WORKSHOP

Georeferencing Historical Maps

More or less 90°

Georeferencing Peter Nenning’s plan of the Benedictine Abbey of Petershausen, Konstanz, South West Germany

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Abstract: In 2002 in Petershausen quarter of Konstanz South West Germany planning permission was granted for a large new communal administrative building within the area once occupied by ancillary buildings of the Benedictine Abbey in Petershausen. An excavation was planned and in preparation, historical plan material was examined. Exceptional in this respect is the plan of Petershausen by the Austrian architect Peter Nenning dating to around 1800. The plan shows a collection of buildings varying in date from medieval to the late Baroque. The question arose as to whether the plan might be a useful and accurate historical source? Could it help us as a non-intrusive prospection tool in the forefront of the excavation and provide us preemptively with important details allowing a more targeted Excavation? The project turned into a discourse between the ordered world view of a late Baroque/Rococo architect and today’s real, considerably less rectangular topography. And with the dig that followed it was possible to test the method as a soft prospection method against the actual excavation results.

Keywords: historical plans, rectification, excavation, Konstanz.

Petershausen Abbey

The Petershausen quarter of Konstanz lies to the north, across the Rhine from the ancient town. The first archaeological findings from Petershausen originate from the Iron Age and the Roman period. Down the centuries the River Rhine had always been crossed here, on its exit from Lake Konstanz. The Abbey of Petershausen was founded by Bishop Gebhard II of Konstanz in 983. Sometime between 985 and 996 the monastery church became home to the relics of St. Gregory the Great (Pope 590–604). The monastery church, which will feature importantly in this short project description, therefore retained its dedication to St Gregory, though the Abbey itself was named St Peter’s according to the medieval idea of Konstanz as “Roma Nova” or “Roma secunda” propogated by Gebhard‘s predecesssor Bishop Konrad the Great – Petershausen as “Petrus trans Rhenus”, reflecting Petri Domus in Rome (MAURER 1989: 78, 79).

Background

Today Petershausen is home to a number of important municipal buildings including the county council offices *(Landratsamt),* the Baden-Württemberg State Archaeological Museum, Konstanz police headquarters and the municipal housing offices. It was the construction of the municipal housing offices in 2005 which provoked the excavations, in the forefront of which, the work described in this paper was carried out (Fig. 1).

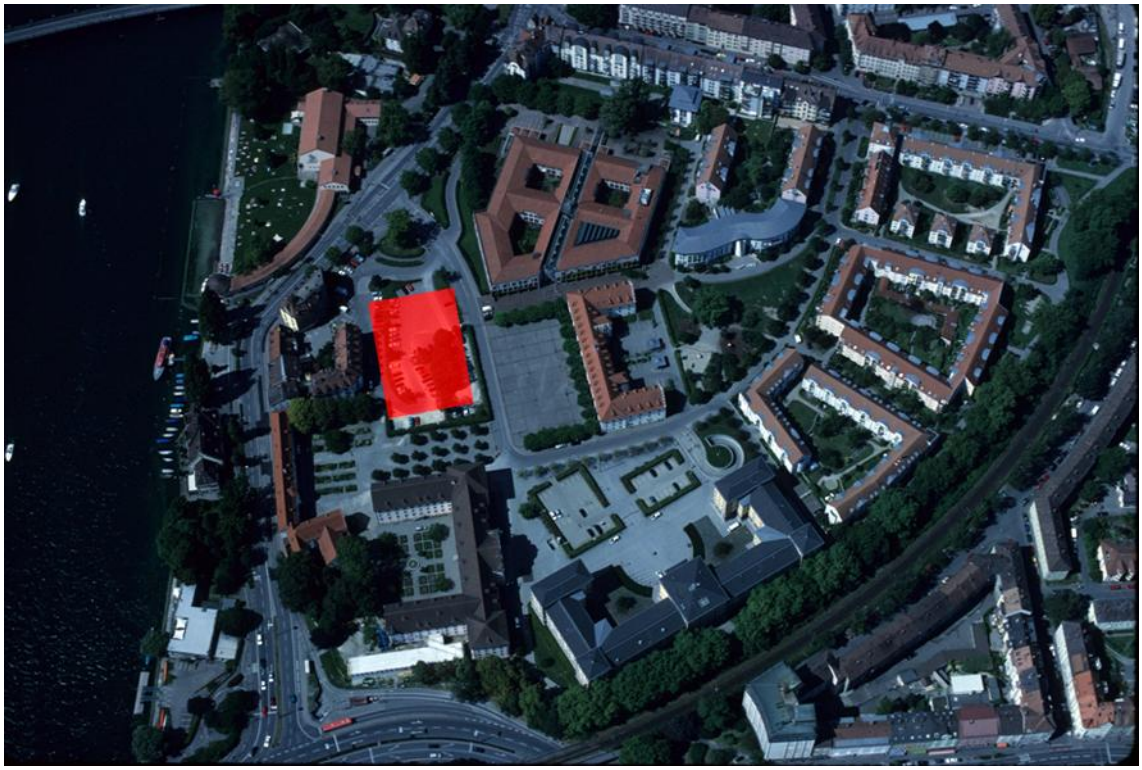

Fig. 1 – Aerial photograph of Petershausen, view direction: east. In red the planned municipal housing offices. Above to the right the county council offices. Below the State Archaeological Museum. To the right of the museum: the police headquarters.

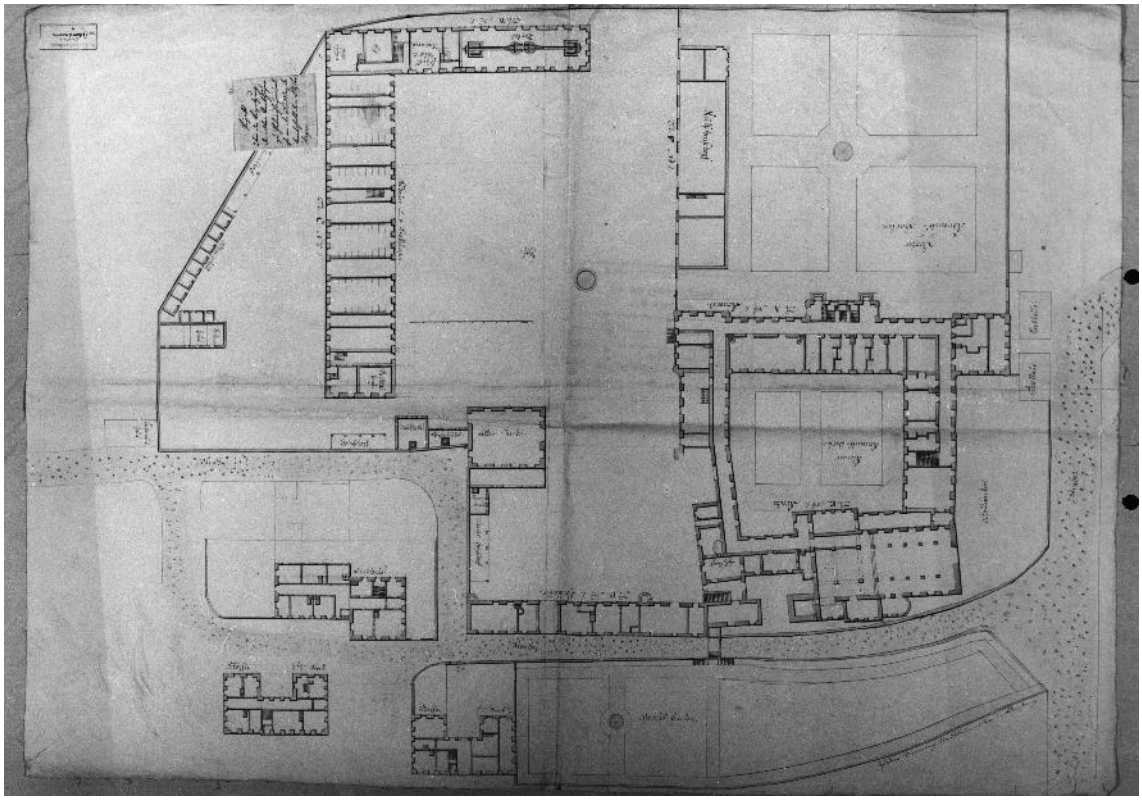

Fig. 2 – Peter Nenning's plan of Petershausen, 1800–1802 (GLA Karlsruhe, plan P5).

The Nenning Plan

For just about the whole area which was to be excavated there exists a historical plan: The “Nenning Plan” (Fig. 2). Peter Nenning (1735–1825), born in Lingenau near Bregenz in Vorarlberg, Austria, was a master builder and autodidactic architect. In the year 1789 he became, the “Master of Buildings” in the City of Konstanz and in that function, though not a surveyor, he presided over the production of the plan of Petershausen Abbey, dating to 1800–1802, as part of an inventory at the time of the Napoleonic secularization, at which time the Abbey passed from the church into the possession of the margraves of Baden. Nenning was in his late 60‘s when the plan was made. It shows a diverse collection of buildings dating from the medieval period to the late Baroque. In the area to be excavated in 2003 it shows details of buildings such as part of the stables, the coach house and the *alter Torkel* (old wine press) no longer present today.

Methodology[1]

The hope was that the Nenning plan could offer the chance for non-intrusive, pre-excavation “soft prospection”. There are enough correspondences which should make the clear identification and correct positioning of each building possible – the convent building itself, the prälatur (prelacy) and the pfisterei (bakery) serve here as examples. However, when an attempt is made to simply superimpose either the convent or the prälatur the situation becomes a little more complicated (Fig. 3). Whilst the individual buildings depicted in Nenning‘s plan are for the most part accurate, their positions relative to each other are not. Nenning, clearly following the *Zeitgeist* of his youth, positioned them in tidy, idealized right angles to each other. Therefore, although the buildings themselves are pretty exact, the Nenning Plan is not an accurate topographical representation of Petershausen Abbey around 1800.

Fig. 3 – The Nenning Plan overlain on the modern Cadastre. If the convent building is put in the correct position the prälatur is wrong (left), with the prälatur in the right position the convent is wrong (right).

[1] Software employed: AutoCAD, Autodesk Map + Raster Design; Kubit PhoToPlan; Adobe Photoshop; Adobe Illustrator.

The convent building, coach house and stables recorded in the Nenning plan of the turn of the 18th and 19th centuries were then new. Much of the medieval substance – which had survived until at least around 1590 – 1600 had been replaced in the last third of the 18th century. Building work commenced in 1769 and took three years to complete, so the new parts of the Abbey were only just 30 years old when recorded by Nenning. The architect of the 18th century renewals was Subproir Franz Übelacker. Born in Meersburg on Lake Constance in 1745 he was, as well as being a monk and an architect, a scientist, an industrialist, a diplomat, an imperial librarian, a mathematician and a contemporary of Nenning's and he shared his abhorrence of angles of anything but 90°!

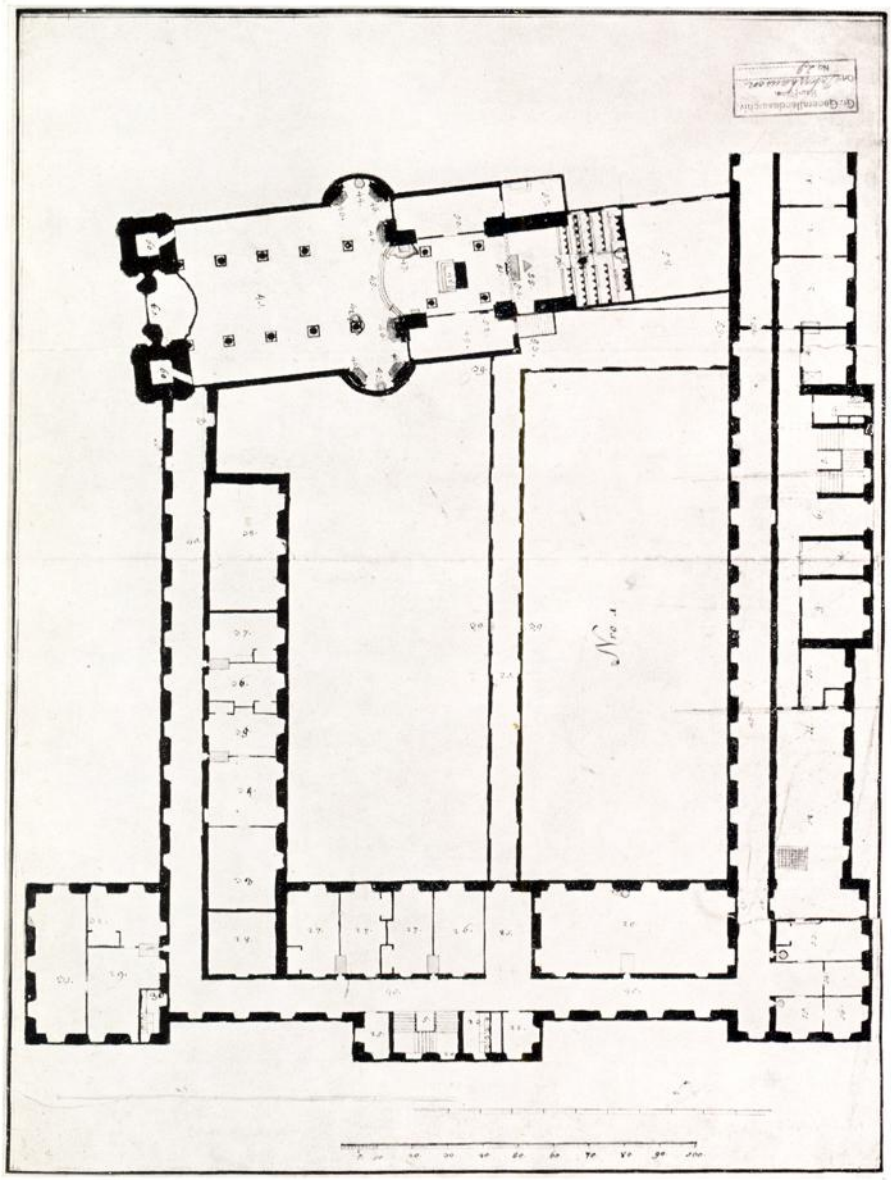

Fig. 4 – Franz Übelacker's Architect's plan for the new convent and church, 1769 (Petershausen plan 29, GLA Karlsruhe, reproduced from MOTZ 1961: Abb. 8).

Fig. 4 shows Übelacker's plan for the new 90° convent and a refitted church. The convent building itself was constructed almost exactly as shown on the plan, though the new church was never realized and the original

church remained in place until it was demolished in 1830. Even though Übelacker’s plan only shows a refurbishment of the existing church in its original position, considering his views on “irregular angles”, it is more than likely that he would have much preferred to demolish it and build one exactly perpendicular to the convent: When appraising the existing buildings prior to their demolition to make space for the new (as he called it) “properly angled” monastery, he indignantly observed that “The ancient convent was *slanting!*” – i.e. neither the church nor the prälatur nor the convent were at mutual right angles to each other or other abbey buildings. He goes on to say (rather smugly) “I pulled the flights straight when I pegged out the foundations of the new buildings, and the two angles now dissect each other” (MOTZ 1961: 40). Übelacker’s intention was to build a squared set of buildings. As we now know, despite his best intentions (and his loud proclamations) he only partially succeeded. It is only Nenning’s idealized plan of Übelackers buildings that seemingly completed Übelacker’s triumph.

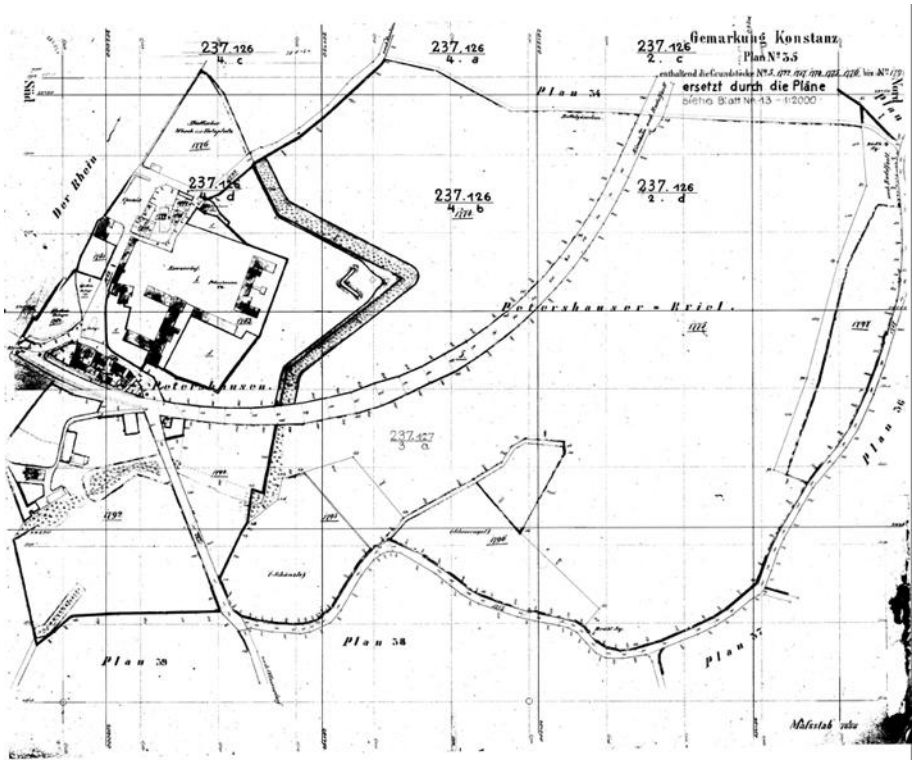

Fig. 5 – The Konstanz *Urkataster*, 1870/71.

With Nenning’s plan alone it is neither possible to ascertain the exact positions of the individual buildings, nor their spacial relationships to each other. But with the help of intermediate historical plans as “stepping stones into the past”, it is possible to extract the individual buildings from the plan and overlay them in their likely correct positions on the present day cadastral map of Konstanz. Luckily more than one stepping stone survives. In first place is the Konstanz *Urkataster* dating to 1870/71 (Fig. 5), which can be overlain onto the modern cadastre with unexpected and remarkable accuracy. And if we compare the *Urkataster* with the Nenning plan we find buildings common to both the *Urkataster* and the Nenning plan, but not present on the modern cadastral plan (Fig. 6).

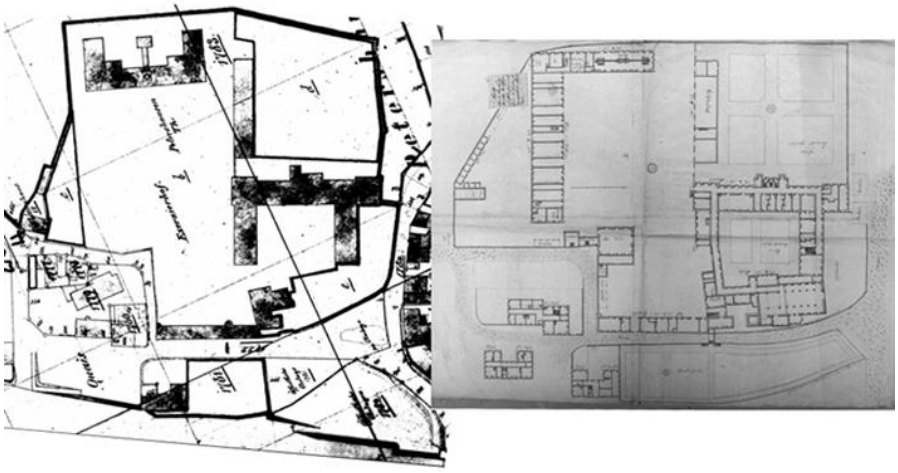

Fig. 6 – Comparison of the *Urkataster* (left) and the Nenning plan (right).

At this stage, with the help of the *Urkataster* alone it is already possible to position the coach house and the *prälatur* by simple transformation. With the coach house and *prälatur* in position it now possible to add the stables, their north wing remains standing today as the so called *„Neue Torkel"* (new wine press) and can hence be identified on today's cadastral plan (Fig. 7).

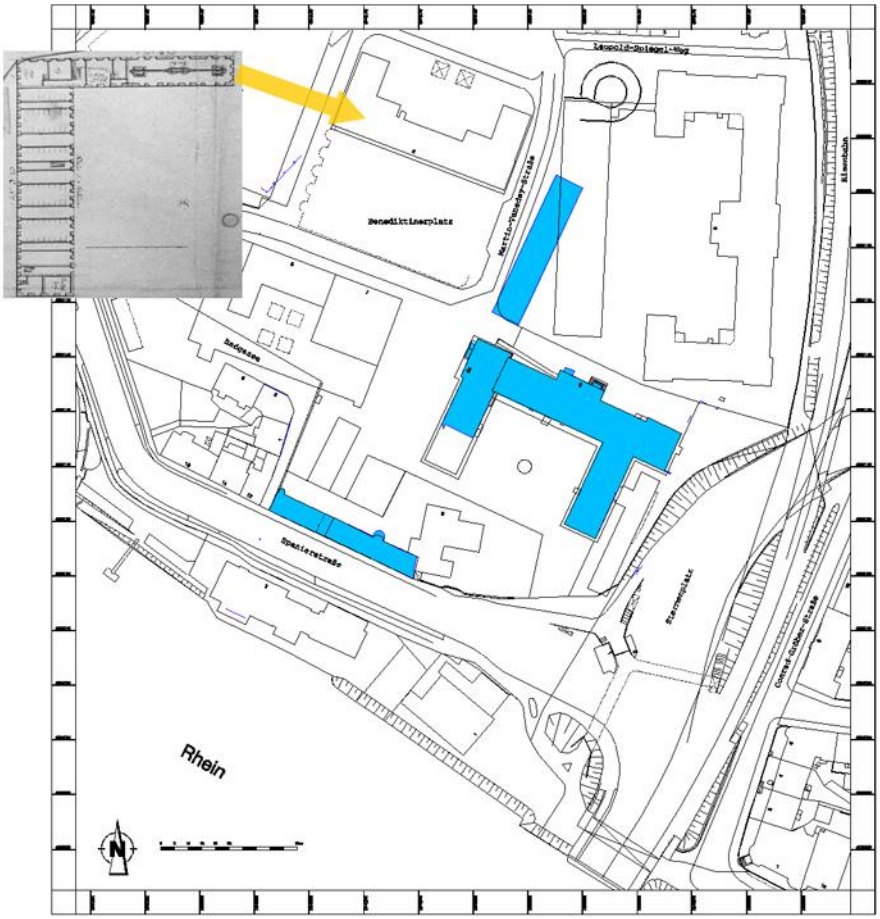

Fig. 7 – With the help of the Konstanz *Urkataster* it is possible to correctly position the convent, the *prälatur*, the stables and the coach house from Nenning's plan.

In the absence of more “stepping stones” no further progress would have been possible. Luckily the City Archive kept turning up more material – in a plan from 1832 the church has disappeared and although this plan looks more like the results of a “real geodetic survey” than Nenning’s, it is in fact quite distorted (Fig. 8). However, it does provide important information on the monastery wall. This is especially useful in the south west part of the complex, where it shows us that the corner of the monastery enclosing wall, where it runs north from the west end of the prälatur and then turns sharply to the west, is identical to the end point of the wall still standing in that position in 2003. A slight bend in the wall to the west of the corner is also identifiable.

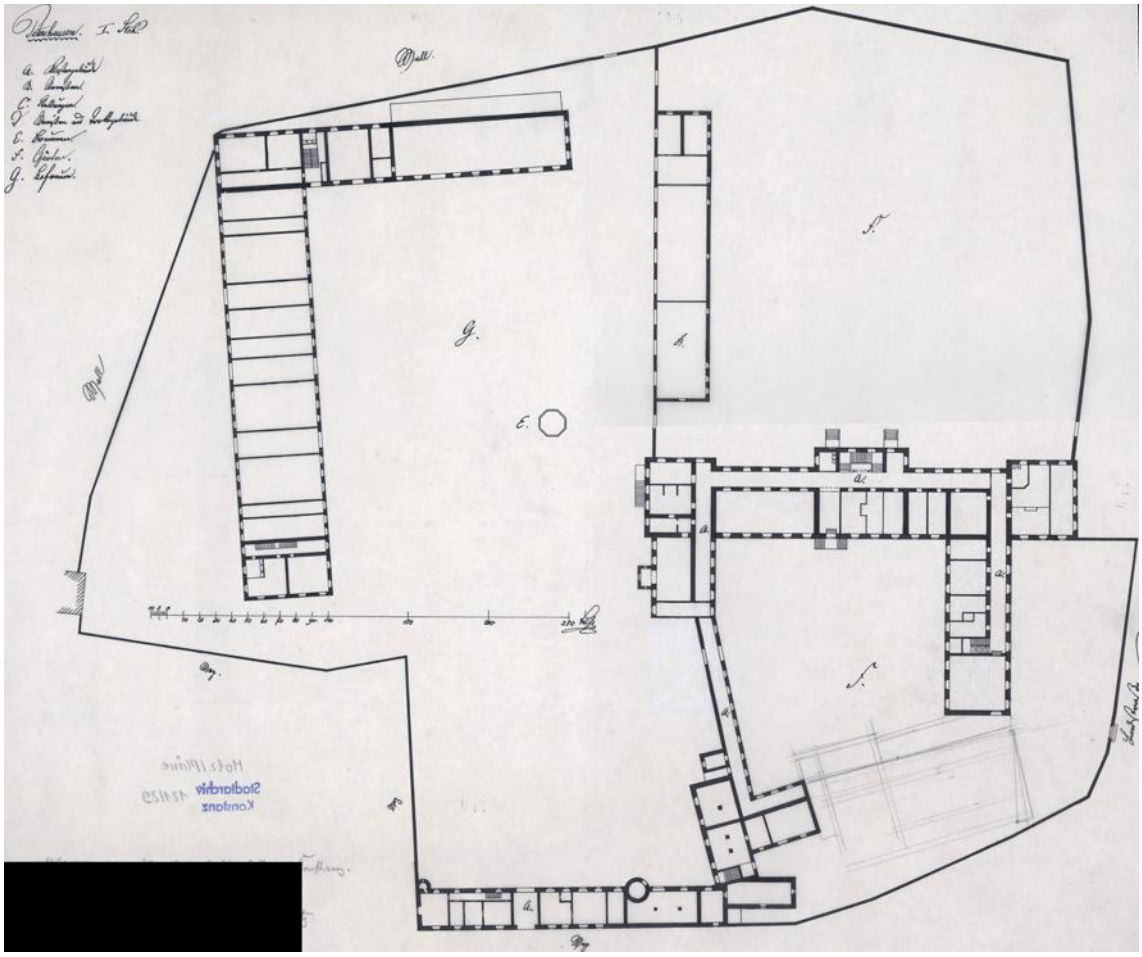

Fig. 8 – Anonymous Plan of Petershausen Abbey after 1832. Konstanz city archive, Motzpläne 121/29.

Using this information the *alte Torkel* can be brought into position, its northwest corner being identical with the end of the wall. With the *alte Torkel* in position, its corners help to position the wash house and the kitchen (Fig. 9). And so the Plan grows. A comparison of this section of the rectified plan with the foundations uncovered by the excavation shows the level of accuracy attained by this soft prospection-method in this case.

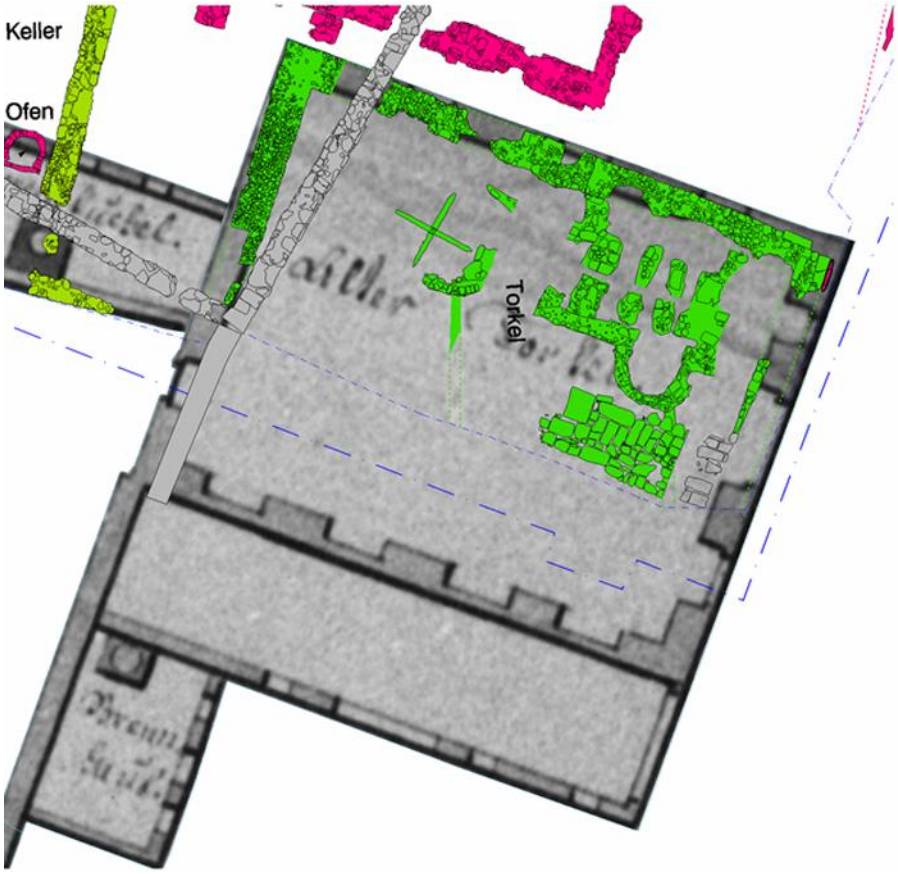

Fig. 9 – The rectified position of the *alte Torkel* compared with the excavated features – including the cross shaped foundation of a wine press.

The most difficult part of the project was the positioning of the monastery church. Jammed in as it was, trapped and slanting, between the convent building to the north and roads to the west and north east. In reality it lay at much more of an angle than Nenning desired. A sketch from 1825, shortly before its demolition, clearly shows the angle at which the church stood (Fig. 10).

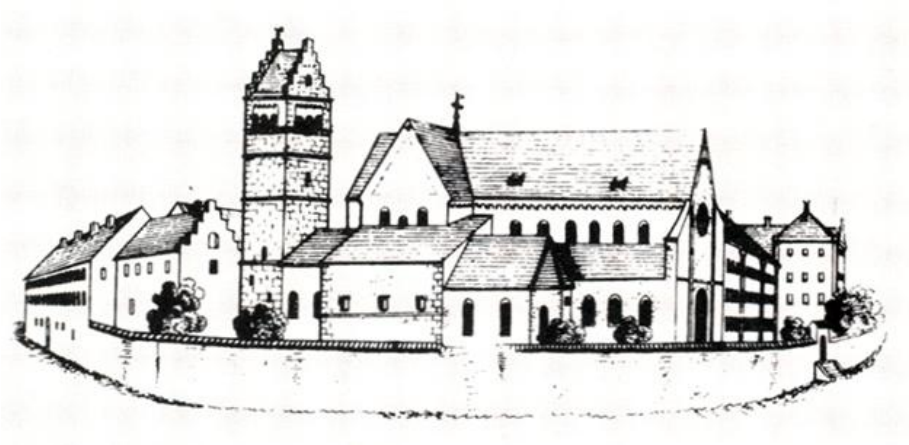

Fig. 10 – Petershausen Abbey 1825 (SCHREIBER 1825).

Nenning’s version is extremely distorted. Despite all his efforts he still could not manage to make the church stand exactly parallel to the convent building to the north, he did however succeed in making the task of rectification extremely difficult! Even so, some clues can be found. Firstly the *pfisterei*, well preserved both inside and out, is still present today and well documented in five different plans (Fig. 11). But, using the plans alone, it isn‘t easy to decide which rooms have survived intact and which corridors have been truncated. What can actually be used as the basis for the positioning of the west end of the church? A combination of a careful comparison of all the variations and a new tachymetric survey carried out especially for this project lead to a successful positioning of the building.

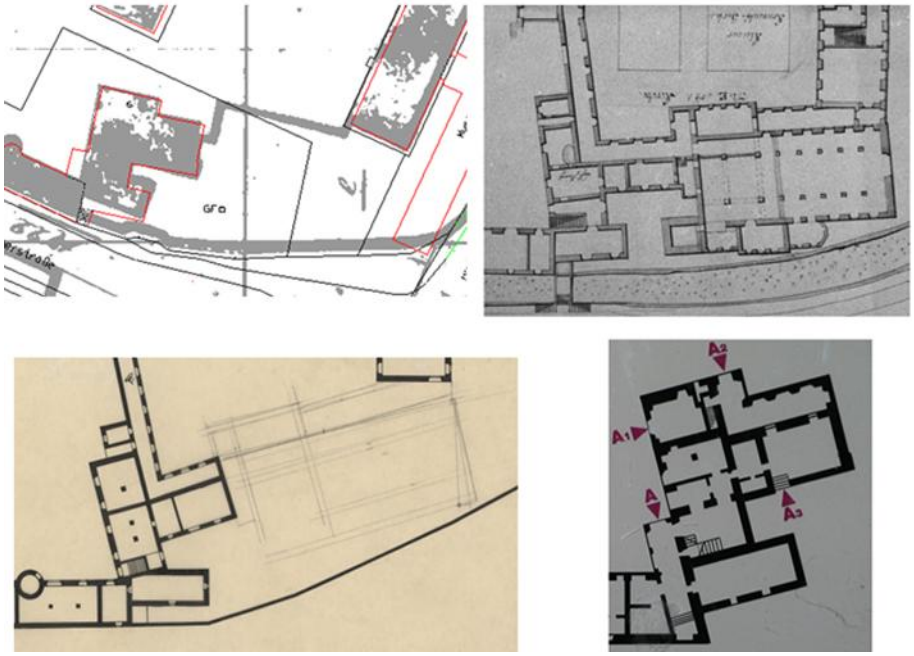

Fig. 11 – Five plans of the *Pfisterei.* Clockwise from top left: modern cadaster and Urkataster; Nenning; modern ground plan, ground floor; 1832.

In the east the situation is somewhat better. During excavations in 1998/99 part of the foundations of the east gable of the church were uncovered. Using these, it was also finally possible to georeference wall-fragments uncovered during the excavations in 1937 directed by Friedrich Garscha from the Baden State Museum. In actual fact he only dug two narrow trenches and tried to (wrongly) reconstruct the ground plan of the whole church as trapezoid. These excavations could also be correctly georeferenced. The georeferenced excavation findings provide an exact position for the east end of the church (Fig. 12).

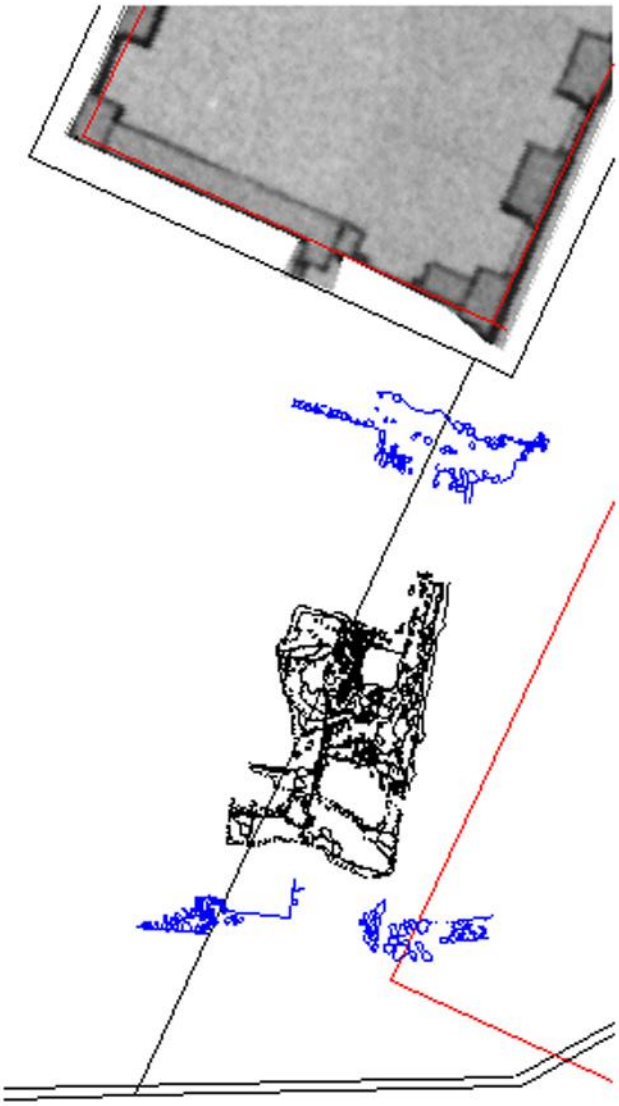

Fig. 12 – Excavation findings 1937 and 1998/99 showing the exact west end of the Abbey Church.

More information on the position of the church could be gleaned from the rather beautiful plan of the Konstanz shoreline surveyed in 1826/27 by the “Official Surveyor and Chief Inspector of Roads” Ignaz Rudolf Dekkert in the forefront of new shoreline revetments and harbor walls (Fig. 13). Created some thirty years later than Nenning’s, this plan was the work of a surveyor rather than an architect. It has a high level of accuracy for the period in which it was created and any tendencies to see right angles where none are present are greatly reduced. It contains many valuable details. Although he didn‘t survey the monastery, Dekkert did record the church tower, two years before it was demolished.

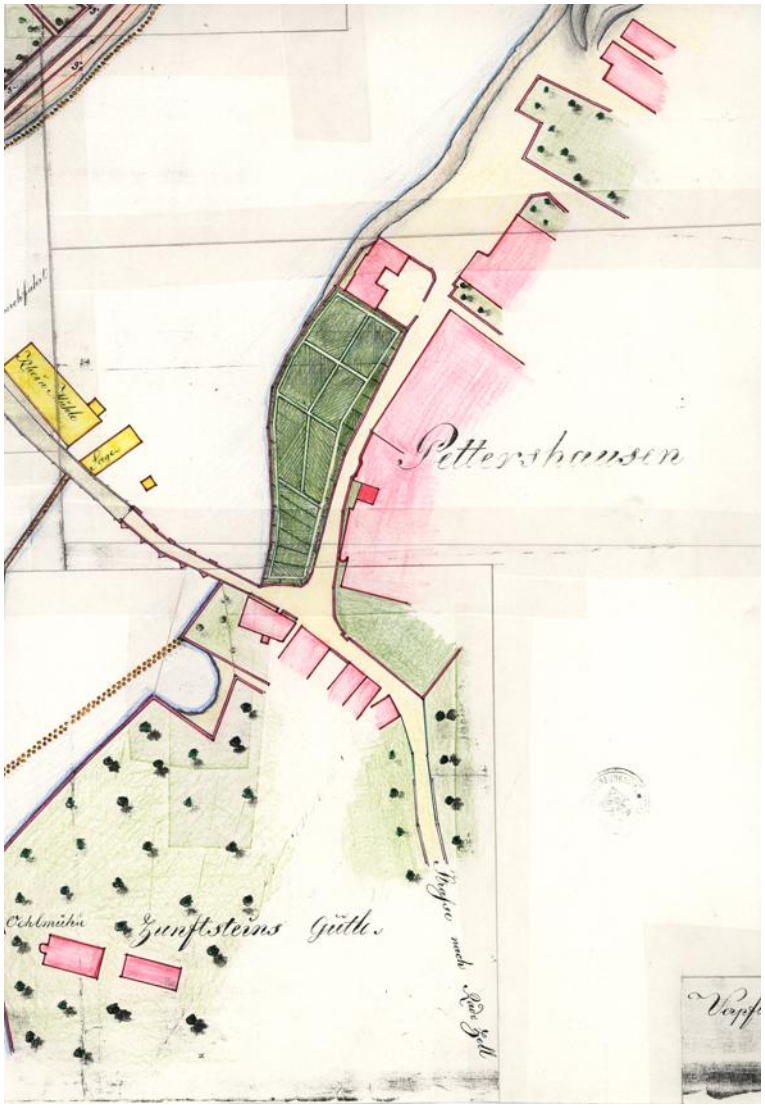

Fig. 13 – 1826/27 plan of the Konstanz shoreline by the Surveyor and Chief Inspector of Roads Ignaz Rudolf Dekkert, Petershausen sheet. Konstanz city archive Z IIa/5.

Important is the exact positional relationship of the tower to a kink in the monastery wall which is not only present on Dekkert’s plan but also on the *Urkataster* and the contemporary cadaster (Fig. 14).
By combining all these points of orientation and by reducing some parts to individual wall-flights it was possible to bring the church into a position which, on the basis of the evidence available, seems plausible (Fig. 15). Only some excavation could test the accuracy.
Comparison of the rectification with the excavation in other parts of the project also give cause for optimism (Fig. 16).

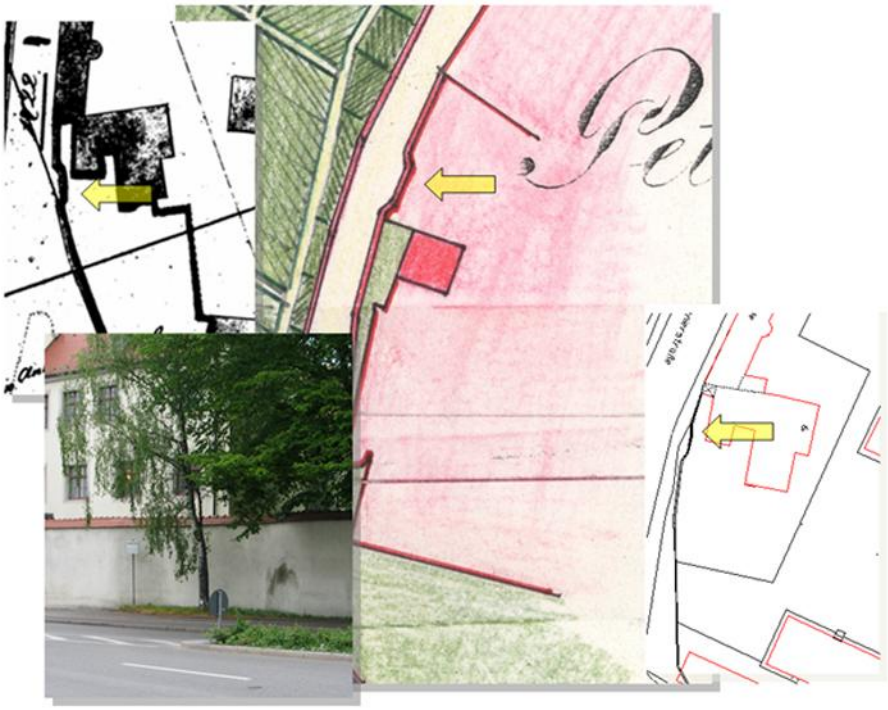

Fig. 14 – The important “kink” in the monastery wall identified on both Dekkert’s and Nenning’s plans, the *Urkataster*, the present cadaster. Bottom left a photograph as proof of its continued existence.

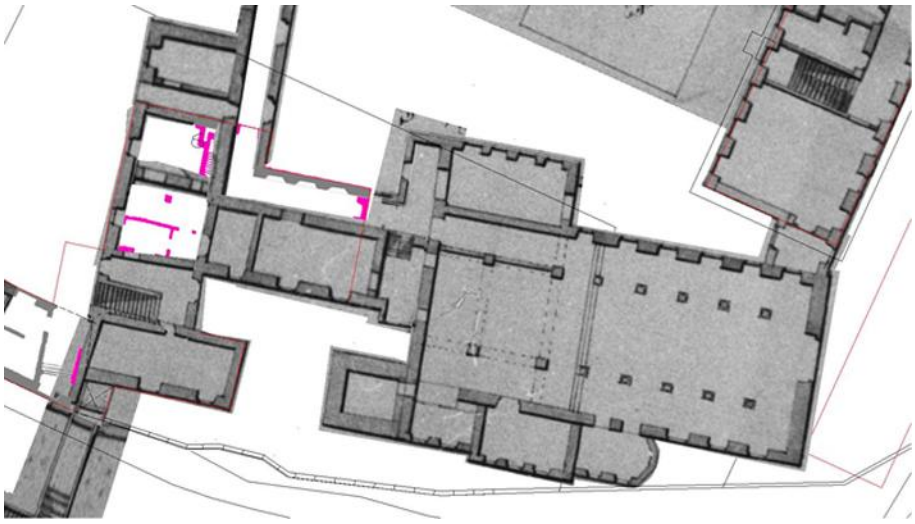

Fig. 15 – The “correct” position of the abbey church based on the evidence available.

Fig. 16 – The results of the excavation overlain with the rectified Nenning plan. Note the south wing of the stables, no longer present in 1800 when Nenning’s plan was drawn.

Summary

Such historical plans and representations hide within themselves potential to provide information on the real topographical situation of their epoch. At first sight this seems self-evident, at second sight less so. It is only with a detailed analysis of the problems involved (including an attempt to analyze the mind sets of the original perpetrators), and a reduction of the historical plan into its individual components, to be transported across historical stepping stones and “rebuilt” in their real topographical position, that the full prospection-potential of such plans can be realized. In this case the results (Fig. 17, 18, 19) were achieved by employing three such stepping stones to put the buildings in Nenning’s into their right places: the *Urkataste*r of 1870, the plan of 1832 and Dekkert’s colored plan of the Konstanz Shoreline from 1828, augmented by excavation and tachymetric surveys.

It would be gratifying to think of this work as only the first stage of a larger project, which would in a next step attempt a rectification of the renaissance or even medieval Monastery. In the meantime, it has now become clear that the Abbey of Petershausen at the turn of the 18th and 19th centuries is much better represented by David Alois Schmidt’s aquarelle of Petershausen seen from the cathedral tower in Konstanz (Fig. 20), in which we can recognise almost all the buildings discussed in this paper, than by Nenning’s tidy right angled plan.

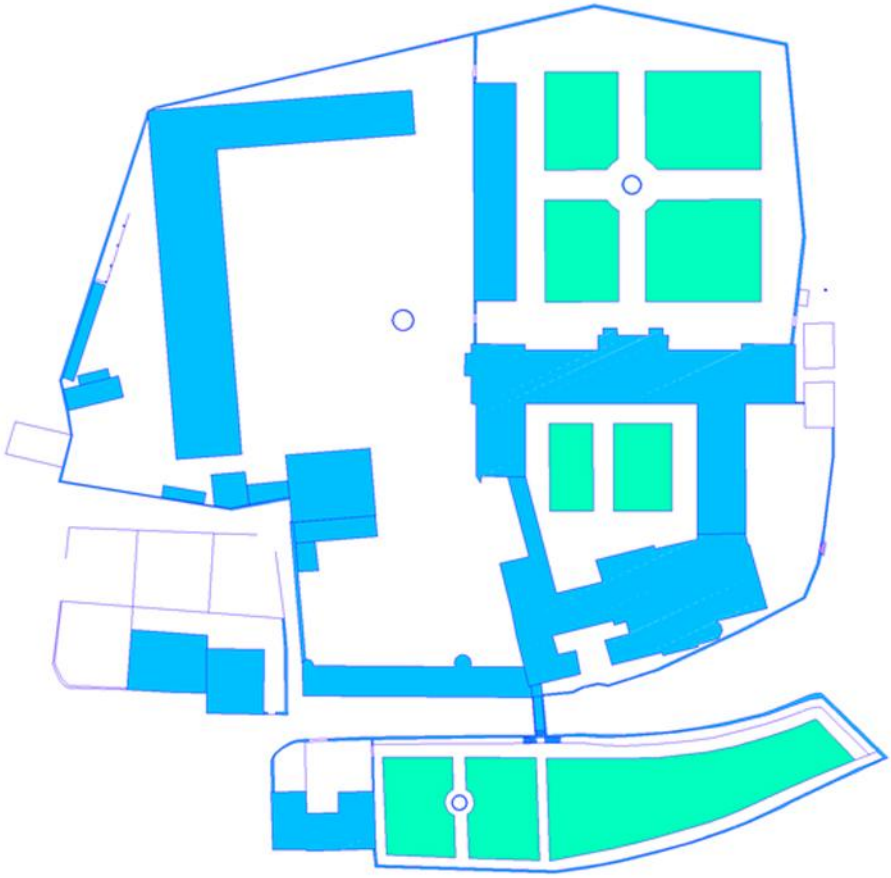

Fig. 17 – The final results of the rectification of the Nenning plan of Petershausen Abbey. The ground plan as it might really have been.

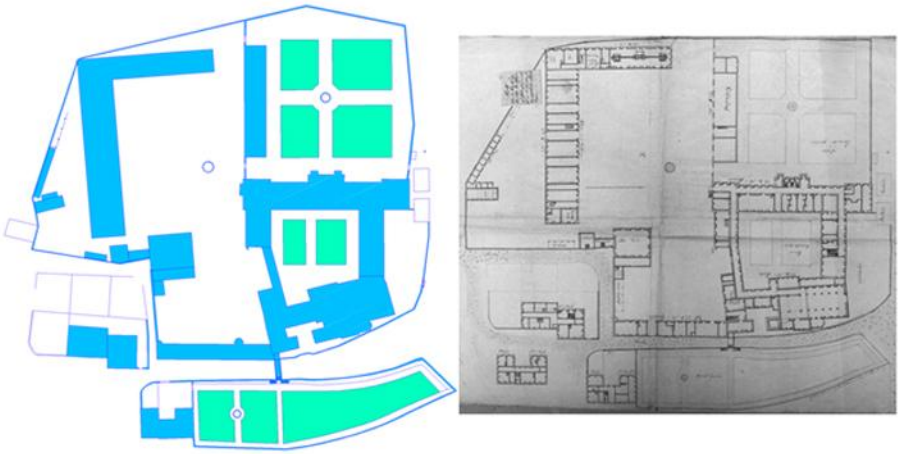

Fig. 18 – Comparison of the rectification and the Nenning plan. Convent building at the same scale and the same orientation in both cases.

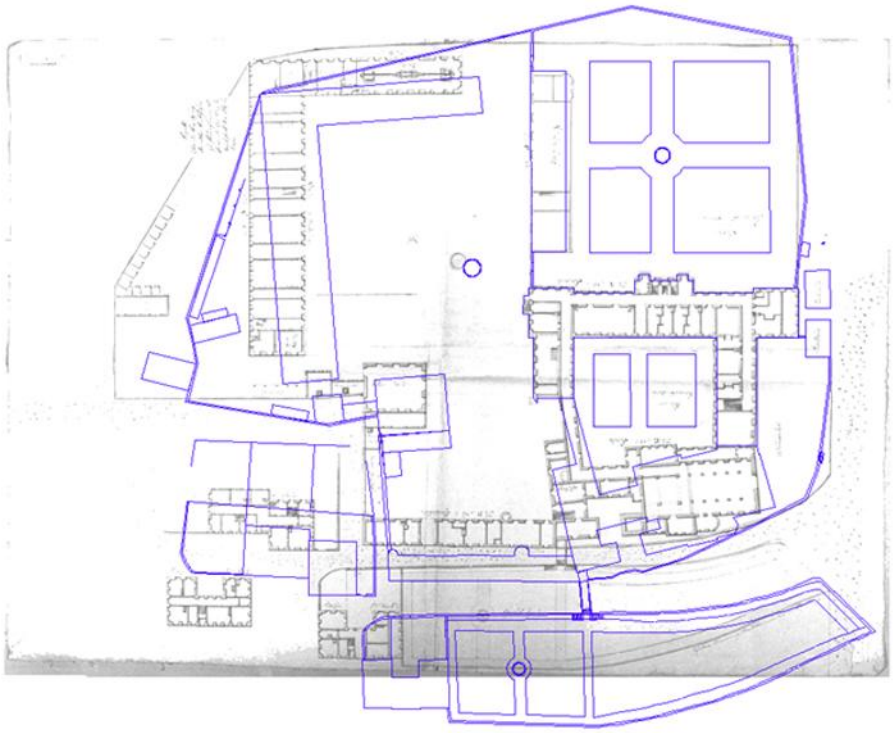

Fig. 19 – The Nenning plan overlain with results of the rectification. Convent building at the same scale and the same orientation in both cases.

Fig. 20 – Aquarelle of Petershausen Abbey by David Alois Schmidt, 1830 (Rosgartenmuseum Konstanz).

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Now you see it, now you don’t

Integrating remote-sensing data with historical data in changing environments

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Abstract: Few landscapes change more rapid than the marine. Sandbanks, channels and even complete coastlines can change dramatically overnight. This is a threat not only for modern mariners, our seafaring forefathers knew this problem also all too well. With modern techniques we can monitor these changes and adapt our maps on a regular basis. These techniques not only provide saver shipping, they can also be used to find the wreck of unfortunate former mariners. How can this method be used to predict where wrecks can be found. And, if a wreck is found, is it possible to preserve it?
In order to get a full picture of possible wreck sites, we need to know what the underwater landscape was in various periods, and how it has changed over time.
Historic Cartographical analysis can give and insight in the use and sometimes in the morphology of former landscapes. The problem with this is that it only provides qualitative information; i.e. descriptive data (map legends, interpretations, names or remarks). Modern remote-sensing devices give purely quantitative data. In order to model changes in landscape overtime, the historical qualitative data should be in some way ‘quantified’ to make calculations possible. If the historical records provide quantitative data as well, they should somehow be extrapolated to be comparable with modern high resolution data. This ‘quantifying’ of data can also be used for modern qualitative maps, such as soil type maps or land use maps.
This way historical data can be integrated with modern remote-sensing and survey techniques.

Keywords: Data integration, data analysis, applied historic cartography in GIS.

Introduction

The Dutch marine landscape is a very dynamic landscape. Most people see the short-term changes, as shifting sandbanks, channels or even changing coastlines due to storms or foods. But the North Sea is more than just water; the appearance of the whole of the North Sea basin has changed often and dramatically since mankind first roamed this area. This means that the relationship with man and this environment has been complex and, in archaeological terms, very divers.
Up onto the end of the last ice-age, about 10000 years ago, most of the area we now know as The North Sea was a low lying tundra landscape. The coastline was formed by the massive Shetland Hills in the northwest, and the Norwegian Trench in the north. There was a hill massif in the central region, northwest of the present day Holland: the Dogger Hills. These hills functioned as a watershed for the rivers flowing north (nowadays the German Elbe-Weser rivers and the English Dee-Tweed-Ouse drainage) and those flowing south via the present English Channel (the Rhine-Meuse-Scheldt basin and the river Thames).

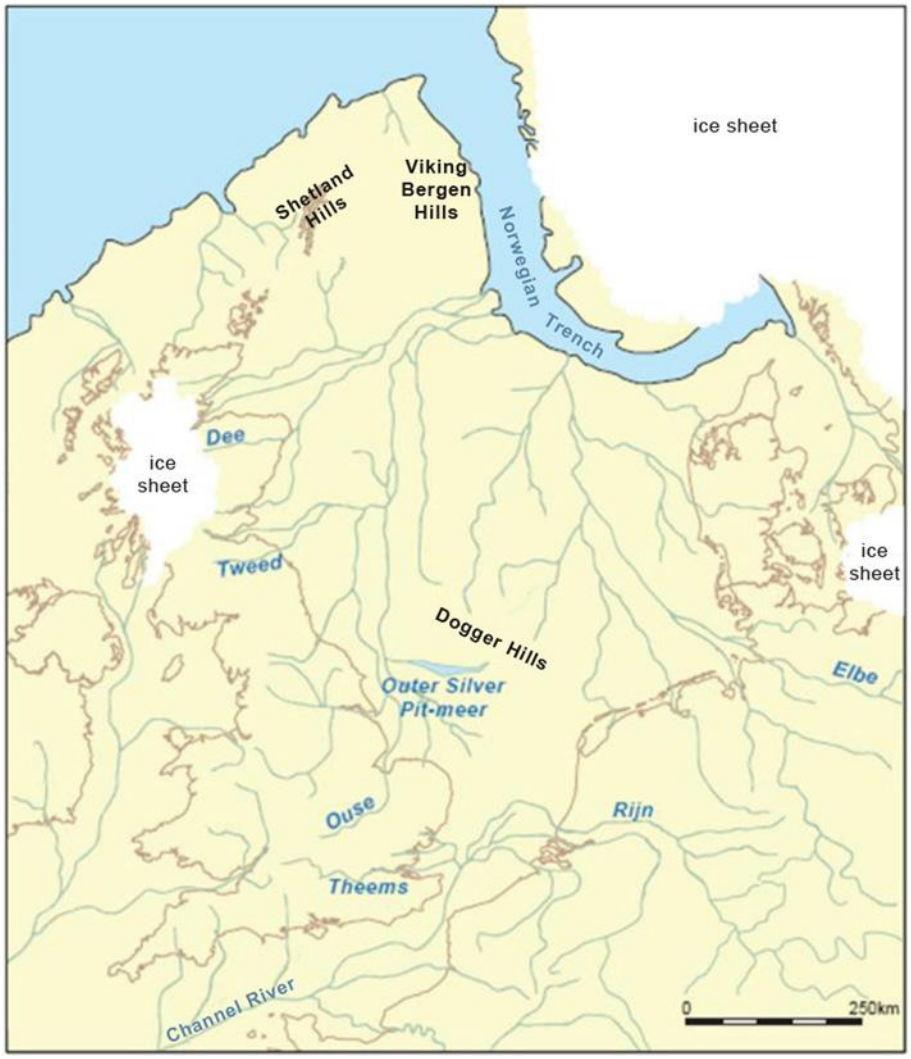

Fig. 1 – The prehistoric North Sea landscape. The brown lines depict the present coastlines (after GAFFNEY et al. 2009).

This landmass was populated with large animals a mammoth and deer, who acted as a magnet to the hunter-gatherers that followed them around. Often modern fishermen find traces of these animals and the pursuers in their nets, varying from animal bones and teeth to prehistoric weapons and tools.

When the icecaps melted and the sea took possession of these lands, the North Sea was formed. But this was not the North Sea as we know it today; the low lying river basins of the Netherlands and Norfolk, Suffolk and Essex were formed by an interaction between erosion and sedimentation from both sea as rivers.

Over time the relationship between humans and this new environment changed as well; from early over-sea transport to land reclamation and modern shipping, traces of different human activities can be found buried in the shifting sands of the North Sea.

This obviously rich archaeological treasury needs as much attention, and possible protection, as the known dry-land archaeological sites. The problem in a marine environment, though, is that where you find archaeology it is exposed to the elements. This leads to rapid deterioration, mechanical (currents, grating and sanding), biological (bacteria and the dreaded ship-worm *Teredo Navalis*), chemical (water erosion and the washing out of material) and by human activities (deep-water anchoring, drilling for oil or gas and fishing). Well protected archaeology is covered by (several meters of) sediments, and cannot be detected by

‘dry-archaeological’ methods. In this paper I will give some techniques for finding that archaeology and discuss a new method to predict threats and possibilities to this soil-archive in order to make long-term protection policies.

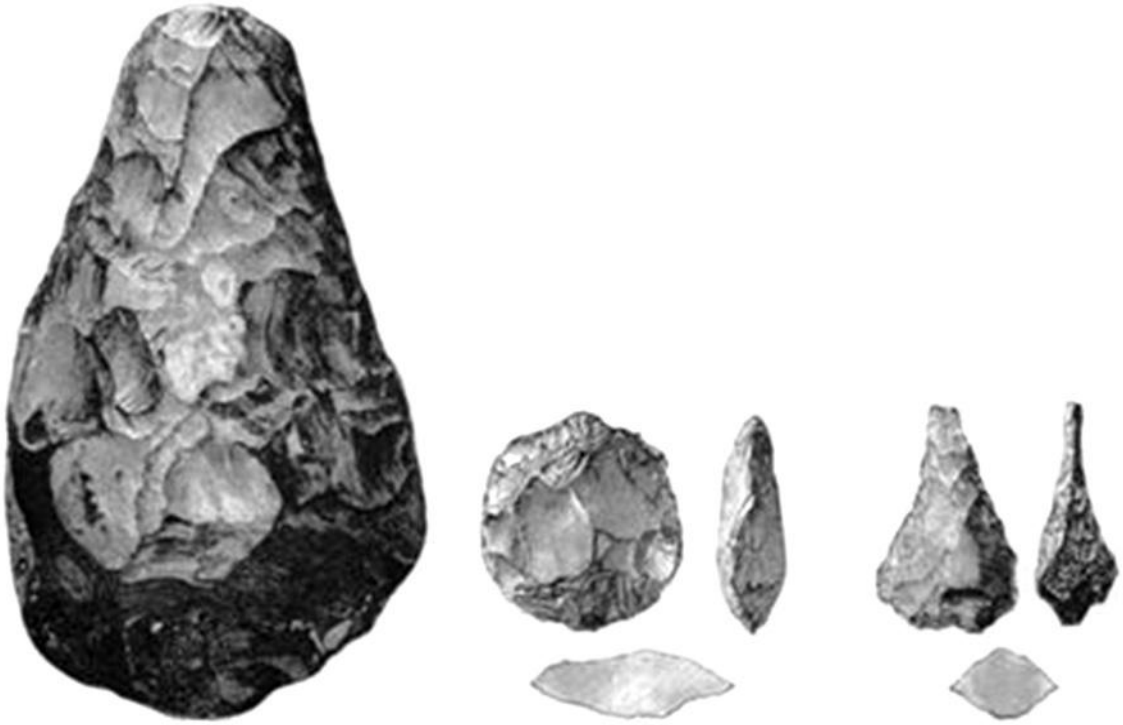

Fig. 2 – Prehistoric tools fished-up out of the North Sea (photo RCE).

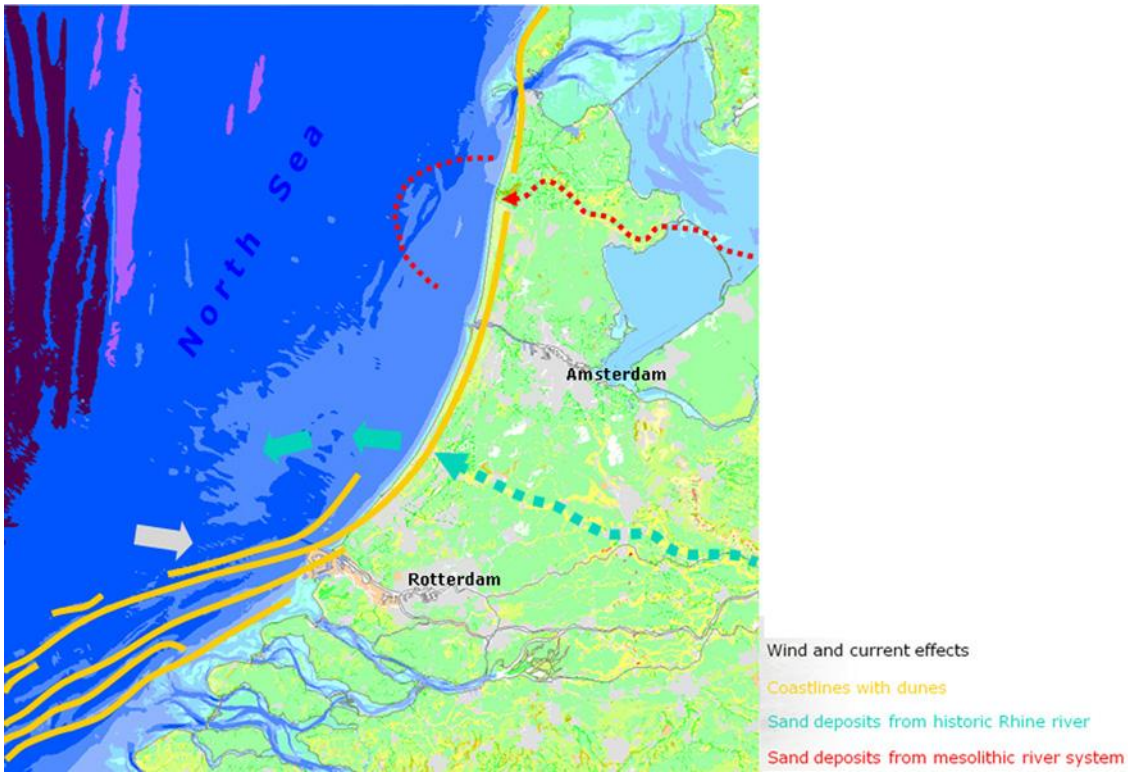

Fig. 3 – Morphology of the North Sea and Dutch coast; recognizable elements in the underwater landscape (map by M. Kosian).

Fig. 4 – The dreaded ship-worm *Teredo Navalis* (from G. Sellius, Historia Naturalis, 1733).

Surveying hidden depths

For a long time the waters of the sea were an unknown, mysterious world beyond human observation. Only with the invention of sonar (Sound Navigation and Ranging) was it possible to guesstimate what was below the waves. Before that only the plumb-line gave information on what lies below, and could only be used to give information on depth and soil condition. The change that you would find anything the size of a shipwreck was minimal, let alone finding things as small as prehistoric tools. With the evolution of the sonar techniques we now can have very sharp images of the seabed, with a resolution of less than 10 centimetres. For the first time we can actually 'see' underwater, and not just the 'blip' on the sonar-screen as popularized in films, but the actual object, with all its detail (Fig. 5).

When found, such an object can be accurately identified, and, with modern diving techniques (whether scuba or with remote operated vehicles (ROVs) studied. Also underwater cameras are of a very good quality: were Bob Ballard's first pictures of Titanic, however spectacular, rather coarse, the latest expeditions gave us pictures in full HD, despite depth and darkness.

For the seabed sonar gives a good image of the present landscape. Shoals and deep-water trenches can be mapped in great detail and with that the shifting sands can be monitored. The limitation of this survey technique is that it can only see what is the current state of marine morphology.

The nature of marine sediments is, after all, that it covers up past stages. And while sonar can give a HD image of the seabed, it can't look through. Hidden landscapes, covered up ancient riverbeds, low hills etc.

are not found. Features like that are, however, for archaeologists vital clues for understanding human interaction with their environment and therefore for predicting archaeological sites. We want to see what’s *in* the ground after all.

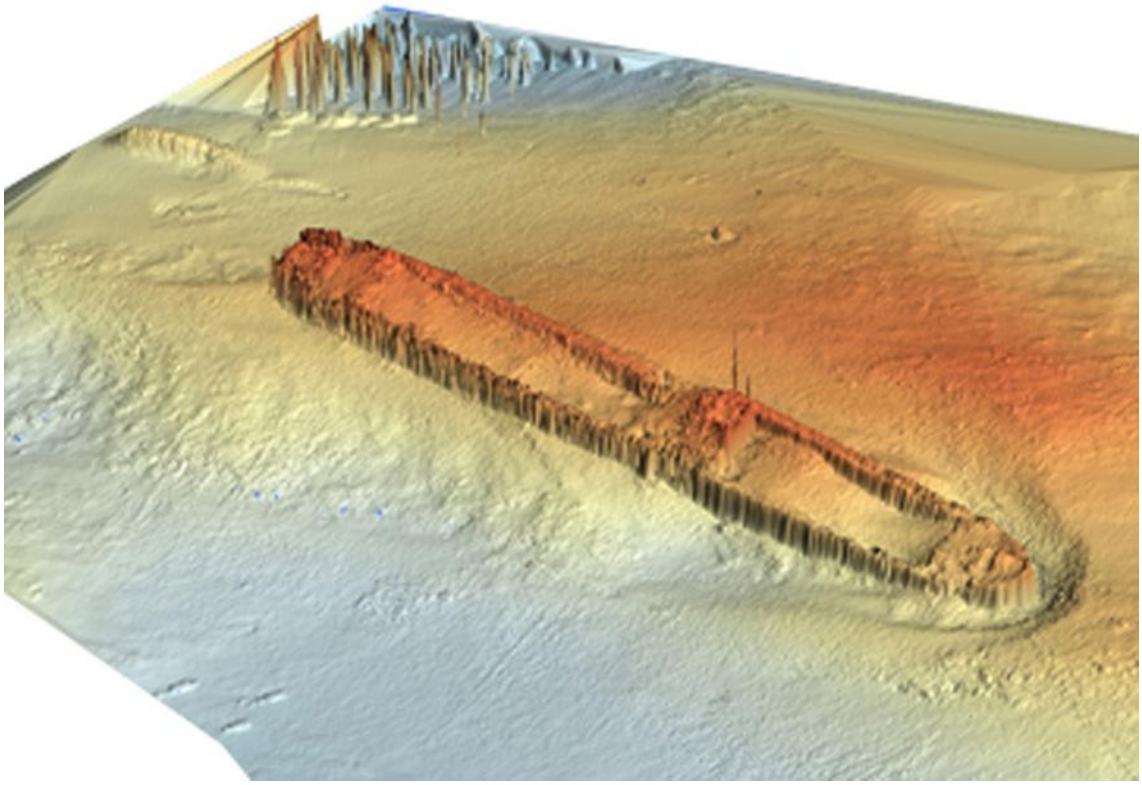

Fig. 5 – Sonar image of a sunken freighter near Wemeldinge (province of Zeeland) (image M. Kosian).

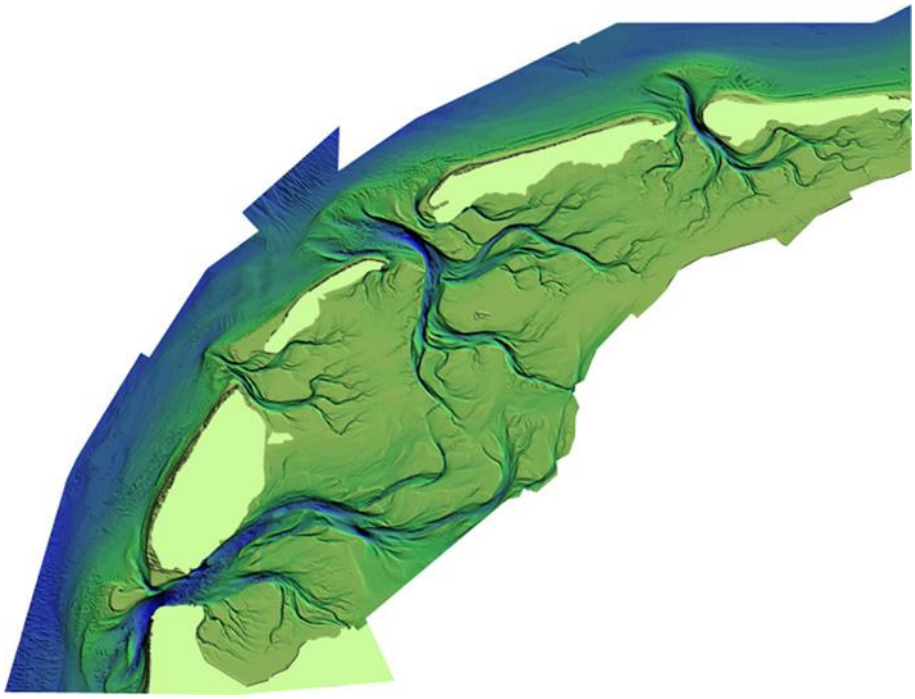

Fig. 6 – Sonar image of the marine landscape of the Dutch Wadden Sea. data 2004 (image M. Kosian).

Archaeologists are not the only ones who want to look into the ground. Geologists and especially geologists working for the oil and gas industry want it too. They have developed a method called seismic, where loud sounds are used (like explosions) to look at the sound wave reflections off rock formations. This way they can 'look' deep inside the earth to determine the several layers of rock that might contain precious minerals. These images are of the earth's structure far deeper than the archaeologically interesting layers. Recently a team of researchers from the University of Birmingham, working with these data, discovered echoes from a much shallower depth in these data. Tuning these oil-data for shallower depths they discovered the covered landscapes of the North Sea basin in all their rich variety; river dales, creeks, hills etc. Mapping these features gave a first insight of landscape the mammoth-hunting hunter-gatherers knew. This technique led to the project of mapping the so-called 'Doggerland' , the prehistoric landmass between mainland Europe and present-day United Kingdom (GAFFNEY et al. 2009).

The Dutch research institute Deltares now develops a technique where this seismic method can be used especially for shallow depth research. With that lots of until now hidden landscapes in sedimentation areas as the Wadden Sea can be discovered and mapped.

This led to the European program SPLASHCOS (Submerged Prehistoric Archaeology and Landscapes of the Continental Shelf) researching and mapping prehistoric sites and settlements in the North Sea basin.

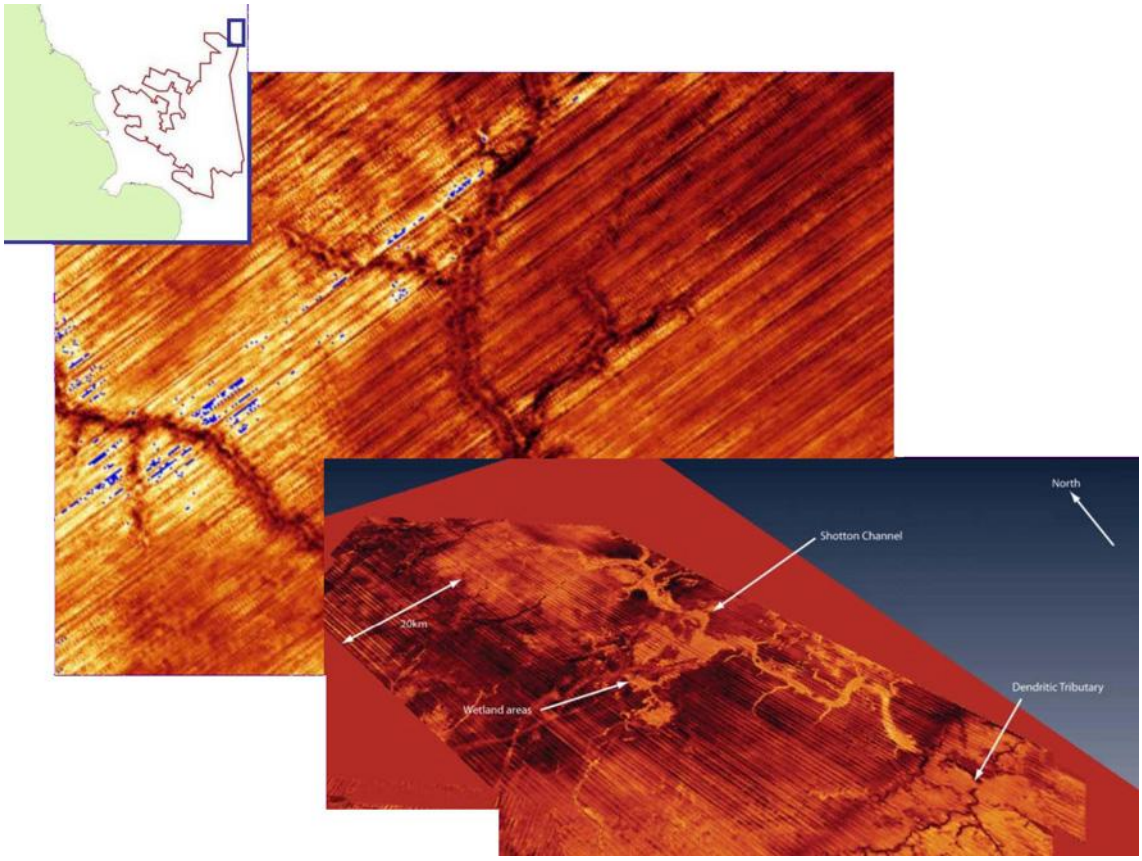

Fig. 7 – River-systems visible on seismic image (images University of Birmingham).

Fig. 8 – Mesolithic sites around the North Sea (SPLASHCOS map).

Mapping the sea-lanes

Although modern survey techniques have led to a better picture of what lurks beneath the waves, knowing the dangers of the sea was important for people ever since they first ventured out onto the seas. A lot of information about the historic marine landscape can therefore be obtained from the journals of ancient mariners. Most of the knowledge, however, was only passed down orally, from skipper to deckhand. Interviews with old fishermen for example can provide us with historical navigational knowledge (LOOMEIJER 2005; VAN OIJEN 2010), historical navigation charts give an insight in how the marine morphology has changed over the centuries.

In order to indicate the deep-water trenches to aid the seamen for a safe passage of coastal waters, the Dutch coastal waters were marked with buoys and beacons. This meant that the deep-water trenches were sounded on a regular basis. Depth sounding was done manually using a plumb-line. Data obtained from these soundings were recorded in seamen’s almanacs and early charts. Since these data were obtained manually, the data-resolution is far from modern standards. This aspect makes it hard to compare historical data with modern high-resolution data; the gaps in the old dataset are way too big to interpolate from the existing points. Luckily, the old maps give more than just data-points. Where the almanacs give just a broad range (‘the channel over here might give *n* fathom in summer at low tide’) maps also give the known contours of shoals, channels and coastlines.

Fig. 9 – Detail of the map *Tvlie ende Tmaersdiep* by Lucas Jansz. Waghenaer from 1584, depicting buoys, beacons and soundings in the Texel Roads. The deep-water trench is clearly marked by the soundings.

The first problem we encounter on using historical maritime maps is that they are seldom drawn in a modern projection system. This means that for the untrained eye a historical map might look distorted and incomparable with modern, accurate, information. The other problem is the way these maps were drawn. In a time were latitude could not be exactly pinpointed, and most navigation was done by triangulation of visible points along the shore, how could they transfer that information correctly onto a map? Let alone transfer it onto modern maps. Using GIS techniques it now is possible to compare (parts of) historical maps with modern ones. The primary technique to achieve this is by georeferencing. In georeferencing known points on a historical map are modern, known, coordinates. The more points you can correctly place (georeference) the better the map will fit the modern map. For some of the older maps you can only fit relatively small portions with the modern topography, for, since these old maps do not have a (modern) projection, the overall shape differs significantly with the modern map. To overcome this problem the fitting part of the map should then be redrawn in GIS, and the next part should be georeferenced until the whole map is redrawn in a modern projection (KOSIAN 2009). Although this is a very time consuming task, the big advantage is that you end up not only with the shape of the historical map, but, if done properly, also with a database of soundings, buoys, beacons and a legend for all the GIS-shapes drawn.

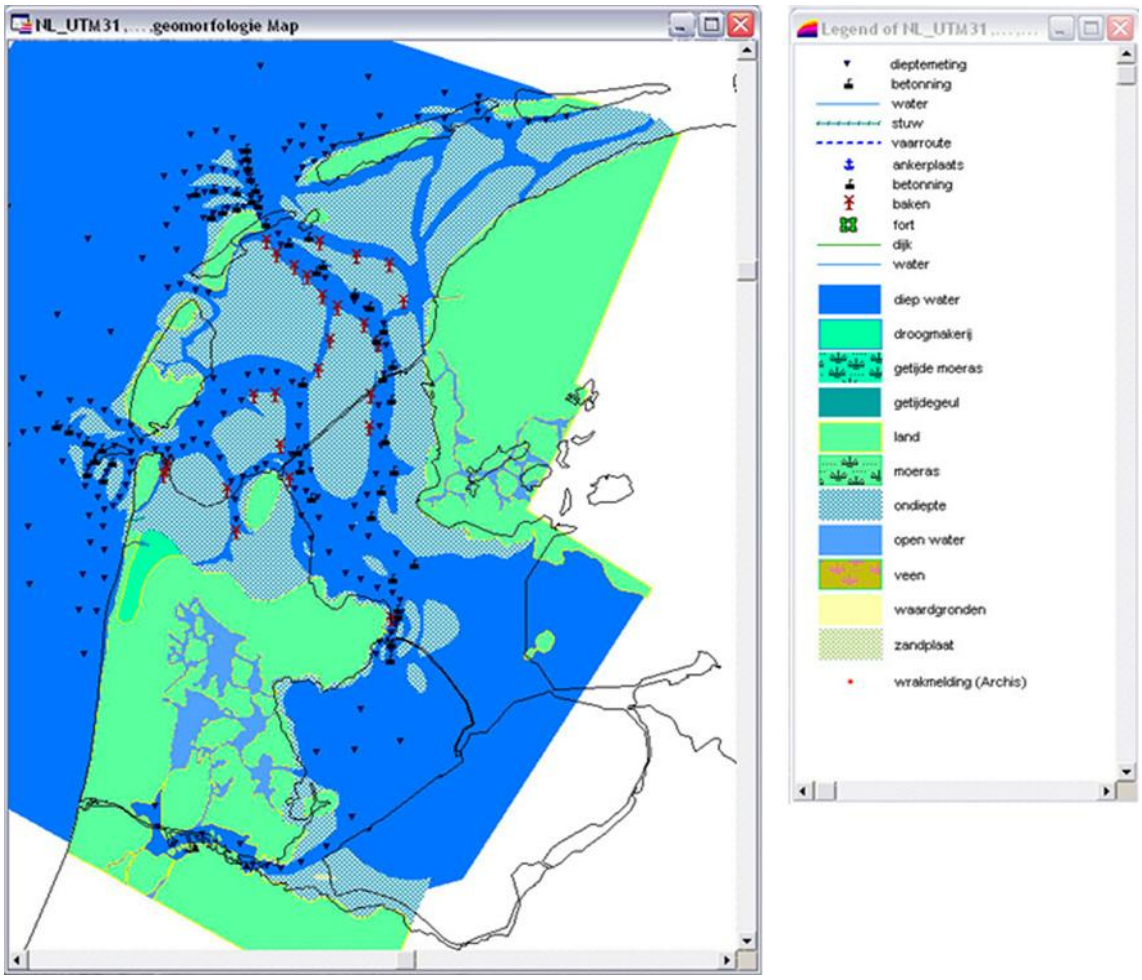

Fig. 10 – The 1584 Waghenaer map vectorised into a GIS, with all data and legend keys put into the database (map by M. Kosian).

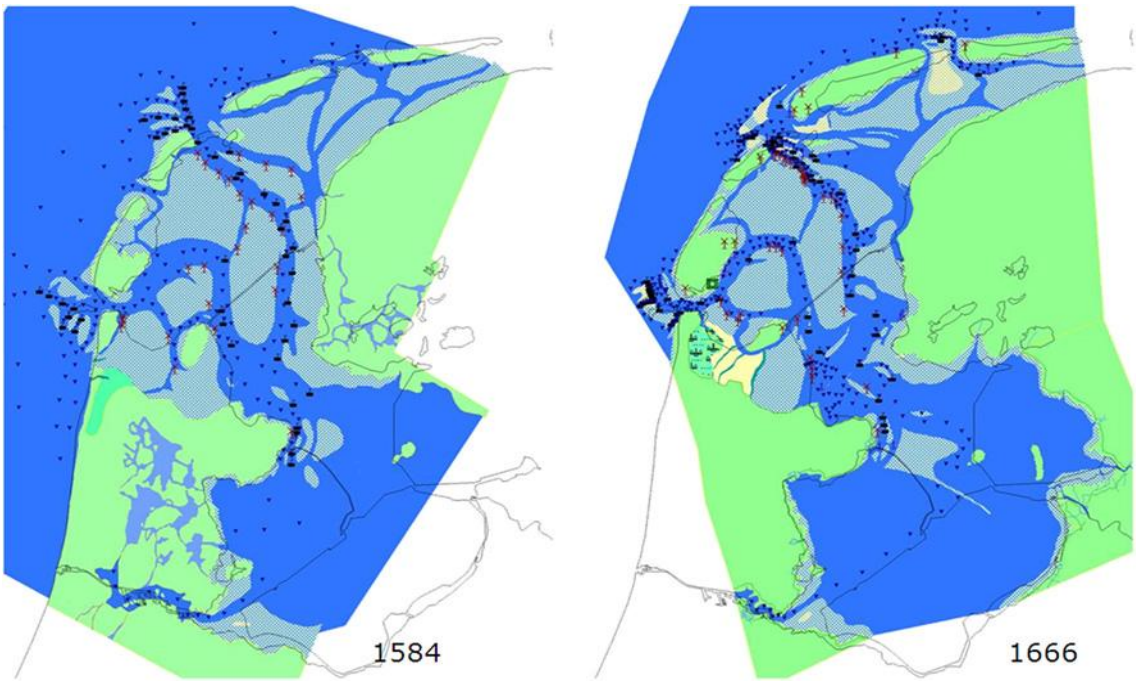

Fig. 11 – Comparison between the 1584 Waghenaer map and the 1666 map by Pieter Goos of the same area. Both put into a GIS with comparable legend (map by M. Kosian).

If you do this for several historical maps with a, preferably, fixed interval, you can not only compare one historical map with the present day situation, you can actually see the changes in as a dynamic landscape as the marine.

Now we know how the landscape changed, we can postulate how humans interacted with it, and predict archaeological sites.

Now you see it, now you don't

When archaeological remains are found on dry land, it is mostly due to anthropogenic soil disturbance; ploughing, building activities, mining, etc. With our modern knowledge we can, in several ways, predict where we 'expect' archaeology, based on soil condition, geomorphology, historical sources, stray finds etc. We can define policies on how to react with that 'to-be-found-archaeology'. In the modern age of 'Malta archaeology' there is even European legislation stating, roughly' that the 'disturber' (i.e. the property developer, mining company, etc.) is responsible for financing archaeological research.

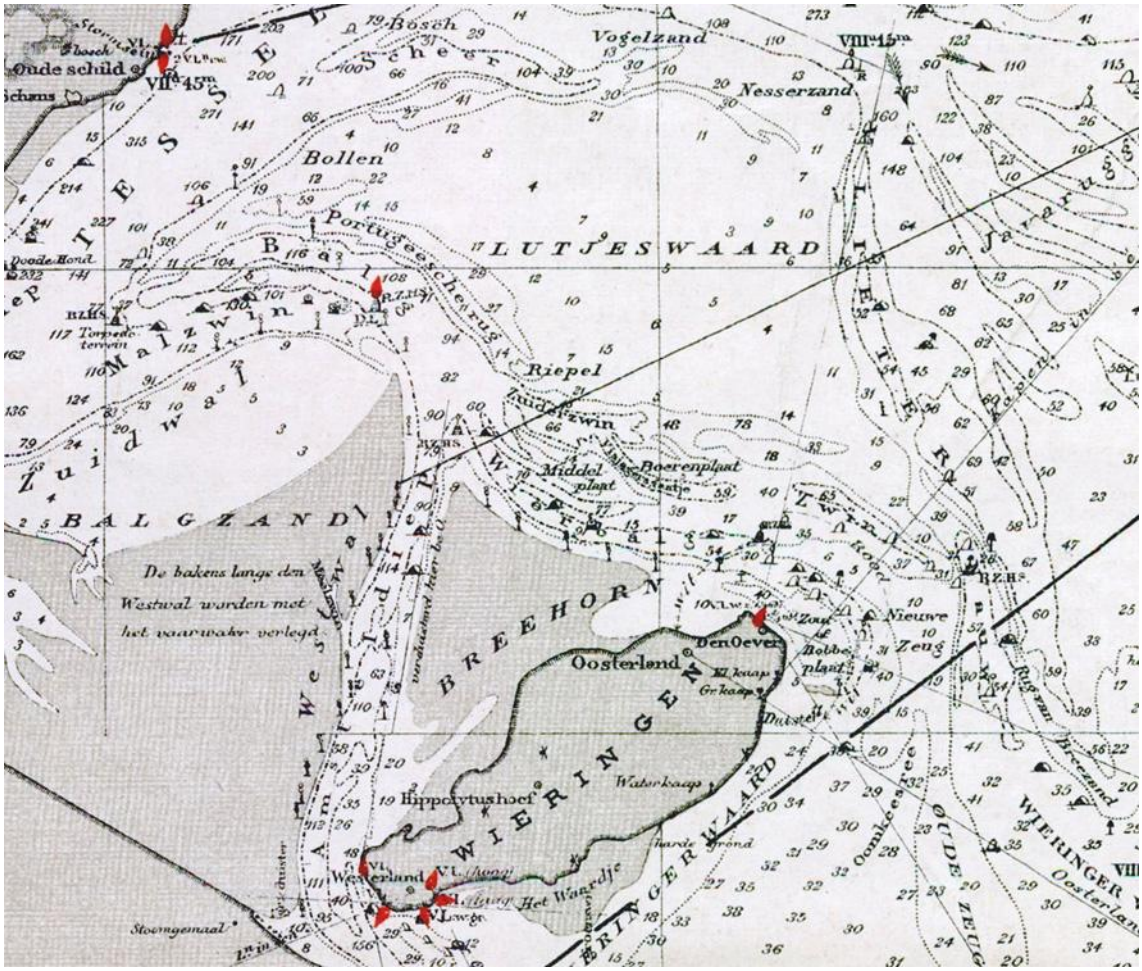

Fig. 12 – Detail of an early 20th century map of the Texel Roads. You can see clearly the number of soundings is far greater than on the Waghenaer map from 1584 (see Fig. 9).

At sea, this is far harder. For a start, finding maritime archaeology often is due to natural phenomena, like shifting sands and erosion. There is no ‘disturber’ so no finance... and due to the techniques involved it is often far more costly. Another problem is that it is hard to predict where hidden archaeology might become exposed, or even, were known archaeology might become covered up again. Of course, we now have the high definition data from sonar soundings for modern navigational maps, there is data on the behaviour of sandbanks and currents, but they ‘only’ go back to the beginning of modern sonar technology. From the end of the 19th century lead sounding was intensified in order to get better sea-charts, but that still was nothing like he modern grid resolution.

At least it was all numerical data, and therefore comparable in marine morphology models. These models are the base for modern sea-charts and research into phenomena as sand transportation along the coast, sand suppletion policies and erosion models for coastal defence. But the time span is too short to predict archaeological threats and possibilities.

At the Cultural Heritage Agency of the Netherlands we have developed a new historic-bathymetrical model. The basis for this model is formed by in GIS vectorised historical maps, going back to 1584 *(In the Netherlands we are very fortunate to have a long cartographical tradition. The oldest sea-chart used for this model is from the atlas Spiegel der Zeevaerdt by Lucas Jansz. Waghenaer first published in 1584. A very comprehensive cartobibliography of the former Zuiderzee and the Wadden Sea is WALSMIT et al. 2009)*. The depths recorded on this map were only taken in the deep-water trenches, but shoals, tidal-lands and sandbanks that stand clear of the water at low tide were charted and have their own key.

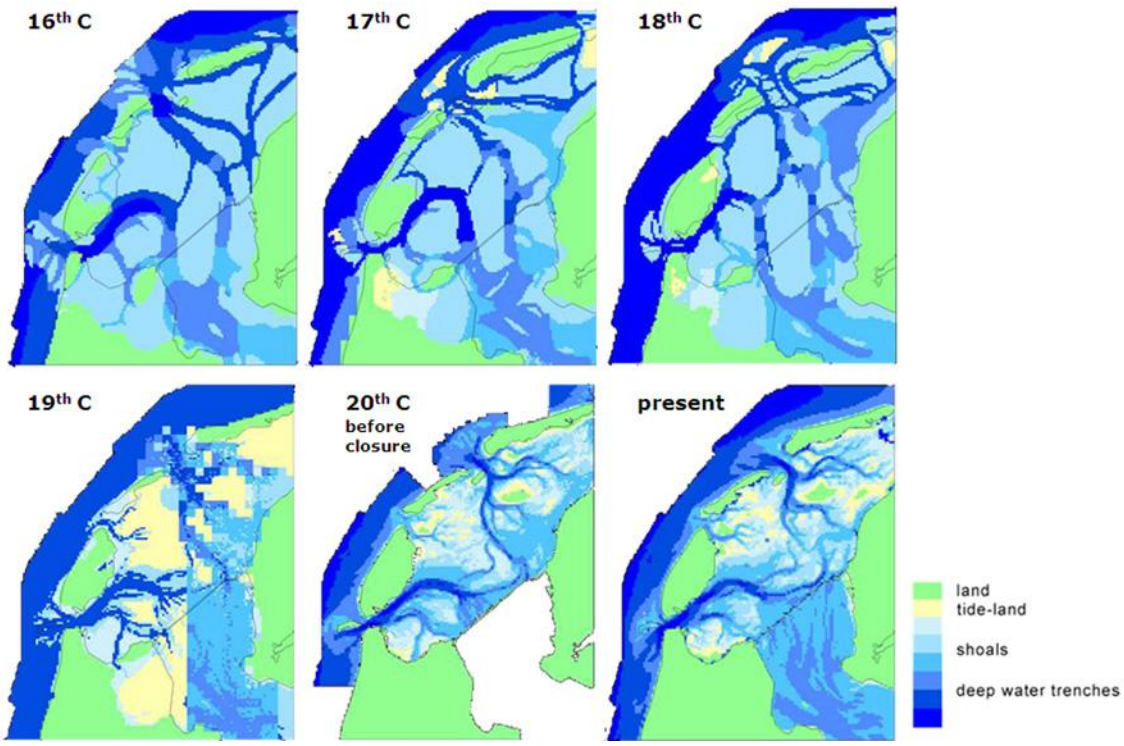

Fig. 13 – The historic-bathymetrical model depicting the changes in the marine landscape of the western Wadden Sea (map by M. Kosian).

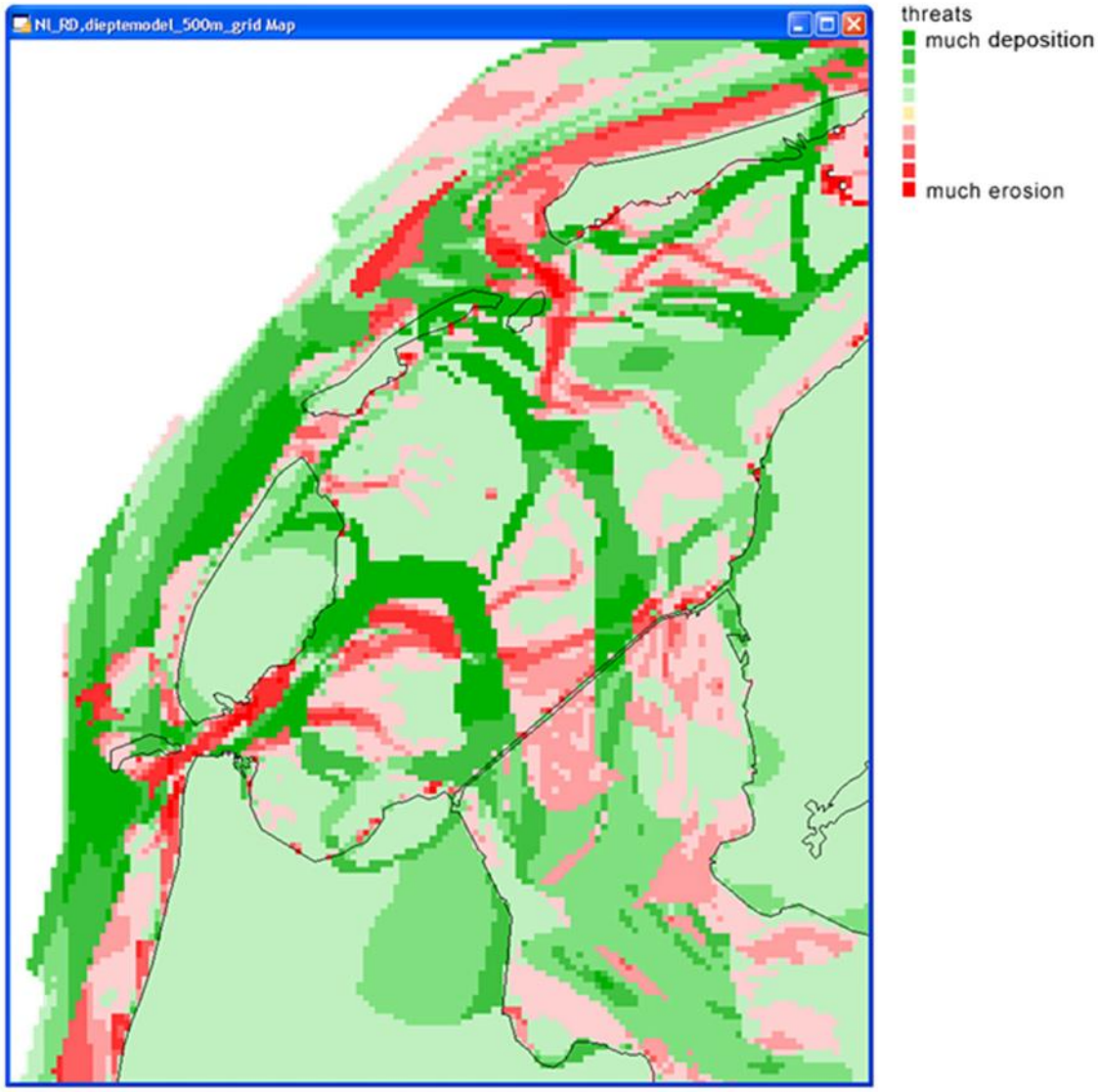

Fig. 14 – Calculated areas of erosion and suppletion from the historic-bathymetrical model. This map depicts the difference between the 17th century and the present day; green depicts the covered-up 17th century landscape (suppletion), red the eroded 17th century landscape. Archaeological finds in the red areas therefore are under threat (map by M. Kosian).

Modern navigational maps have a uniform classification: clear of the water at low tide, tidal-land, 0–2m, 2–5m, 5–10m, 10–20m and >20m. Interpreting the several different legend keys of the historical maps it was possible to come to a reasoned uniform classification. The next step was to make a vector-grid in GIS in which both numerical as interpreted data could be assigned to a grid-cell to locate this new classification. Grid-cells in sounded deep-water trenches were filled by averaging the original soundings over adjacent cells, so that the course of the trench could be followed within reasonable precision. Every historical map (we have now an interval of about 75–100 years) was added to this grid, which eventually was filled with the modern data. This way it was possible to create a model that not only give the historical development of the trenches and islands, but can also be used to calculate the degree of erosion or suppletion.

With this it is possible to say something on conservation of archaeological wreck sites from different periods: are they covered up, or, on the contrary, eroded away, have they been subjected to erosion in the past (VAN OS and KOSIAN 2011)?
This model can help in developing a new method for archaeological prediction for underwater heritage.

Conclusion

The fast changing, highly dynamic landscape of the marine gives a rich archaeology, from prehistoric hunters to East-India company shipwrecks. There are not only finds, but entire covered-up landscapes to be found. The problem, due to the for humans hostile environment, often is to find them. Modern survey-techniques have come a long way to uncover hitherto hidden treasures, but the old survey techniques are still valuable. The main ‘trick’ is to use them integrated with the modern datasets. Modern GIS techniques can be of assistance here; georeferencing make maps from different periods comparable, new ways of modelling join quantitative data like soundings with the qualitative descriptions of almanacs and chart-legends. Combining these with modern data can give a better understanding of how the marine landscapes have changed overtime, giving an insight in both human interaction with their environment (where to find archaeology), as well as in the possible state of preservation of that archaeology. This can lead to future predictive models not only on location, but on period **and** preservation as well.

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Digitizing and rectifying historical plans of Cherchel and Großkrotzenberg

Sandra RIEKE

Abstract: Based on examples from Cherchel, the antique Caesarea Mauretaniae in North Africa and Großkrotzenburg, a Roman fort with associated vicus in the German State of Hesse, the possibilities and limitations offered by the digitalization of historical plans will be discussed.
Plans and drafts in the French military archive in Vincennes were used for a composite plan containing both the antique and modern Cherchel, as well as numerous excavation drawings to be found in the Centre Camille Jullian, Université d'Aix-en-Provence, where many original excavation plans of various French excavation teams have been digitalized. In addition aerial photos of excavations, antique engravings, published illustrations and modern town maps were used. All of this material was combined into a composite overall plan.
Excavation plans from various excavation campaigns from the beginning of the 20th century up to today were used to compile an overall plan of Großkrotzenburg. Cadastral plans, town maps and published reconstructions were employed. A new cadastral plan of Roman Großkrotzenburg is planned for the near future, despite all the problems facing the correlation of such varied material.
Despite careful rectification, an accurate fit was not always possible. In some cases dimensionally unstable photocopies of excavation drawings can shake the foundations of the whole reconstruction.
How might one recognize these sources of error? How should they be treated? Should they be mentioned or silently interpolated?

Keywords: Digitalization, rectifying historical plans, combining plans.

Introduction

In order to produce a comprehensive plan of Roman sites in Cherchell we assessed a number of plans, maps, and original plans from previous excavations by various French archaeological teams, aerial photographs and publications. This rich source of documentation was then brought together in a digital map. Whilst working on this map a conscious effort was made to consider all possible options to produce an overall plan. However, problems arose with sources of error and limitations when dealing with historical maps.

Cherchell

Cherchell is an ancient coastal town on the Mediterranean Sea in Algeria. Founded in the 4th century BC the town was initially named Iol and became the capital of the ancient Kingdom of Mauretania. Iuba II renamed the town Caesarea in honor of the Roman Emperor. Since the year 40AD Caesarea had been the capital of the Roman province Mauretania Caesariensis.

Originals and Analysis

In order to gain an overview of all ancient monuments we looked at a variety of maps from the following sources: Centre de Camille Jullian in Aix-en-Provence, the military archive in Vincennes, the Museum in Cherchell, the private archives of Christa Landwehr and Philippe Leveau.

Original maps, publications and scientific literature were digitized. The digitization project was conducted through a conventional scanner and professionals such as those of the university in Aix-en-Provence. In addition we have used professional digital cameras. This formed the basis for further scientific evaluation. The aim was a general plan at a scale of 1:2.000, which reflects the area within the Roman walls. Then, contour maps were produced using AutoCAD 2010. For removing the perspective distortion of the maps PhoToPlan 5.0 was used. In the following I will explain which methods were necessary to match the historical record with the present context.

Maps from the French military from the 1840s

Important for our work is the period of the French occupation from 1830 until 1962. The French military produced a number of maps in the 1840s. These maps were used to position the individual finds. But they mostly represent the city. The reason is the original purpose of the maps. It was solely to assess the urban development and to plan the location of military buildings. The recording of ancient buildings was not of interest to the military and was therefore neglected. So, to be able to position those individual finds that are situated outside the City of 1841, an additional map was used. While recent maps may still include information on monuments, the most recent one from the 1970s proved to be unsuitable due to destroyed or damaged historical fabric following the intensive development of Cherchell during that decade. Instead, a map from the 1930s seemed to be more suitable.

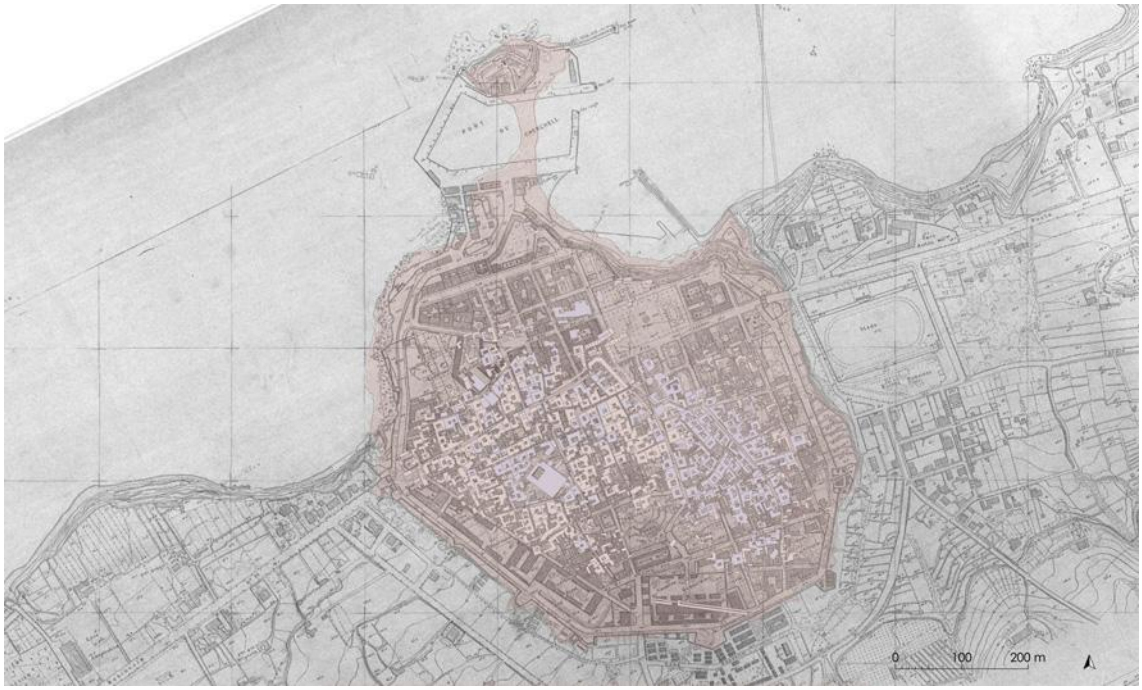

Fig. 1 – The city map from 1930 and the overlay with the building fabric of 1841. The city area of 1841 is marked red (Plan de la ville de Cherchell. French military archive in Vincennes. SHDGR GR 1 H 588 009_H. 1841. And Plan de la ville de Cherchel. 1930. Christa Landwehr).

Plans of previous excavations

Plans of previous excavations were mainly drawn by Ravoisier, who was travelling in the Mahgreb during the French occupation and who researched and documented a number of monuments. The plans were positioned into the city map from 1841 and 1930 using adjacent buildings as reference points. On these plans measuring chains provide points of reference to adjacent buildings. When taking a closer look at the central Roman bath we can notice a problem: despite the fact that the area was surveyed it is impossible to insert the site plan exactly. This is due to differences in measurement, probably errors in the survey data since both site plan and area map were produced at the same time.

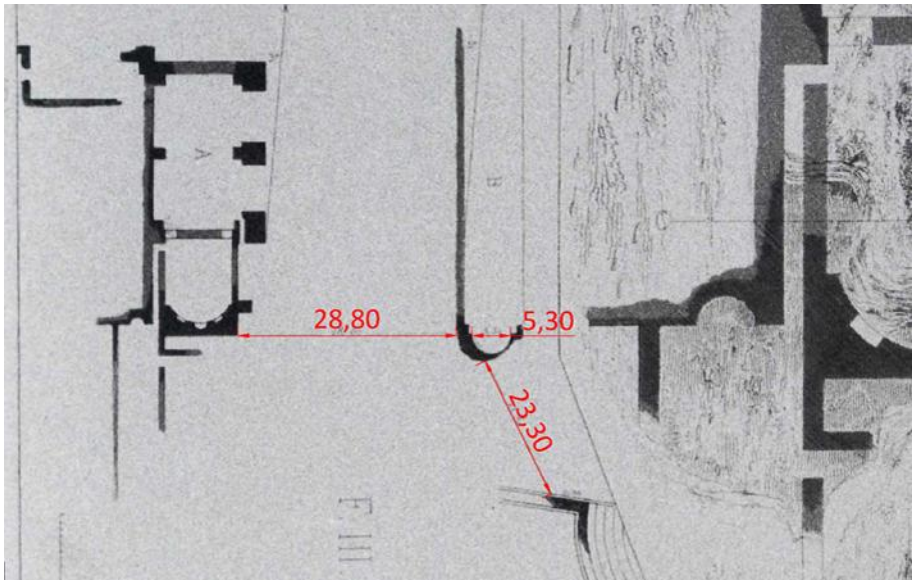

Fig. 2 – Feature drawing of the Central Bath by Ravoisier including the original measuring chains (RAVOISIER 1846: pl. 35).

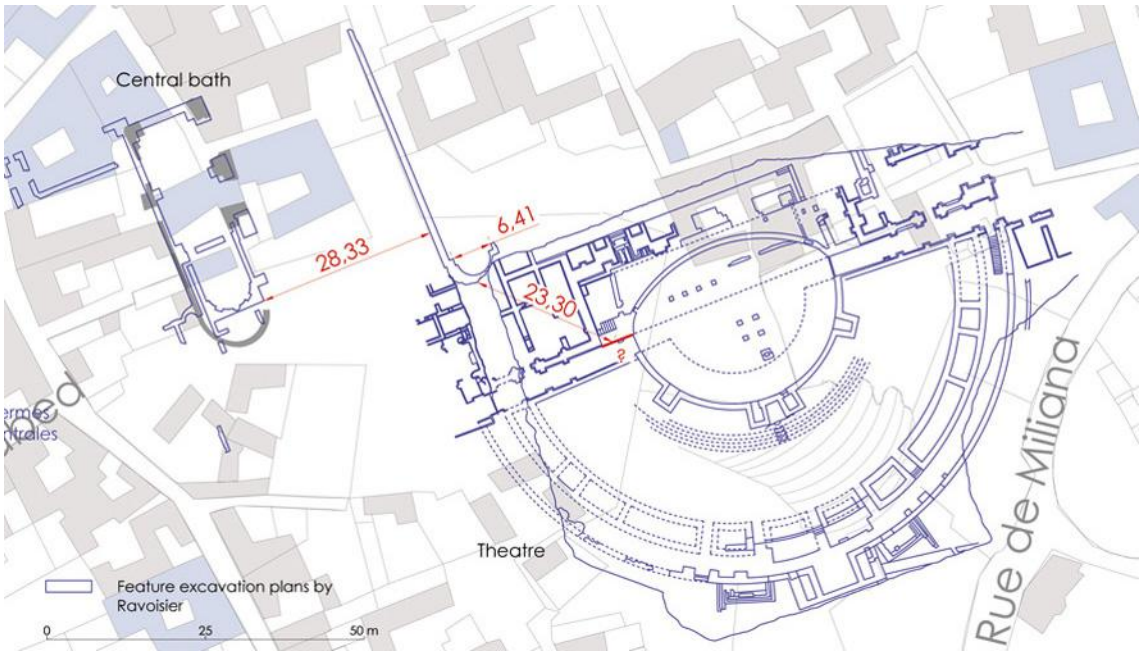

Fig. 3 – The feature drawings of the Central Bath located in the map of 1841. The measurements by Ravoisier differ from the distances in the plan of 1841 (Sandra Rieke, FIAK Cottbus).

Fig. 4 – Aerial photograph of the Roman villa Caïd Youssef. Looking from north to south (Centre Camille Jullian, Université d'Aix-en-Provence, CNRS43339).

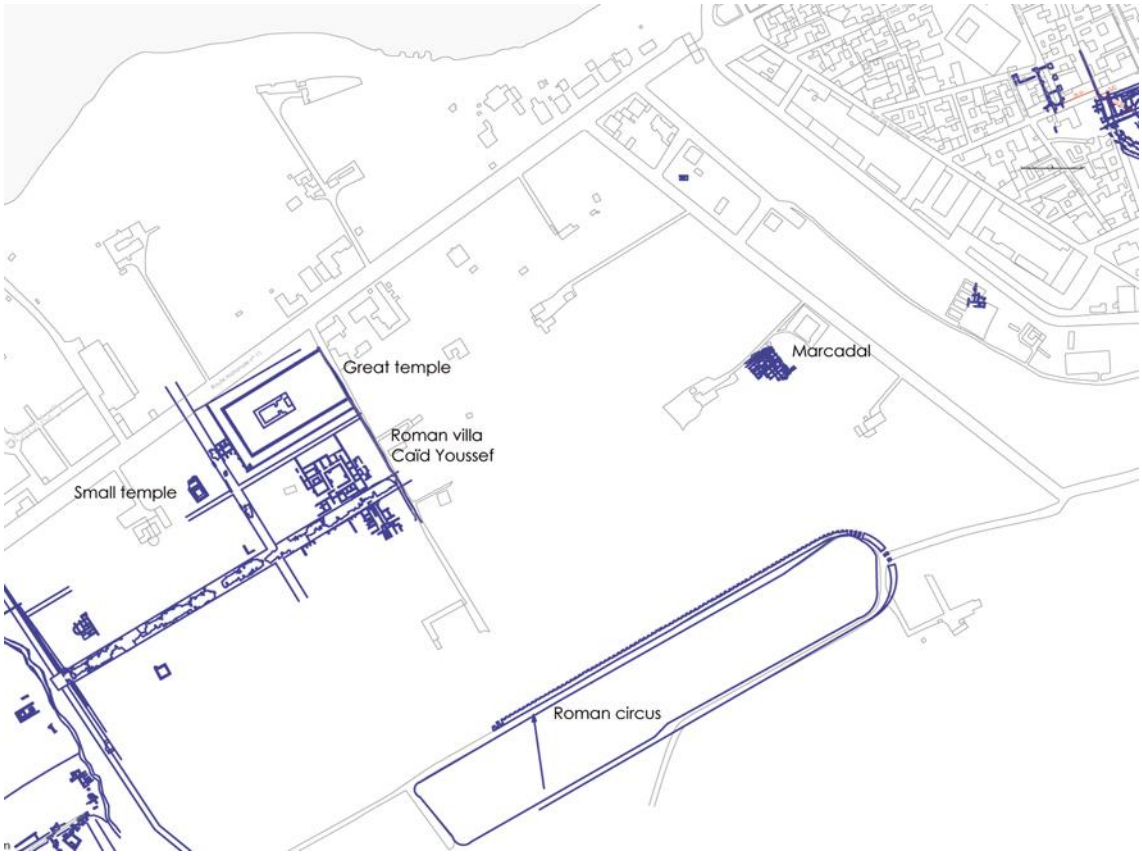

Fig. 5 – The feature drawing of the Roman villa was positioned by using the aerial photograph (Sandra Rieke, FIAK).

There are many site plans that do not have any survey data. However, one way of adding survey data is by using the military maps that show monuments, such as the theatre, amphitheater, the Roman baths to the West and other sites. One other possibility for matching plans of previous excavations with the area map would be to use coordinates of ruins that are still visible today.

Aerial photographs of Cherchell were taken by the French military in the 1930s. On these photographs you can see a number of Roman ruins that were damaged or built over in subsequent years. Known paths, roads or buildings are helpful to gain orientation. The positioning can only be done roughly, but it enables us to get a complete picture.

The archaeologist Philippe Leveau, was the first person to produce reconstructions of the ancient monuments and the road grid (LEVEAU and GOLVIN 1977–79: 821). Thanks to the findings of his research we are now able to integrate the road grid into the area map and can complement it with the latest research. In figure 6 we can see a summary of the different methods to position the drawings. It is also worth mentioning that there are building plans that could not be positioned in the current area map. Their location is still unknown or referred to in narrative records.

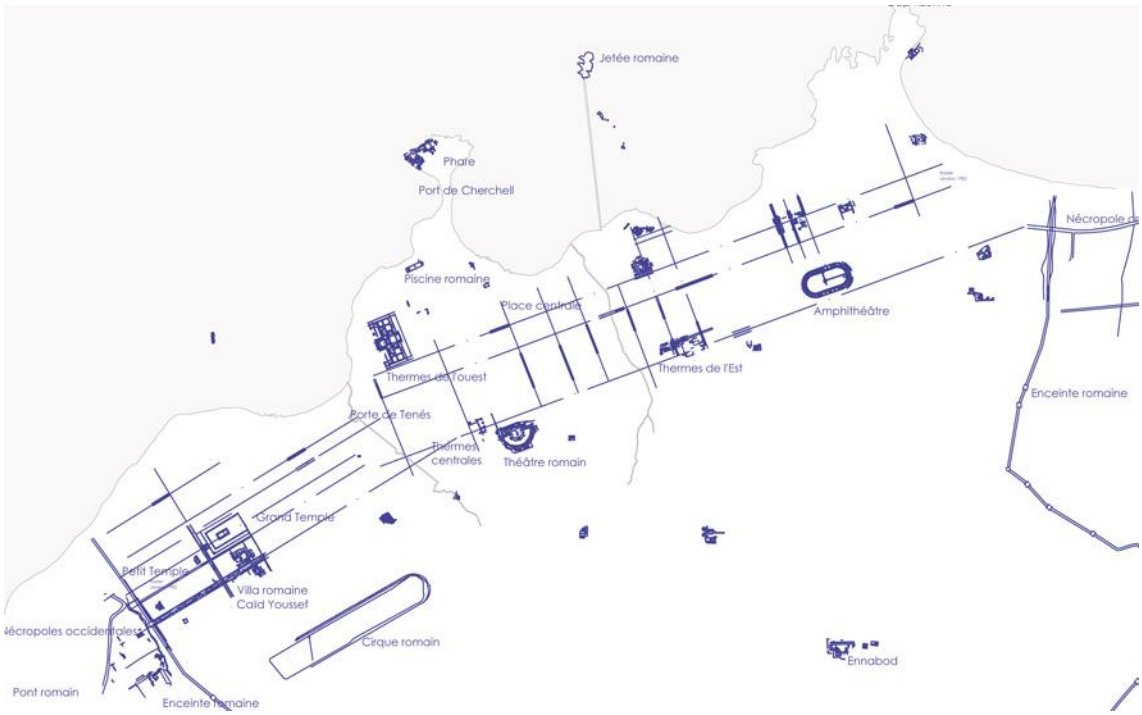

Fig. 6 – Composite plan of the antique Cherchell (Sandra Rieke, FIAK).

Conclusion

This project illustrates the many possibilities of how to merge historical maps with a current area plan. The accuracy not only depends on the available equipment and knowledge of past excavations (like survey methods, reference points and the integration with a height reference system) but also on the content and accuracy of area maps and their reproducibility in current area maps.

The example of Cherchell shows us how underdeveloped excavation methods were used by Ravoisier. The individual find seems to have been the main point of interest and the big picture was not considered

important. The result of this is that individual archaeological features can only be mapped in a rather inaccurate way. There is another aspect of high significance that determines the quality of the analysis of historical maps: dimensional accuracy and distortion of maps and plans. I would like to explain this further.

The fort Großkrotzenburg

Großkrotzenburg is situated within the core zone of the Limes Germanicus, a UNESCO World Heritage site. The Limes runs southwards and passes the fort to the east. There is marshland to the north of the fort.
The 20th century saw an expansion of the town. Today the fort is completely built over and sits under the old town of Großkrotzenburg. To the south of the fort is the river Main which runs further to the west.

Topic/Excavation activities

A growing consciousness about the cultural heritage of the fort led to initial archaeological assessments.
In 1881 the Historical Society of Hanau decided to start with archaeological excavations of the fort that were completed by the Reichslimeskommission in 1893. The research focused mainly on the fort’s actual fortification and on parts of the Stabsgebäude (principa). Throughout the 20th century and until today archaeological watching briefs revealed further building features as part of the fort, such as the vicus, the Roman baths, sacred sites and others.

The task of bringing together the plans

There are plans to produce a new cadastral map of the Roman fort Großkrotzenburg for the Landesamt für Denkmalpflege Hessen section Bodendenkmalpflege and the Geschichtsverein Großkrotzenburg. This map will bring together plans of previous excavations, excavation findings of the 20th century and the survey results of the visible fort remains, which will then be integrated into a current town map.
Soon all site maps will be combined into a new cadastral map for Großkrotzenburg. The basis for this will be site plans and published reconstructions, but also the results of a survey of the visible fort walls carried out by FIAK[2] will feed into the cadastral map. The modern excavations by FIAK are available as encoded total station data. The data is geo-referenced and transformed into CAD (used software: AutoCAD 2010).
Excavation plans from campaigns from the beginning of the 20th century were scanned and inserted in CAD.
For the mapping of the fort we used the work of Georg Wolff[3] who produced a substantial set of narrative documents and also drawings of the fort and vicus. Figure 7 shows a selection of plans of archaeological features that were produced in the scales of 1:50 to 1:200. Taking a closer look at these plans one can see that merging the archaeological features with the area plan is impossible. This is due to the fact that there is no reference given, for example references to adjacent buildings or any sort of relation to a known coordinate system. This made it necessary to start using a more inaccurate scale. On the basis of his research Wolff produced a reconstruction of the fort in the scale of 1:1000. We inserted this into the current

[2] FIAK (Freies Institut für Angewandte Kulturwissenschaften) is a archaeological excavation company in Cottbus, Germany.

[3] In 1893 Georg Wolff leads the excavation at the roman fort of Großkrotzenburg on behalf of the Reichs-Limes-Kommission.

area map to be able to position the archaeological features. Though inaccurate, we decided that this intermediate step was necessary.

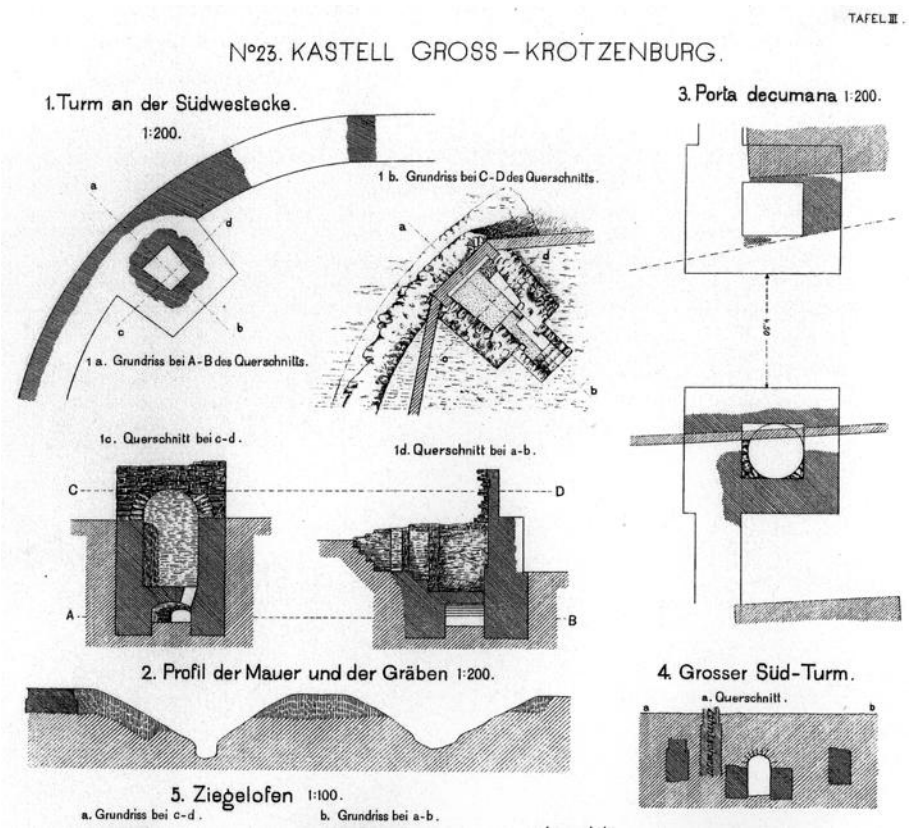

Fig. 7 – Details of feature drawings by Georg Wolff (WOLFF 1903).

Map analysis

When comparing the juxtaposed plans we can notice great differences. Firstly, the course of the roads matches the north-south direction of the present roads. But there are huge differences in the east of the area. Secondly, there is an inconsistency of the farmland borders. At first sight, one can recognize an expansion of the town during the 20th century. This had a drastic impact on the building fabric within the old town. Had there been any references in the historical plans of archaeological features to the adjacent buildings, they could not be retraced now. On the basis of the above considerations, it is possible to conclude that Wolff's reconstruction is showing distortions.

In a further step the distortions should be corrected by using PhoToPlan. Old buildings, whose locations matches in the historical and present map, have been used as points of references. The result shows a satisfactory fit in parts of the map, whereas other parts have great deviations. The Analysis identified undefinable distortions of the historical map. We came to the conclusion, that it may not be rectified totally. In order to minimise distortions we tried to only consider the areas around the archaeological features. For this purpose Wolff's map was split into several areas. The results are not usable. The features are now distorted towards each other. So we came to the conclusion that the distortions cannot be corrected satisfyingly, even with special rectification software.

In 2011 we surveyed the visible remains of the fort walls using latest technology. When comparing the reconstruction with our survey results we noticed many inconsistencies between the current and the historical survey.

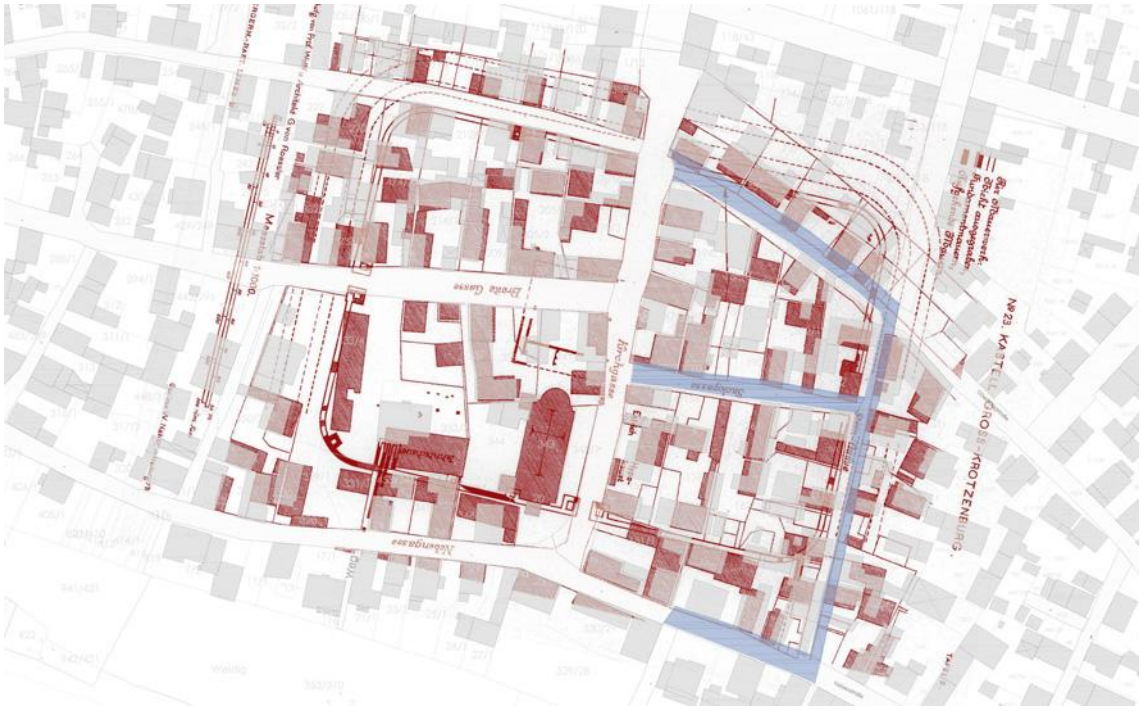

Fig. 8 – Reconstruction of the Roman fort by WOLFF 1903 (red). The differences in the course of the streets are marked blue (WOLFF 1903).

Fig. 9 – Feature drawings by Wolff. Overlaid with modern survey (WOLFF 1903 and FIAK 2011).

In this case we can say that a new survey of the still visible archaeological features is vital. Historical maps can only provide a small clue for the digitisation here.

Conclusions

Historical maps and site plans can be used for producing an accurate area plan only under certain circumstances. There will always be inaccuracies when integrating historical maps and site plans into an overall plan, which by today's standards are not good enough. A new survey using modern technology, where possible, is required. Historical records do however provide the option to visualize and to approximately locate the archaeological features.

When working with historical plans the following errors should be expected:

- Inaccurate survey techniques
- The lack of integration into an overall area map or a coordinate system that can be retraced today. It is common practice today to measure site plans into a superordinate geodetic system, which will be preserved in the future despite being changed in the area plan
- Errors when reproducing maps (by tracing, copying, scanning)
- Storage conditions (temperature, humidity, and the way a map is folded, whether the map is hanging or lying in storage) and base material have a major impact on the distortion of maps.

In order to rectify distortions on maps and plans we need to know about the reason for the deformation. There are two types of global distortion: linear and undefinable deformation. Copying and scanning can cause shearing, compression and rotation. These kinds of deformation are linear. Mathematically, linear distortion can be rectified with minimal error.

Undefinable distortions of the base material occur even in optimal storage conditions. Reasons for this are environmental impacts, like temperature and humidity, but also the way maps are stored. When storing maps by hanging them up, for example, they get deformed by their own weight. Repeated scanning and copying of maps have the same effect as the linear distortion. The stronger the deformation is, the stronger the error. Strong local deformations, like creases, cannot be rectified.

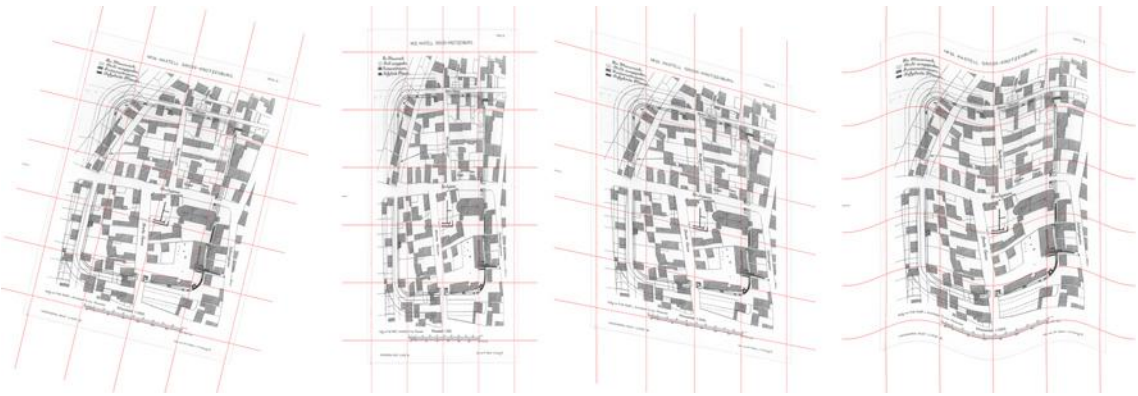

Fig. 10 – Various kinds of distortions – rotation, scaling and shear and undefinable distortions (Sandra Rieke, FIAK).

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Integration of historical cartographic material in geographic information systems at the Generaldirektion Kulturelles Erbe Rheinland-Pfalz / Germany

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Abstract: The paper shows the integration of historical cartographic material for several fields of the cultural heritage management in the German state of Rheinland-Pfalz. These examples include the Roman city of Trier, a medieval monastery on the Donnersberg, the baroque city park in Mainz and the Westwall, a military defense line which was built in the 1930s. The most significant project of this kind is the GIS-based processing of urban archaeological plans in Trier recorded since 1870. This involves the digitization, rectifying and georeferencing of more than 2500 archaeological plans and numerous handwritten archaeological sketches that provide a broad basis for the comprehensive mapping of Roman and medieval finds in the urban area of Trier. Thereby the Roman street grid which to date was predominantly based on theoretical models can be reconstructed in detail for the first time using georeferenced archaeological plans of the past 140 years.

Keywords: GIS, georeferencing, historical maps, historical excavation plans, Rheinland-Pfalz.

Preface

The Generaldirektion Kulturelles Erbe is the administration for cultural heritage in the German state of Rheinland-Pfalz in the western part of Germany. The duties of the Generaldirektion cover the management of cultural heritage monuments and archaeological sites as well as the presentation of cultural heritage in several museums.

Processing of historical maps for cultural heritage management

In 2010 we started to use historical maps and plans in a GIS-context in connection with several projects. After scanning the maps in many cases post-processing has to be done. This contains filtering, improving image contrast or brightness or removing the background of a historical map. For this work we use image processing software like Photoshop or Gimp. After that, rectification and georeferencing of the historical maps are done with Quantum GIS or AutoCAD 3D Map. For the mapping Quantum GIS, Global Mapper or HillGIS (a GIS linked to the cultural heritage database PGIS) were used. The examples presented in this paper contain the preservation of archaeological monuments (Roman Trier where historical excavation plans of the 19th and 20th century had been used, the medieval monastery on the Donnersberg where an 18th century map was georeferenced), garden heritage conservation (with the project dealing with the

development of the city park Mainz where several 18th to 20th century maps had been used) and the preservation of historical monuments (conservation area „Westwall“ where we used maps from 1937–1940).

Historical documentation of Roman architecture in Trier

The history of the archaeological documentation of Roman Trier started in the late 19th century. In connection with a completely new canalisation, new living houses and the founding of new outskirts mostly Roman and medieval architectural artefacts were excavated. Today more than 2500 archaeological excavation plans, about 500 books of provisionally sketchy drawings and remarks of observations and many field-drawings like profiles, plans etc. covering the city of Trier are stored in the archive of the Rheinisches Landesmuseum of Trier. Because of the very dense documentation the first effort to connect all the punctual and singular observations to a complete Roman city plan started already in the early decades of the last century (SCHINDLER 1979). The second attempt took place in the early 1990s and used the old documentation in order to establish an overall plan of the Roman city (KUHNEN 2002; 2003; PFAHL 2002; DENKSCHRIFT 2005). Based on a cadastral plan, the historical documentation seemed to fit, but it was done in the pre-GIS era without georeferencing the historical plans. For this reason significant shifts and distortions occurred. The resulting plan was the basis for many published plans of the Roman Trier that are not exactly located.
The new project started in 2009 aimed at the GIS-based mapping of the extent of excavations in the urban area of Trier. Therefore different work fields are our project’s basis: The first step was the mapping of the archaeological activities as points in the urban cadastre. In a second step the excavation areas were determined on the basis of historical cadastral maps and are mapped as polygons in the GIS. The aim was to georeference archaeological site plans in order to create GIS-overlays for the cadastral map. With the GIS-based blend of historical documentation and current cadastral maps or aerial photographs, it is possible to determine the findings on the house or property boundaries accurately. This makes detailed assessments in the course of building projects in the urban area of Trier much easier and faster.
The basis for the integration of historical excavation plans is the current cadastral map. Currently all plans of archaeological observations in Trier are digitized and recorded in a database. This allows a quick and direct access not only for mapping. The archaeological plans are scanned at 600 dpi. For georeferencing the plans are downsized to 300 or 100 dpi. To execute the georeferencing persistent reference points must first be obtained from both the plans and the cadastral map. In many cases the integration of historical plans in GIS is problematic because of the lack of reference points especially on a large scale. Old plans had old cadastral maps as a basis, which first have to be digitized and georeferenced to create intermediate steps backwards in the past. This workflow enables the georeferencing of large-scale archaeological plans from the19th century. The digitized plans were georeferenced in AutoCAD and converted to GIS-Data (GeoTIFF). The example in Fig. 1 shows an area that was covered with buildings in 1895, 1930 and 1970. Through the combination of all archaeological plans an overall picture of the Roman findings – private houses of two insulae – are obtained. The overlay of the reconstructed Roman streets and the insulae shows which excavated finds belonged to which insulae.

Fig. 1 – Trier, map extract of the area between Kaiserthermen and Tempelbezirk Altbachtal: aerial photo with georeferenced excavation plans from 1895, 1930 and 1970 including archaeological records of two insulae (© Rheinisches Landesmuseum Trier & Landesamt für Vermessung und Geobasisinformation Rheinland-Pfalz).

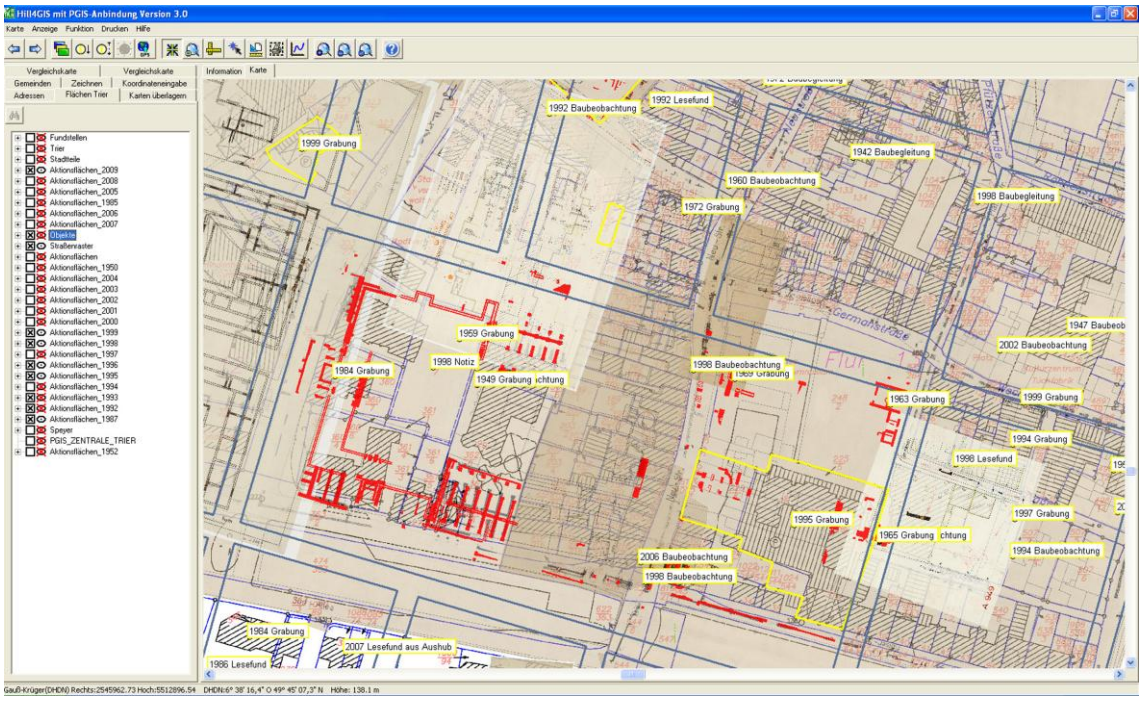

Fig. 2 – Trier, extract of the recent cadastral map with overlayed historical cadastral map, Roman street grid from 2002 (blue), archaeological excavation plans in the area of the Forum (red) and mapping of outlines of some excavations as polygons (yellow) (© Rheinisches Landesmuseum Trier & Landesamt für Vermessung und Geobasisinformation Rheinland-Pfalz).

Another example in the context of the Roman Forum (Fig. 2, red) shows the combination of large-scale archaeological recordings from 1940s and 1980s. All excavation sites were previously represented as point

data in the GIS without georeferenced or even digital plans. Now the so far adopted Roman street grid of Trier shows the inaccuracies in the road axes that were included in the former street grid. Thus, not only new scientific results, but significantly more precise requirements for building construction surveys can be achieved.

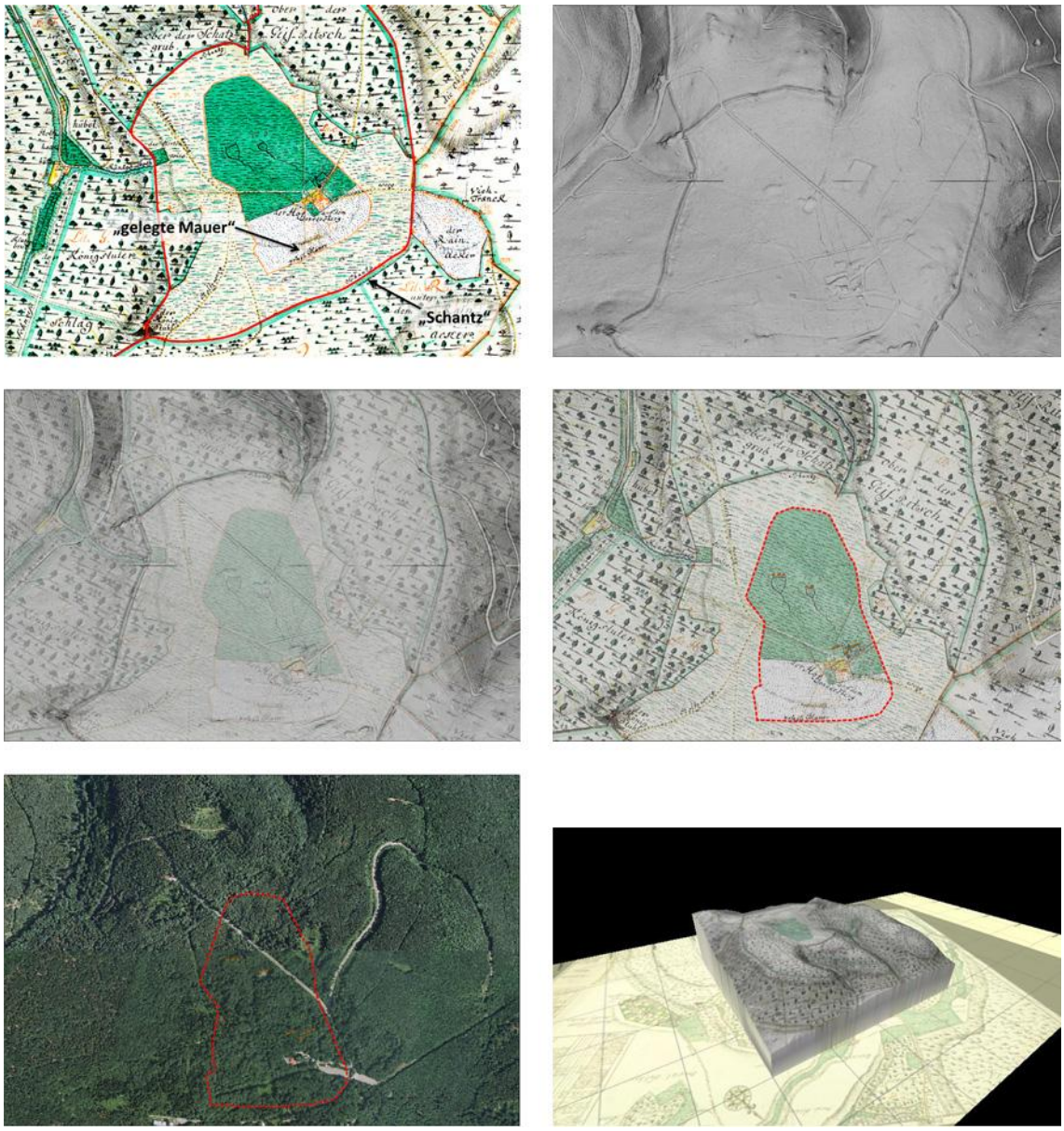

Fig. 3 – Donnersberg: georeferenced historical map from 1762 (© Hessisches Staatsarchiv Darmstadt) combined with LiDAR-data and aerial photo (© Landesamt für Vermessung und Geobasisinformation Rheinland-Pfalz).

Donnersberg

A further example for the usage of historical cartographic material in a GIS-context is a project at the Donnersberg. The Donnersberg is located in the mountains of the Nordpfälzer Bergland and is well known for a Celtic hillfort at the mountain-top (ZEEB-LANZ 2008).

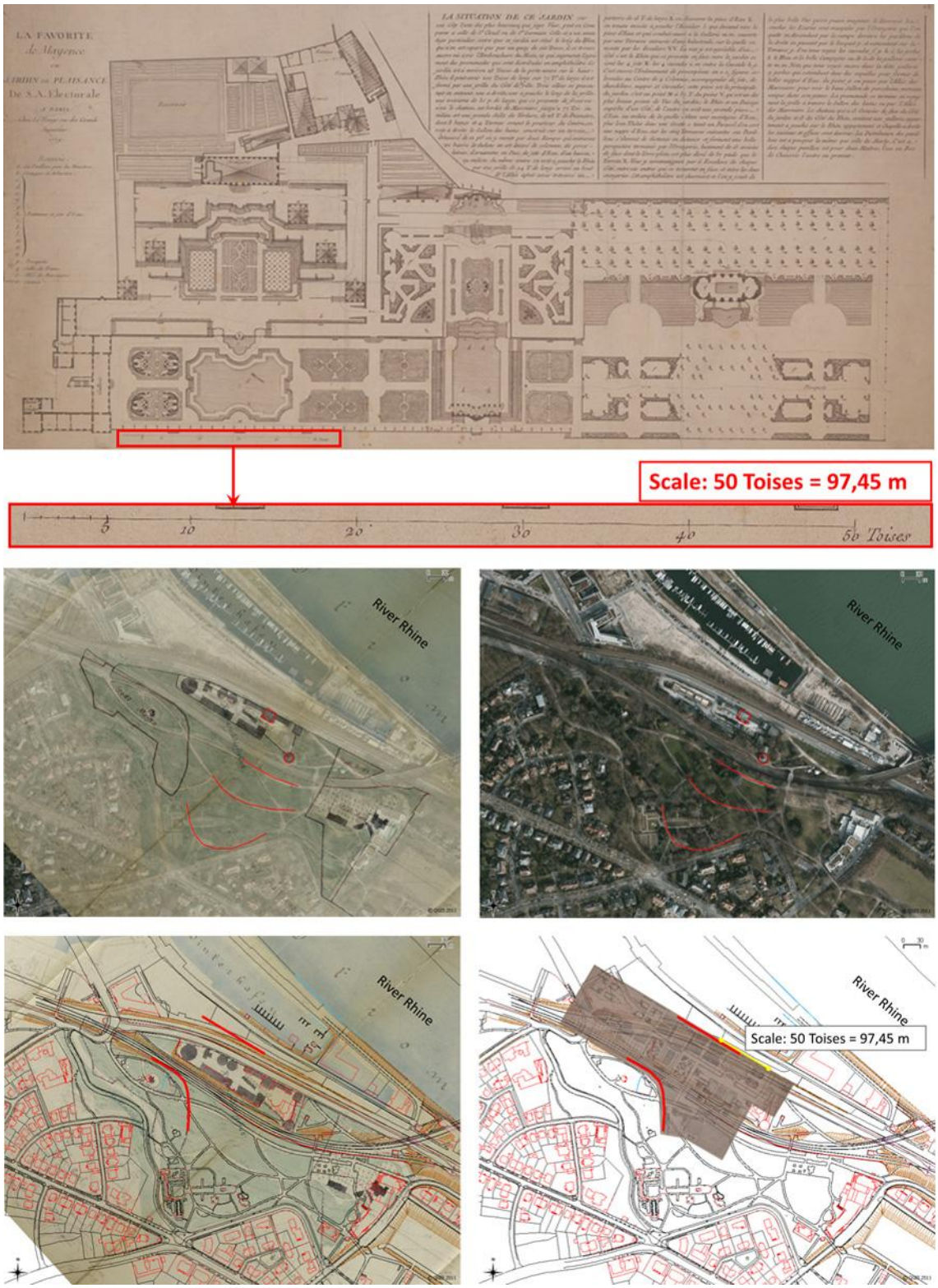

Fig. 4 – City Park Mainz: cadastral map and aerial photos (© Landesamt für Vermessung und Geobasisinformation Rheinland-Pfalz), historical maps from the 18th century and from 1890 (© Stadtarchiv Mainz).

Some historical records mention the medieval monastery St. Jacob on the Donnersberg, of which the dimensions had not exactly been explored until today. The goal of the GIS work was the reconstructing of these dimensions and landscape features like ponds, dams and roads in the surroundings of the monastery.

For this purpose a historical map from 1762 was georeferenced to create a GIS-overlay for the LiDAR-Data that are available for this area. This historical map shows besides the Celtic wall the outer wall of the monastery as well as some ponds, dams and roads (Fig. 3, upper left). All these relics of the monastery had been largely disappeared today. Fig. 3 (upper right) shows a hillshade image calculated from LiDAR-Data of the Donnersberg mountain plateau. In this area approximately four measuring points per square meter were recorded. Fig. 3 (middle left) contains the LiDAR-Data overlayed with the georeferenced map from 1762. For the georeferencing the prehistoric ramparts could be used as proved ground control points. It turned out that the accuracy of the historical map was quite high for an 18th century map of this scale (mean error about 5 meters). Fig. 3 (middle right) shows the medieval structures mapped from the georeferenced historical map and in Fig. 3 (lower left) the mapped structures from the historical map are combined with recent aerial photographs. The software Global Mapper was used to create an interactive 3D-view of the LiDAR-data with the georeferenced historical map (Fig. 3, lower right).

City Park Mainz

For garden heritage conservation the development of the city park Mainz near the River Rhine was analyzed using 18th to 20th century maps and plans. The goal was especially the localization of the 18th century baroque garden so called “Favorite” for further landscape planning (GLATZ 2007; KARN 2009). Fig. 4 (upper) shows the baroque garden on an engraving from the late 18th century. This plan also includes a scale in the French measurement unit toise (50 toise = 97,45 meters), so we were able to scale the plan. Fig. 4 (middle) shows some structures that could be used as ground control points for georeferencing a map from 1890. This plan could be used as a link to the 18th century plan of the baroque garden. In 2009 a wall of the baroque garden was excavated, which could be used as a reference point for the location of the 18th century garden (Fig. 4, lower left). Another reference structure included in the 18th century plan was a park lane mapped on the georeferenced map from 1890 (Fig. 4, lower left). This lane could be identified as the one from the 18th century plan by using the known scale units. By this means the location of the baroque garden in the 18th century could be reconstructed in the GIS. (Fig. 4, lower right).

Westwall

The last example leads us from the baroque garden to the warfare of the 20th century. The Westwall was a line of defensive forts and anti-tank defenses built from 1938 until 1940 (FINGS 2008). In 2008 the Westwall with all its objects in the state of Rheinland-Pfalz was declared a conservation area. To locate all those forts and anti-tank defenses and to document their condition topographical maps from the 1930s with records from 1937–1940 were georeferenced. Fig. 5 shows a georeferenced map with records from 1938. All these records were mapped and classified in GIS (Fig. 5, left) and can be used as an overlay for recent geodata which is important especially for the securing of the mostly ruinous objects as well as for spatial planning and forestry (Fig. 5, right).

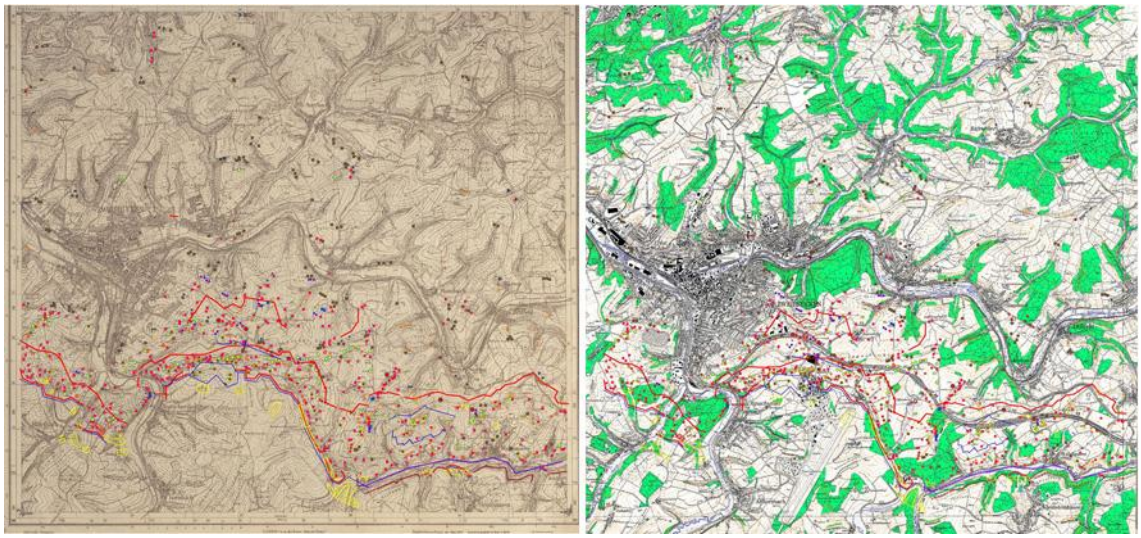

Fig. 5 – Topographical map from the 1930s and 2007 (© Landesamt für Vermessung und Geobasisinformation Rheinland-Pfalz).

Outlook

Our further plans for the usage of historical cartographic material in GIS include the digital processing of historical excavation maps for the GIS-based documentation especially in an urban context (e. g. in the city of Speyer). We also plan to integrate historical map series into GIS for overlaying the LiDAR-data (e.g. for detection and identification of old roads or mining sites). Finally we want to make some georeferenced historical maps available as layer as an addition for the web map service containing the historical monuments in Rheinland-Pfalz (work in progress).

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