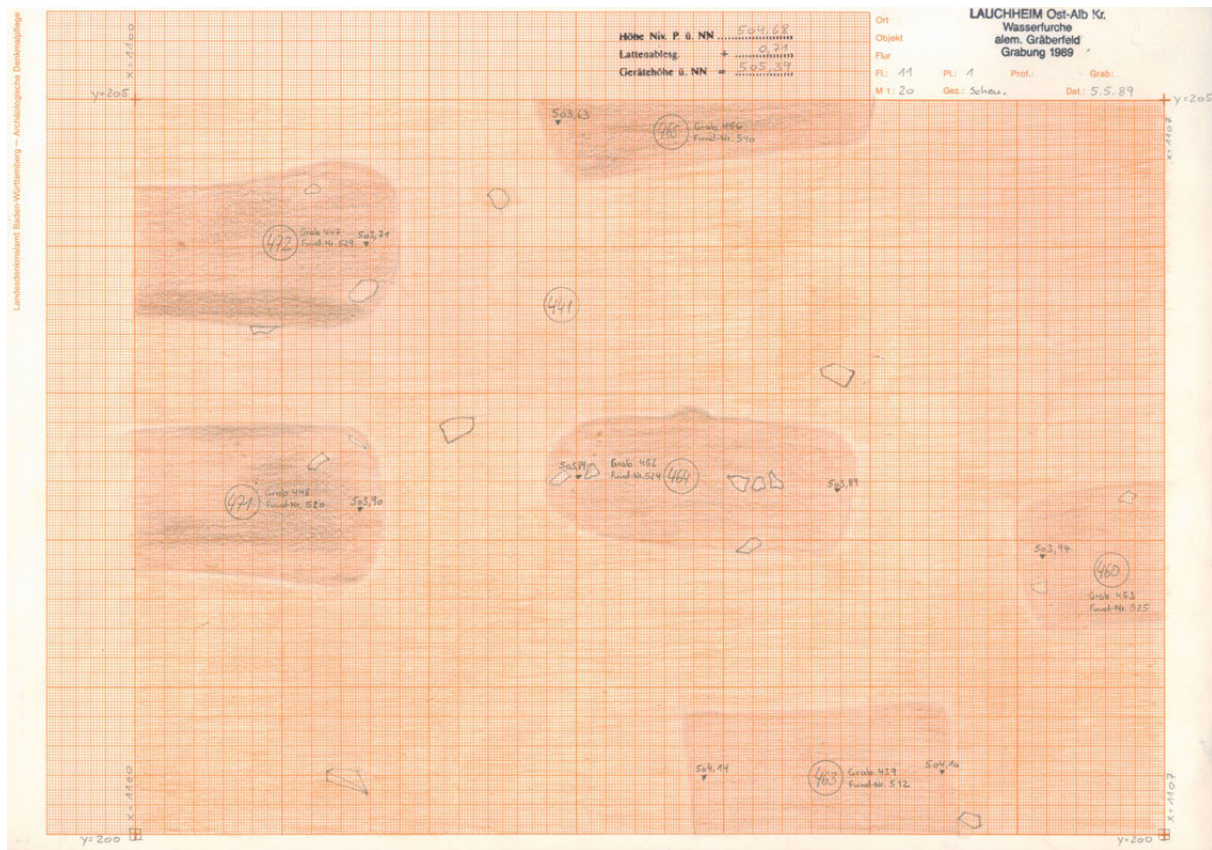


Fig. 9. Standard colored grave Plans 1:20 on A3 millimeter paper.

The coordinate system of the drawings was local. Although no national grid coordinates appear on any of the A3 sheets and no mention of keying the local grid into the national grid could be found in the original excavation record, this, luckily, must at some stage have happened, as will be shown. The plans were drawn with pencil and colored according partially to a pre-defined scheme (yellow for bone, for example) and the draftsman's perception of the nuances of the soil. This was a "standard" German recording method of the time. The 1:20 plans were correlated and manually reduced to hand-drawn overviews at scales of 1:100, 1:500 etc. (Fig. 11). The initial "passage" from analogue to digital took place immediately after the completion of the final excavation campaign in 1996, with the

creation of an Adobe Illustrator version of the plan, produced by digitizing a complete composite hand-drawn overview of all the grave pits and other features from the Wasserfurche excavation (Fig. 2). This plan was constructed by a (competent) draftsman, not an archaeologist. It gives a good visual impression of the overall cemetery, but a closer look shows it to be topologically unsuitable for use in object-based GIS analysis without cleaning (Fig. 12). On the positive side, the slanting lines in the frame of the plan (Fig. 2) turned out to be coordinates of the Gauss-Krueger national grid and so the plan became geo-referencable in a much easier way than had originally been thought. The validity of the coordinates were tested by inserting the final GIS plan into the State cadaster – where it landed on the “right spot.” All work in preparation for the transference of the plan into GIS took place in AutoCAD: closing open polygons (polylines), logical redrawing of some of the excavation border that had been misunderstood by the draftsman and geo-referencing. On completion, the plan was imported into the open source desktop GIS “gvSIG-CE”, where all further analysis (except the production of the “heat map” Fig. 20, which was generated in QGIS), including a stratigraphy of intercutting graves, took place (Fig. 13). The first essential step was the (manual) attributing of feature numbers and, where appropriate, grave numbers to each of the objects in the plan. The thus accrued attribute table served as a basis for joins to the tables filtered out of the project database, thus allowing for special analysis in combination with information from the database.



Fig. 10. Plan of an inhumation and the grave goods (bone = yellow) originally drafted at 1:10, blown up to 1:1 for comparison of details.

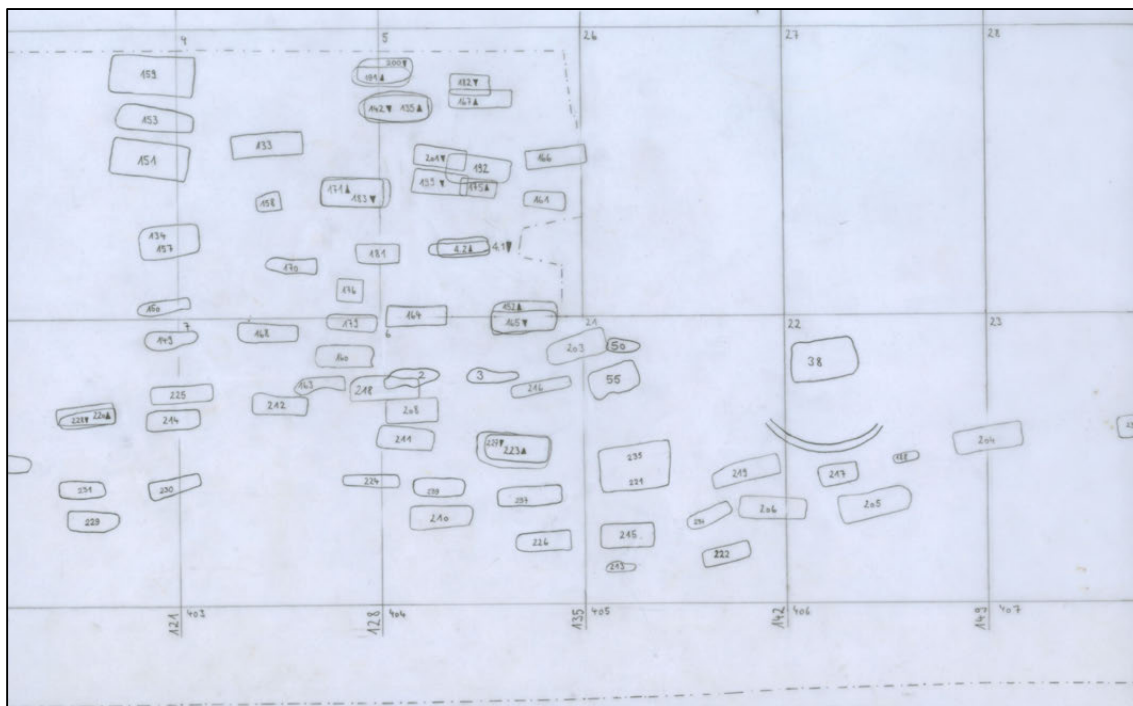


Fig. 11. Lauchheim Wasserfurche, part of the composite pencil plan 1:100.

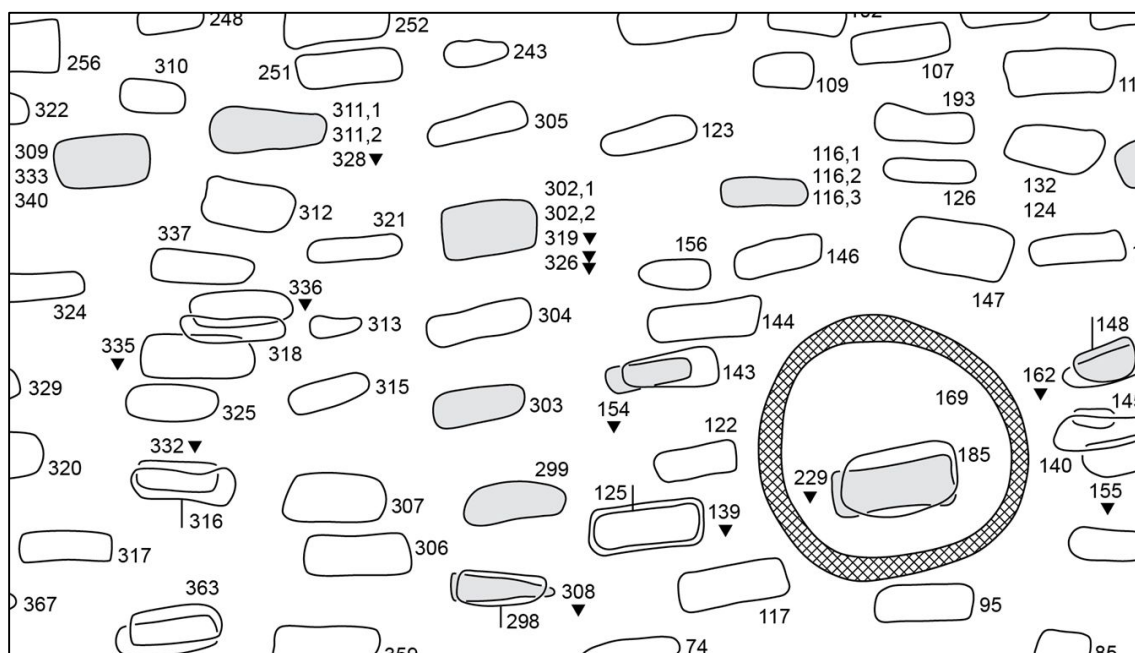


Fig. 12. Close-up of the plan showing topological inconsistencies.

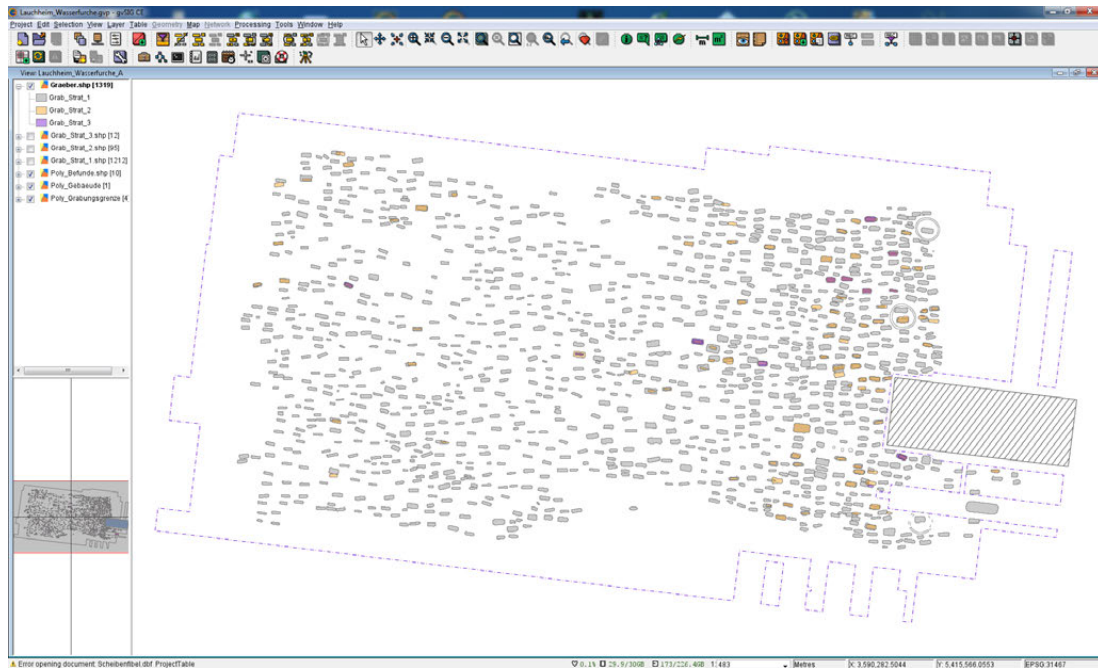


Fig. 13. Final GIS plan (screenshot of gvSIG-CE). In this case, showing the grave stratigraphy, where present.

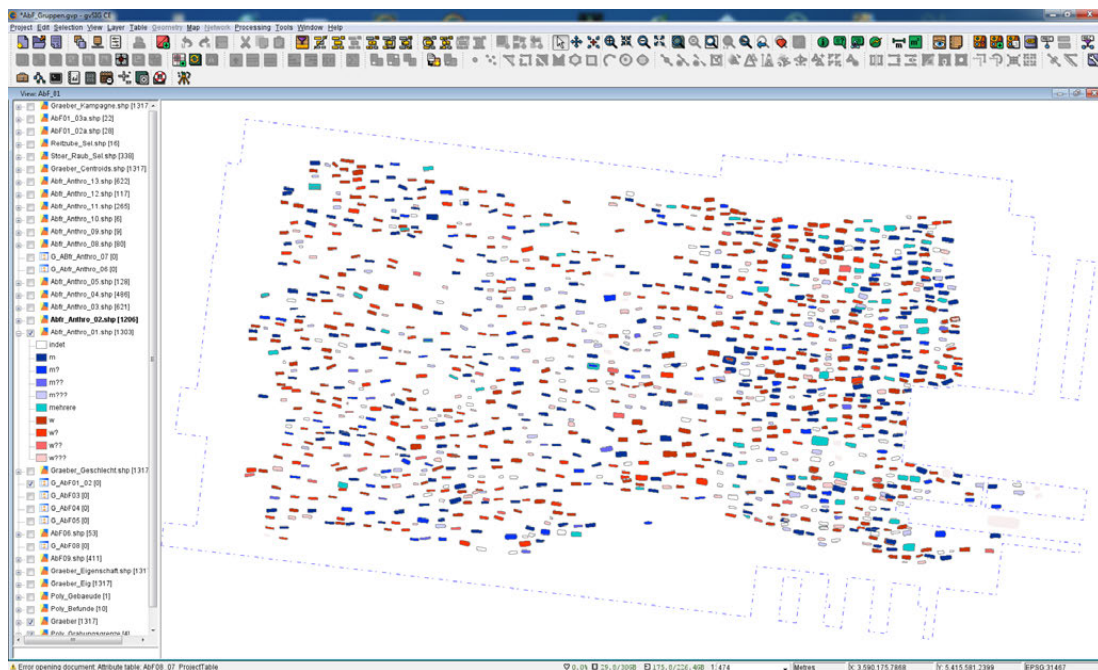


Fig. 14. GIS mapping of sex: Blue = male; red = female. The color gradations indicate the reliability of the sex indicating skeletal features.

9. MAPPING EXAMPLE: ANTHROPOLOGY

The mapping of the basic anthropological attributes sex and age is commonplace (Fig. 14). When combined with chronological data, the picture will become more significant. In the case of the “Wasserfurche” cemetery, we will be provided with more specific individual data (see above). When cross-mapped with archaeological aspects like artefact types or social status, distinctive spatial distribution patterns may show up. For example, it might be interesting to relate warrior graves of different social ranks with the occurrence of weapon-induced traumata, which tell grim stories of serious and sometimes deadly injuries in times of violence. Of course, answering such a question does not require a GIS, but a mere list would not show a significant concentration in a limited area of the cemetery, as the mapping does.

10. MAPPING EXAMPLE: ARMAMENTS

By the use of different layers combined with signatures, complex mappings are possible. In the following case, the underlying attribute table contains only “true” or “false” values. In Fig. 15, all burials containing at least a longsword are marked.

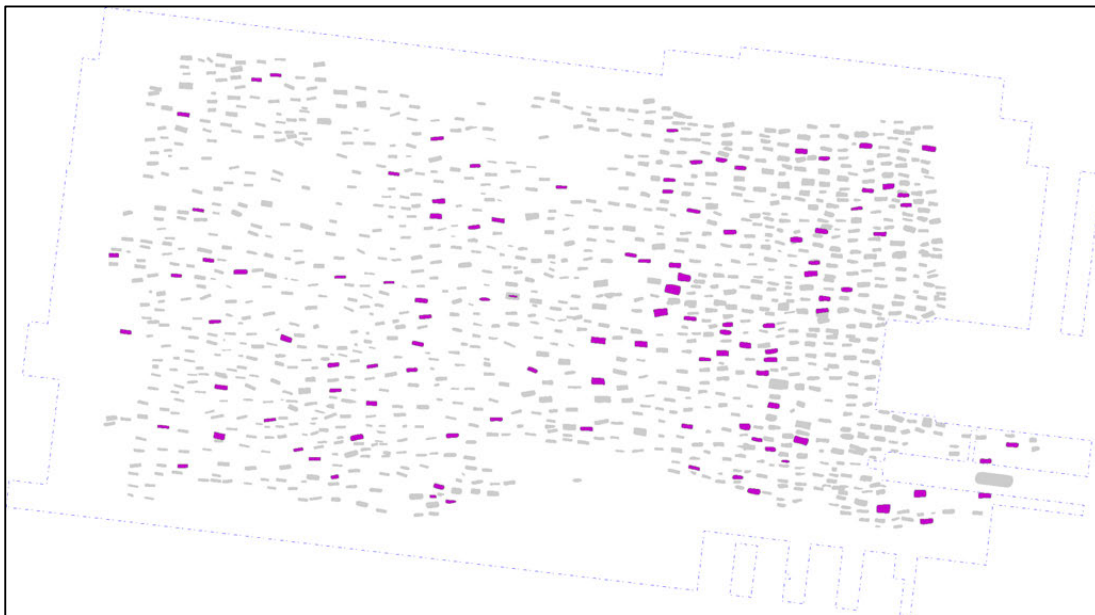


Fig. 15. Graves containing longswords (violet).

The next layer (Fig. 16) shows all burials additionally containing a seax, but not a lance (operator: “longsword”=true, “seax”=true, not “lance”). The opposite is added by the next layer (Fig. 17): longsword plus lance, but no seax (operator: “longsword”=true, “lance”=true, not “seax”). Comparison shows that the last two mappings exclude each other. They also exclude the mapping of the graves containing all three types of weapons (Fig. 18; operator: “longsword”=true, “lance”=true, “seax”=true).

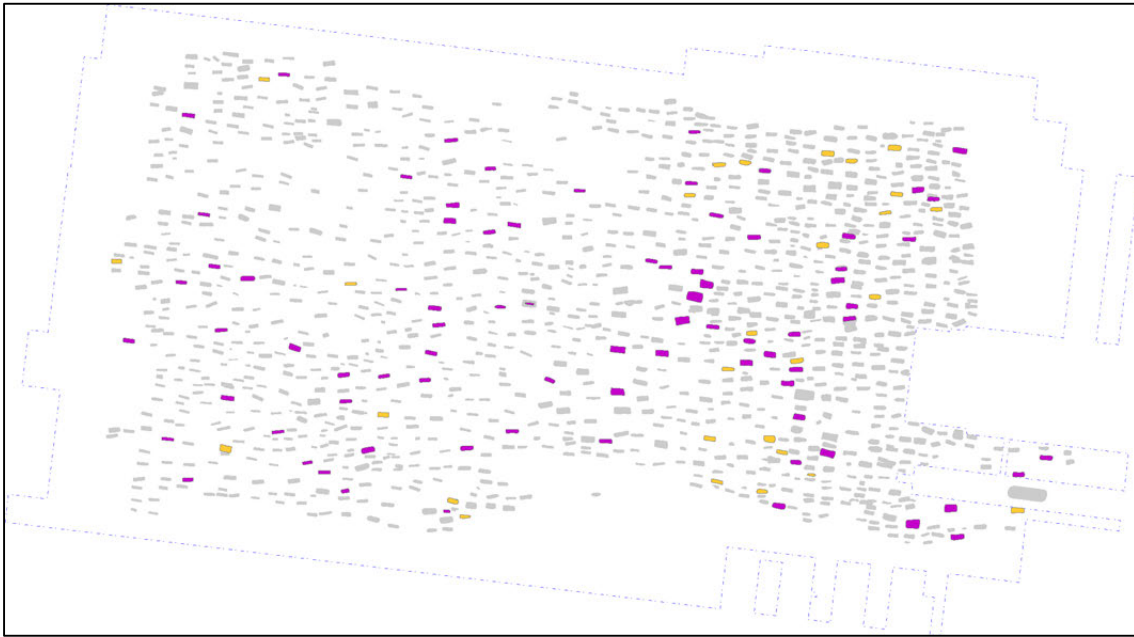


Fig. 16. Graves containing a longsword and a seax but no lance are marked yellow.

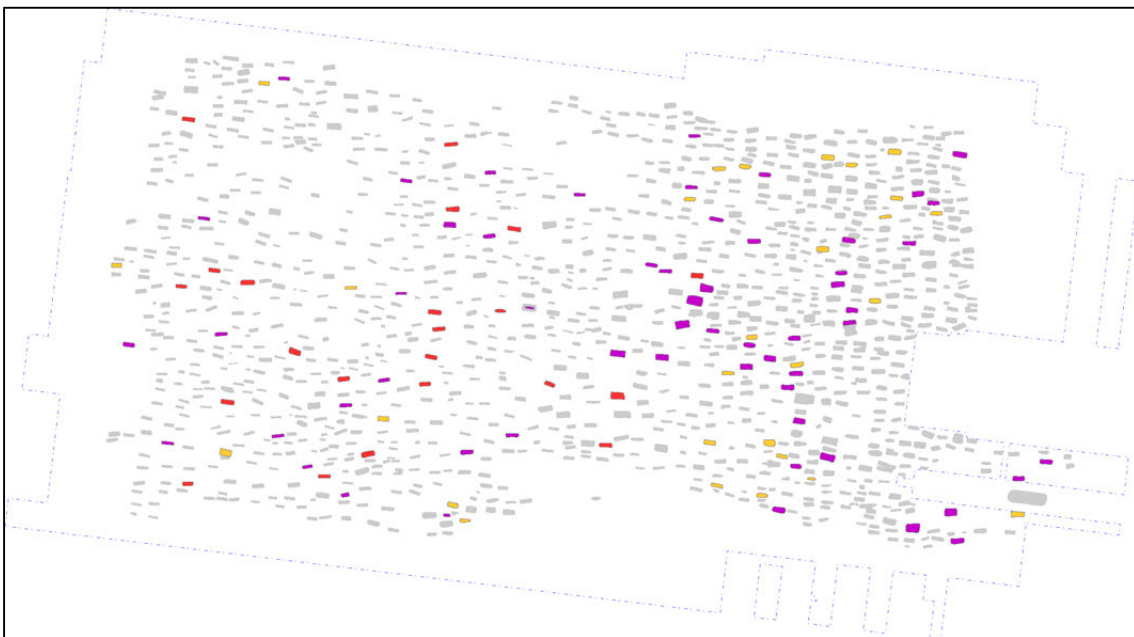


Fig. 17. Graves containing a longsword and a lance but no seax are marked red.

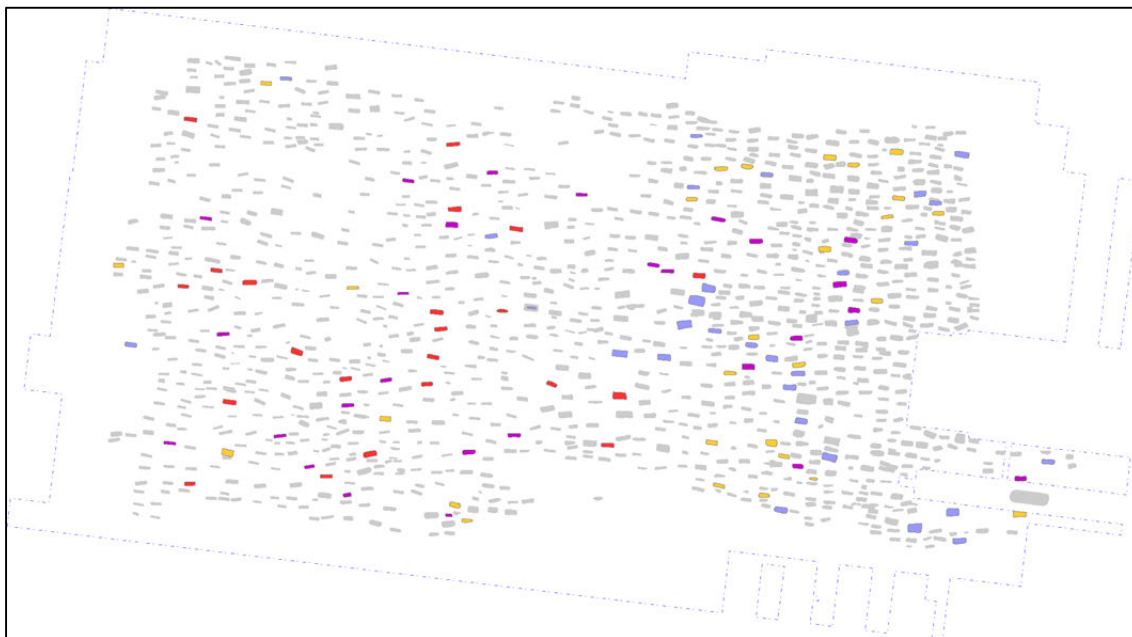


Fig. 18. Graves containing all three types of weapons are marked blue.

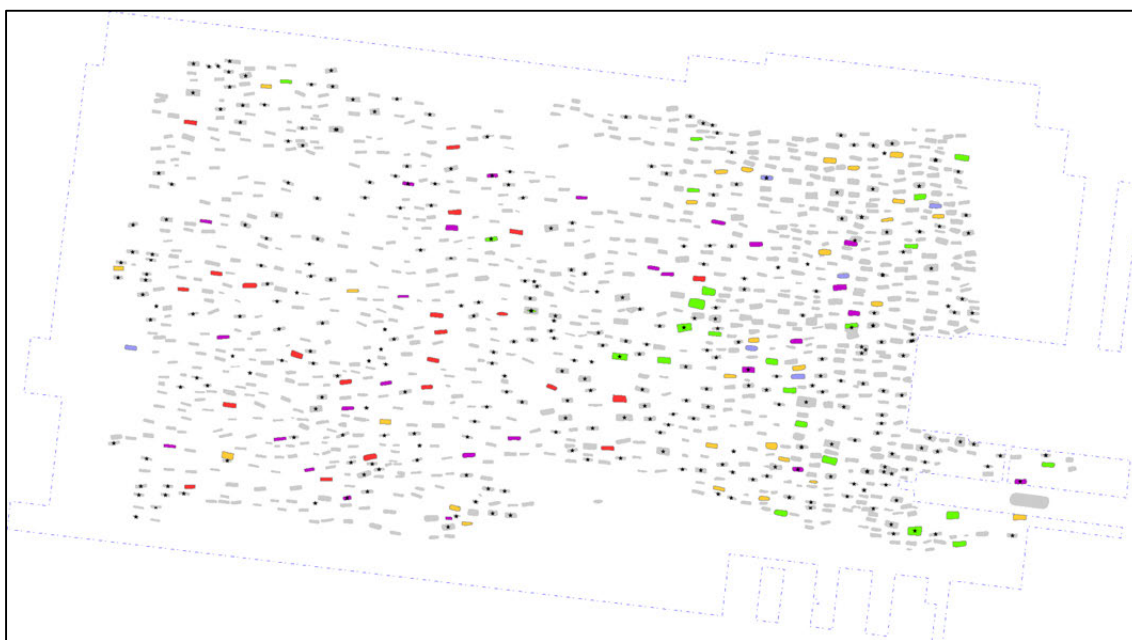


Fig. 19. Graves with longsword, seax and lance combined and additionally containing a shield are marked green. Stars show disturbed graves.

We add shields to complete the armament (Fig. 19). The last mapping shows all relevant information (note: only graves with longswords are captured, not those containing a seax and/or a lance *without* a longsword). The order of the layers is important; when inverted, for example, the first one ("longsword=true, no other conditions) would conceal the ones with more restrictive conditions. Bearing this rule in mind, more layers could easily be added.

Usually we would expect that this mapping reflects some sort of social stratification of the warriors. But what if the graves lacking a complete set of weapons have been plundered? We simply have to add a signature for known disturbances atop (Fig. 19). It reveals no remarkable coincidence between disturbances and equipment. There is another problem: Burials from a period of 200 years are mixed, during which standards of armament have changed, so we have to differentiate by time. As mentioned above, age determination is work in progress, but – technically – it will not be a problem to implement this filter in our GIS mapping.

The mappings are based on the information exported from the project database. The xml-lists, which result from the queries, have to provide distinct values like "longsword=true", "lance=true" etc. for every grave number. As far as the database is concerned, the query "longsword[and]lance=true" is not required. These combined queries can be performed directly within the GIS program using the attribute table. This means that the more exported data one has, the more combined mappings are possible. New lists from the database can be added at any point to the continuously growing GIS attribute table; some preparation of the data is necessary, however. Henceforth, random combinations can be tried, because it is so easy, and with some luck (or instinct) the immediate visual result may reveal spatial patterns which might never have been expected and never to be noticed by looking at pure lists. This turns the GIS into some sort of an experimental lab.

11. HEATMAP

The varying density of graves has already been discussed above. The tightly packed eastern third of the cemetery consists of seventh century burials. Interpreting patterns of occupancy, we tend to emphasize those agglomeration hotspots. We notice clusters and rows of graves; some of them can be interpreted as distinctive family's burial grounds or the expression of a warrior's allegiance. Other agglomerations may in fact have resulted from a lack of space. In any case, actually it is the *space between the graves* that defines the structure of the site. What does "empty space" in a cemetery mean? We have to think of pathways of varying importance – from narrow, winding paths to wider passageways. By closely looking, we see that many graves seem to be aligned to such pathways rather than to neighboring burials (Fig. 20). Once established, the paths define the structure of the burial ground and vice versa. Many rows of graves would not exist if not determined by paths. When time passes, new paths develop and some old ones, which are no longer used, become overgrown. And there might also have been fences giving structure, not only at the boundaries, but internal ones, too. The initial and the latter sectors of the burial ground could have been separated by a fence, hence the lack of seventh century burials in the central part of the cemetery. Considering the formation of a new upper class in the late sixth century, this could have meant more than the expansion across the original limitation: it may have been the expression of a dissociation from the past [Höke 2016b].

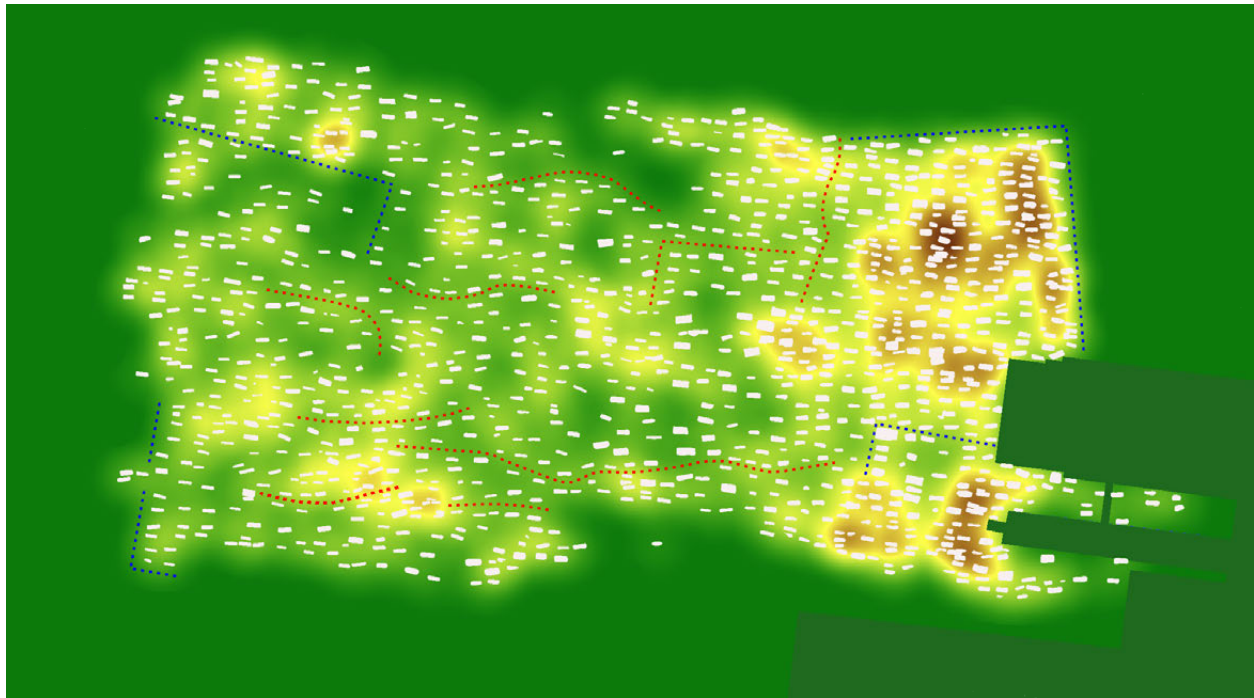


Fig. 20. Heatmap with proposed paths (red dotted lines) and possible fences (blue dotted lines).

12. CONCLUSION

It was our intention with these few examples to show that GIS mapping is not only a tool for large-scale landscape analysis but also can give all new insights into spatial structures and distribution patterns at a smaller scale. In any case, it is superior to a traditional, selective mapping of archaeological data. There are other approaches we will work on such as network analyses, which may turn out to be fundamental for understanding how the society of early medieval Lauchheim was organized.

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