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http://kulturarvsdata.se/raa/fornvannen/html/2012_253
Fornvänn;2012(107):4, s. 253-265
Ingår i: samla.raa.se
The Birka Proto-Town GIS
– A Source for Comprehensive Studies of Björkö

By Sven Kalmring


The Viking Period proto-town site of Birka on the island of Björkö in Lake Mälaren is one of Sweden’s prime archaeological sites. Its significance is not least reflected in its status as a UNESCO world heritage site since 1993, which it became together with the royal manor of Hovgården on the neighbouring island of Adelsö (Lundberg 2007, p. 7). In the summers Birka is one of the most popular tourist destinations around Stockholm, and as such it got its own museum in 1996 in addition to a permanent exhibition in the Historical Museum (SHM). Since 2006 a very committed boat trip company has funded house reconstructions on the island in cooperation with Gotland University, following examples from the Black Earth excavations of the 1990s. The National Heritage Board (Raå) has increasingly withdrawn from active management of the site to more of an administrative role on a governing board together with Ekerö municipality and the Stockholm County Administration. Since 2008 the boat trip company is responsible for operations at Birka that are open to the public. Motivated as they are by profit, they are of course very interested in supporting continuous archaeological fieldwork that attracts tourists. This in many ways fruitful collaboration might risk affecting the quality of the formulated archaeological research agenda and therefore demands a high degree of responsibility in the issuing of fieldwork permits.

A crucial point to the scholar dealing with Birka is that archaeological research here is not directed from one office according to one common research agenda. A range of governmental institutions and university departments are currently involved. In 1973 a Birka committee was formed and produced years of successful work (cf. Arwidsson 1984, Vorwort). This setup nevertheless sometimes hindered internal coordination of independently tackled research questions and even led to slow exchange of available information. Fortunately the current generation of archaeologists is much more open in these respects.
(cf. Hedensterna-Jonson 2012). Yet these difficulties are not only restricted to exchange on a personal level. It can likewise be hard to get an overview of bibliographic information on recent research as many fieldwork and research reports never make their way into national or international libraries. They may be available sometimes quite short-lived web sites, at the issuing institutions themselves or at the National Heritage Board’s archives (ATA) in Stockholm. Accessing this output, which is essential to the understanding of the site, is particularly problematic for scholars working from abroad. They risk being oblivious to the current Birka research. An additional problem, particularly for younger scholars, is a certain Babylonian language confusion as considerable parts of the standard literature on Birka was published in German, while recent literature is in Swedish and English. An adequate discussion of the matter thus demands at least a reading comprehension of all three languages.

In addition to these site-specific complications, Birka studies simultaneously face the intrinsic problems of sites with a comparably long tradition of academic research, as recently emphasised by an international conference in Schleswig: “Quo vadis – Long-term Excavations in European Archaeology” (von Carnap-Bornheim 2012). As one of the prime sites of its era, Birka has a research history going back to the 17th century (Hyenstrand 1992). Archaeological work continues there and will without doubt do so in the future too. Whether “a complete treatment of the Birka question” as promised by Hjalmar Stolpe (1873, p. 12) on the eve of the World Archaeology Congress in Stockholm in 1874 will ever be possible may in fact be doubted, considering to the persistent increase in knowledge. However, to keep track of this vast amount of information and draw a comprehensive picture of the state of the art, to define research gaps on this basis and be able to identify profitable future research directions is a standing challenge.

Too Much of a Good Thing?

In a research program for archaeology in Stockholm County, Anders Wikström (2006, p. 22) has pointed out that although much has been done within urban archaeology there is still a great need for detailed summarising syntheses. As for Birka in particular, Michael Olaussen (2012) has reached the same conclusions. In the County Archaeologist’s research program, he writes: “Birka is a key site in central-place and town studies. Early burial excavations, particularly from the end of the 19th century, are still the dominant source material. At the end of the 20th and the beginning of the 21st century, some research excavations have touched the Black Earth, parts of the town rampart including building terraces attached to them, Birka’s hillfort and the area outside of it, the so-called Garrison. Small-scale surveys have also been undertaken in (the nearby modern hamlet of) Björkö by and in Birka’s harbour. Extensive publications are available on various features, but compilations are missing. Not least the report from the Black Earth excavations (1996–95) is lacking” (p. 61ff; translation by author).

The lack of summarising syntheses is in considerable part a result of the current doctoral examination procedure. While smaller artefact assemblages and features are being dealt with in bachelor’s and master’s theses (C/D-utpasser), PhD dissertations are increasingly taking the shape of article theses. These no doubt have many advantages such as regarding the issue of completion on a tight schedule. Yet they typically consist of several case studies on a general topic and thus hardly leave any room for comprehensive artefact or site studies as in classic monographs. Concerning Björkö, many guide booklets are available, written by scholars involved in Birka research and published at short intervals and in many editions (Stolpe 1888; Lindqvist 1926; Lofterud 1970; Odelberg 1974; Ambrosiani 1988; Magnus 1998; Gustin & Magnus 2009). On the other hand only few academic attempts have been made to sum up the huge amount of available information (Hallström 1913; Arbman 1939; Holmqist Olausson 1993).

In Sigtuna, the High Medieval successor of Birka, the development of a Geographic Information System (GIS) has proved fruitful both as a tool for heritage management and for the protection of surviving cultural layers despite the needs of the present town (Wikström 2006, p. 20). Such a GIS is also a powerful tool when a large amount of data invites scientific analysis of
the overall development of a site. A GIS system, according to the software vendor ESRI, integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information and thus can also be applied to nearly all archaeological finds and features possessing such spatial information. In archaeology, GIS systems have rapidly been adopted as basic tools over the last two decades – for management of archaeological resources, excavations, post-excavation analysis, landscape studies, spatial modeling and simulation of various processes (Conolly & Lake 2006, p. 33 ff). In addition to Sigrún, GIS systems are being used at Gamla Uppsala (Ljungkvist 2009; Ljungkvist et al. 2011), Kaupang in Norway (Skre 2007), Hedeby in Germany (Schulze 2008; Kalmring 2010) and Dorestad in the Netherlands (Rijksmuseum van Oudheden 2011, p. 74) to mention only a few.

Digital tools – including Computer Aided Design (CAD) software for precise drawings, originally developed for architecture and engineering, and GIS software products for complex analysis on the basis of map projections including coordinate systems and databases – were introduced at Birka already at an early stage. For the Black Earth excavations of 1990–95 directed by Björn Ambrosiani, all field documentation was done digitally using a combination of an Oracle database storing coordinates measured with a total station and the GIS system ArcInfo especially developed for the project (Price & Rundqvist Nilsson 1990; Ambrosiani 1992, p. 84). Under the technical supervision of Kjell Persson of the Archaeological Research Laboratory at Stockholm University, the CAD software MicroStation had been introduced for the mapping of survey results of the Viking age shoreline at Kugghamm below the terminal of the town rampart (Kristiansson 1996), the interior of the hillfort (Stavrum 1997), the leveled section of the town rampart (Wahlander 1998) and the harbour area below the garrison (Stålberg 2000). For the study of water level changes a coarse three-dimensional digital terrain model of the island was created using SURFER software enabling the visualization of algebraic surfaces and MicroStation (Persson 2002).

In 1997 Örjan Hermodsson (2004) re-surveyed and reinvented the field monuments of Björkö and Hovgården for the National Heritage Board. His report in the ATA archives is accompanied by a CD containing MapInfo GIS files with the monuments indicated as points that were later converted into shape files for ArcView GIS. Also documented in ArcView are the results of the marine archaeological projects “Viking Age ships and constructions” 2002–08 and “Maritime Birka – Maritime centered research and public archaeology on Björkö” from 2010 onward. They have been carried out by the National Maritime Museums (SMM) in cooperation with maritime archaeologists from Södertörn University College, known since 2010 as the Maritime Archaeological Research Institute (MARIS; Olsson 2004; Eriksson 2005; Bolin et al. 2008). For a term paper Christin Hemåg (2006) mapped the stone foundations of jetties on Björkö visible above ground and tried to relate them to shoreline displacement using ArcGIS. Excavations at Björkö by and Grindsbäcken in 2005–07 were recorded digitally using Intrasis software (Bäck et al. 2010, p. 13), an specialised ArcGIS platform developed for archaeological use by the Archaeological Excavations Department (UV) of the National Heritage Board. Lastly the Intrasis-based database Fornsök shall be mentioned, being a part of the the National Heritage Board’s on-line sites and monuments register (FMIS). It offers basic map-related information on registered sites and monuments (Blomqvist 2009) including the ones on Björkö.

Yet none of these manifold efforts have been used as a starting point for the development of a comprehensive GIS gathering all the available information in one system. Thus there has until now never been a map showing the precise location of all excavated trenches on the island (cf. Ambrosiani & Eriksson 1992a, p. 23; Gustin & Magnus 2009, back cover) or – to up it even more drastically – from which parts of Björkö information is in fact available for accurate overarching study. This state of things led Olausson in the Stockholm County Administration’s archaeological program to the conclusion that “the need to establish a town and survey GIS for the development of Birka is obvious” (2012, p. 60; translation by author).
Equipment and Data Acquisition

In the scope of a Humboldt scholarship for a research project on “Birka’s Harbours in Excavation and Surveys” the development of a Birka town GIS was begun at the University of Stockholm in February 2011. The primary aim of the ongoing project is to collect all available data on Birka’s harbour and interpret them with a holistic approach against the background of results reached during the study of the harbour excavation at Hedey which, thanks to a slightly risen waterlevel, offered much better preservation conditions (Kalmring 2010; 2011). However, the proper discussion of harbours forming gateways between land and sea requires a much broader approach than simply focusing on the harbour facilities themselves. As logistical and technical infrastructure they call for a whole range of requirements both on land and on sea that must also be taken into consideration for a proper understanding (Kalmring 2010, p. 20 ff.; von Carnap-Bornheim & Kalmring 2012).

With this broad systemic approach not only features directly connected to the maritime sphere are included, but also findings from other contexts that can contribute to an enhanced understanding of harbours and their sub-systems. This of course presupposes exact knowledge of where on Björkö information is actually available thanks to excavations and surveys, in order to be able to evaluate and relate them to this specific problem. Yet this necessity applies not only for harbour related research, but basically to any research question related to Birka. Because of the sheer amount of information available about the site, building a GIS system seemed an appropriate approach.

For the development of a comprehensive GIS the widely available program ArcMap from ESRI was used. It started from a geometrically corrected and geo-rectified aerial photograph (GSD-orthophoto) of the island, the property map (Fastighetskarta) with a map scale of 1:12,500 and an archipelago chart (Skärgårdskort) with an image resolution of 5 m per pixel. They were provided by METRIA of the Swedish mapping, cadastral and land registration authority Lantmäteriet. Later these geographic base maps were supplemented with digital locality information (Tätortskarta) and a topographic map (Terrängkartan) of Björkö and Hovgården from Lantmäteriet as well as a map generated by the Geological Survey of Sweden (SGU) simulating the coastline of Lake Mälaren a thousand years ago. In addition to modern topographic maps, also various early maps from the late 17th century onwards were taken into account (cf. Holmquist Olausson 1993, p. 32) as a basis showing earlier conditions as well as changes in land use and land tenure until the 19th century (Hallström 1913, fig. 7), maps on place names around the island (Gustawsson 1977, fig. 1) as well as modern surveys of field monuments and archaeological register numbers on Björkö and Grönsö (e.g. Arbman 1939, p. 8; Ambrosiani 1992, fig. 1:2; Holmquist Olausson 1993, fig. 4:1). As a geodetic reference system the old two-dimensional system RT90 (2,5 gon V) instead of SWEREF99, a three-dimensional system introduced in 2007 (cf. Lantmäteriet 2008, p. 3), was chosen as most of the available coordinates from earlier excavations are given in RT90. Transformation between the two reference systems is easily done within the GIS.

In order to feed the GIS, large parts of the literature on Birka to enumerate in detail for outline maps, excavation plans and distribution maps were consulted, too. Here, reference shall only be made to the studies of Birka’s cemeteries (Hallström 1913; Arbman 1940/1943), the publication series “Birka. Untersuchungen und Studien” (Arwidsson 1984), the “Birka Studies” (Ambrosiani & Clarke 1992), its popular science counterparts “Birka vikingastaden” (Ambrosiani & Erikson 1992), “Birkas befästning” (Fennö Muyingo & Holmquist Olausson 1995), “Borgar och befästningsverk i Mellansverige 400–1100 e.Kr.” (Hedenstierna-Jonson 2000) and finally the publication on the Black Earth harbour excavation 1970–71 (Ambrosiani et al. 1973) and investigations and surveys between the years 1976 and 1989 (Holmquist Olausson 1993). In parallel with this study of the literature and maps therein, data collection from the ATA archive began by reviewing all site records with the signature “Up, Adelsö sn, Björkö” including Stolpe’s notebooks, correspondence and grave sketches. In this context, use was also made of important, archive reported but unpublished material such as the documentation from Holger Arbman’s excavations at Kyrkveoten (“church field”) and the town rampart in 1932 (cf. Arbman
Fig. 1. Björkö. Trenches of settlement and harbour excavations from 1932 onwards.
1939, p. 67) and at the “Garrison” west of the hillfort in 1934 (ibid. p. 62). Here also other important sources such as Hermodsson’s (2004) aforementioned digital inventory of field monuments on Björkö and at Hovgården were found.

Much useful material is also found in the archives of the Archaeological Research Laboratory at Stockholm University, viz bachelor’s and master’s theses on recent investigations touching upon the town rampart (cf. Holmquist Olausson 1988; 1993, p. 77 ff), an adjacent house terrace (cf. Holmquist Olausson 1993, p. 90 ff; Fennö Muyingo & Holmquist Olausson 1995; Söderberg & Holmquist Olausson 1996), the hillfort (cf. Fennö Muyingo 1998; 2000; Hedenstierna-Jonson 2000) and the Garrison (cf. Kitzler 1997; Hedenstierna-Jonson et al. 1998; Holmquist Olausson & Kitzler Åhfeldt 2002). These are only to some extent published in periodicals such as *Journal of Nordic Archaeological Science* (JONAS). Note that these term papers do not only concern themselves with artefact groups: some also contribute to crucial structural problems (Kristiansson 1996; Stavrum 1997; Wählander 1998; Stålberg 2000; Bengtzon 2001; Rosén 2003; Hamrin 2003). Term papers on maritime problems from Södertörn University College (Dahlin 2001; Hansson 2004; Heamägi 2006; Wiklund 2009) were likewise retrieved.

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All the many information sources for the GIS cannot be listed in detail here. However, during data acquisition almost every piece of cartographic material with spatial reference for the island of Björkö was collected, scanned and rectified. Hereby a precise location of the many excavation sites and an overview of available information from the areas surveyed is possible for the first time (fig. 1). So far the Proto-Town GIS comprises information on the categories *Stolpe’s cemeteries* including the subcategories Hemlanden,
Norr om Borg/Borgen, Borgs hage/Kvarnbacka, Grindsbacka and Kårrbacka, Ormknös, the town rampart including the campaigns of Arbman 1932 and Holmquist 1987/88 as well as 1995/96, the hillfort, the Garrison including the subcategories Stolpe 1877, Arbman 1934 and Holmquist 1997–2004, and finally the Black Earth and Black Earth’s harbour. Moreover the categories maritime monuments that are still visible above ground, surveys of the Maritime Museum and Björkö by. Finally the categories phosphate mapping, core drilling and geophysics plus historical and interpretational maps grouped under the category cartographic material. The upkeep of this data will of course be a continuous process that has to keep pace with unfolding research. But a first necessary step will be the vectorisation and database linkage of certain rectified cartographic material.

It is too early to present any far-reaching results. A GIS system like this is a tool, a point of departure for comprehensive analysis rather than a scientific result in itself. Nonetheless, thanks to the combination of datasets, some observations can already be made (figs. 2–4). In building a Birka GIS, the well published and easily accessible cemeteries excavated by Stolpe (Arbman 1940/1943; Gräslund 1985) formed a fairly evident starting point. In this context J.J. Nordstrand’s maps accompanying Arbman’s publication (cf. Arbman 1940/43, pl. I–V) on a straightened aerial photograph were scanned, geo-rectified, vectorised and linked to relevant databases. This offers
a detailed overview of the extensive cemeteries and their composition, allowing all kinds of queries to be plotted visually. And in fortunate cases it also allows us to supplement the maps with “lost” graves by means of additional archival material such as sketches in Stolpe’s notebooks.

Data accumulation was lifted to a new level by the recently available airborne laser scanning data (LiDAR) acquired within the project “New Nationwide Elevation Model” (Ny nationell höjdmodell) of the land registration authority Lantmäteriet (2009). It was launched in 2009 on a government contract. The data aspires to a resolution of 0.5 point/m² and allows a unique visualisation of the monuments on Björkö, including the vast number of mounds at Hemlanden and Borgs hage.

And using the ArcGIS application ArcScene we may display a three-dimensional model of Birka (fig. 5). This model can – as in an ordinary ArcMap program – be overlaid with other layers of data in a 3D environment. Applying the simulation of the moving shoreline (cf. Ambrosiani 1982; 1985) to that model, chronological relationships between different cemetery sections or among the stone foundations of harbour facilities visible above ground become readily apparent.

Some important pieces of the puzzle are still missing. At the moment, one rather sketchily documented part of the GIS is the Black Earth excavation of 1990–95 (Ambrosiani 1992) which has
not yet seen final publication. For now there are drawings of trench A from the first year of excavation (Ambrosiani 1995) and the so-called bronze caster’s workshop (Ambrosiani & Erikson 1994, p. 10), a PhD thesis on – along with other aspects – the stratigraphic periodisation including a compilation of the building remains (MacLeod 1997; 1999, p. 58 ff) plus some simplified layout plans of the main development phases (Ambrosiani & Erikson 1992b, p. 24 ff; 1994, p. 10; Gustin & Magnus 2009, p. 90 ff) on hand. Luckily the manuscript of the first of two planned volumes in the Black Earth excavation has recently been completed by the excavator and is now awaiting translation into English.

Another contribution that awaits publication is the geophysical survey performed since June 2011 by the geophysical archaeological prospection group and technical unit of the Archaeological Excavations Department (UV Teknik) in cooperation with the Boltzmann Institute for Archaeological Prospection and Virtual Archaeology in Vienna. This survey aimed to cover the entire island with high resolution geo-radar and magnetometry arrays over a period of three years. So far a few pilot studies and preliminary reports have been published (Trinks & Larsson 2007; Trinks et al. 2007; 2008; 2010) showing fine initial results. But the data itself is unfortunately not yet available to other scholars. That dataset offers a well-founded hope that we will be able to locate the trenches dug under Stolpe’s direction in Black Earth in 1871–74 and 1878 (Stolpe 1872; 1873; 1874; 1876). Then the map of excavated trenches to date on Björkö could finally be completed. These earliest settlement-archaeological attempts are not as well documented, and nor is their documentation as well transmitted until our time, as regards Stolpe’s work with the cemeteries. But in fact there are a few drawings (cf. Hyenstrand 1992, fig. 2:7; 2:8ab) that might one day, on the basis of the geophysical results, be geo-rectified and registered accurately in the town GIS (cf. Ambrosiani 1995, p. 28 fig. 2:9A; Ambrosiani & Erikson 1992b, p. 18 ff).

As mentioned above, the development of a GIS for an archaeological site constitutes no scientific result in itself. It should be seen as a techni-
cal device for handling large amounts of data. However, such an information source can form a point of departure for the next step, which will in this case be a comprehensive study of Björkös defining the Stand der Forschung, identifying academic white spots and, on this basis, developing future research questions intended to suggest a way for Birka research out of its current unfortunate deadlock. The aim is to make the GIS database publicly available in the future. Meanwhile interested colleagues are welcome to contact the author for further information.

Acknowledgements
The development of a GIS for Birka was made possible by the cooperation and unconditional support of my dear colleagues in Stockholm, to whom I am deeply grateful: Lena Holmquist and Kerstin Lidén of the Archaeological Research Laboratory at the University of Stockholm, Charlotte Hedenstierna-Jonson of the Historical Museum, András Olsson and Jens Lindström of the Maritime Museum and Johan Rönby of the Maritime Archaeological Research Institute at Södertörn University College. To Björn Ambrosiani, formerly of the National Heritage Board, I am grateful for discussions of many Birka problems. Finally I wish to thank Ny Björn Gustafsson, Joakim Schultzén and Andreas Viberg at the Archaeological Research Laboratory for making my time there a perfect experience. Generous support from the Alexander von Humboldt foundation made my two years in Stockholm possible, for which I am indebted to this splendid German science foundation. And many thanks to Per Ramqvist of the Department of historical, philosophical and religious studies at the University of Umeå for taking me under his wing as a former Swedish Humboldt fellow.

Tack så hensikt mycket allihopp!

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Summary

The Viking Period proto-town site of Birka on the island of Björkö in Lake Mälaren is one of the prime sites in Swedish archaeology and much research has been done on it. However, work with the site is not directed by any overarching research strategy, but carried out by a range of governmental institutions and university departments. Moreover – in addition to demanding reading comprehension in at least three languages – it is difficult to get an overview of the output of relevant publications as some are only accessible at the offices of the issuing organisations. Lastly, the simple fact of a long tradition of research makes it difficult to define the current state of the art and determine future research directions.

There have been repeated calls for summarising synthesises on Birka. At similar sites such as Sigtuna, GIS systems have proved to be appropriate tools for processing large datasets for post-exca-vation analysis. Such computer-aided methods are nothing new in Birka research. Yet none of the manifold attempts were ever used as the starting point for the development of a comprehensive GIS gathering all available information in one system.

All research questions about Birka presuppose exact knowledge of where on Björkö information is available thanks to excavations and surveys. Because of the vast amount of information, GIS has proven to be a working approach. The system was built on the basis of modern topographic maps and various historic ones. In order to feed the GIS, large parts of the Birka literature were consulted for outline maps, excavation plans and distribution maps, and supplemented by data acquisition at the ATA archive in Stockholm, reviewing the site records. Furthermore, only partly published bachelor’s and master’s theses at the Universities of Stockholm and Södertörn were reviewed.

During data acquisition almost every piece of cartographic material with spatial reference for the site was gathered and rectified. In this manner, for the first time the many excavation trenches can be precisely placed in relation to each other, permitting an overview of available information. Recently available LiDAR data permits the construction of a high-resolution three-dimensional model of Birka which is important for e.g. simulations of shoreline displacement. However, pending the reports on the Black Earth excavations of the 1990s and recent geophysical surveys, important pieces of the puzzle are still missing. To conclude it shall be emphasised that the development of a GIS does not in itself constitute a scientific result. But it can become an important point of departure for new comprehensive studies of Björkö.