Odense ByGIS – Odense Urban Archaeological GIS

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Abstract

Urban archaeology should be managed properly and well-informed strategies are essential. Deposit Modelling can provide the background data and knowledge for these strategies on city-scale as well as site-scale. Deposit Modelling is though not a novel enterprise and it deals with estimation of deposit distribution, accumulation and survival as well as the modelling of the urban topography.

The present piece of writing is based on the MSc and MA dissertations of the author. The project deals with the issues of mapping and assessing of the deposit resource in the Danish city Odense through Deposit Modelling and terrain interpolation. The efforts of the Danish National Cultural Heritage Agency, the English Heritage's Urban Archaeological Database programme and the studies from University of York are referred to.

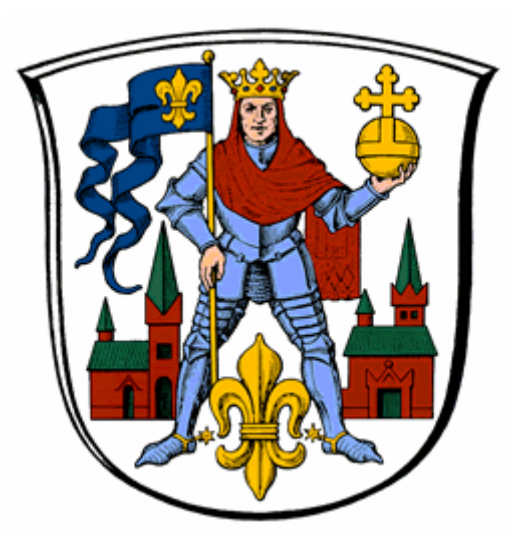

Figure 1: City arms of Odense

Introduction

The archaeological resource within towns is a valuable and vital element of the surviving heritage, and excavations in urban environments are exciting and complex, but expensive projects: damaging to the sponsors purse and the archaeological resource. In the United Kingdom it has been recognized that the urban archaeology has to be properly recorded, mapped and managed through the so-called Urban Archaeological Database programme. In Denmark, the native country of the author, the National Cultural Heritage Agency has recently initiated a programme of mapping the areas of cultural heritage and unique resources on a general level including landscapes as well as urban environments in their contexts.

The author's efforts deals with comprehensive studies of the development in the growth of urban deposits in the medieval city of Odense by applying GIS deposit modelling, terrain analysis and spatial statistics to the material (Note 1). The prime aim is to encourage the Danish medievalists to better understand the 3D development of the medieval town and be aware of the situation of the archaeological resource for the improvement of future strategies for its preservation and study. The result should in practice be a predictive terrain model of the deposits to be utilised for better-informed decisions and priorities prior to intensive investigations and planning schemes.

2. Managing and preserving the cultural resource

1 Areas of Cultural Heritage in Denmark

In the recent years there has been a shift in point of view on the protection of the archaeological heritage in Denmark. Previously monuments were protected singly and more or less separated from context, but now a nationwide campaign on mapping areas of cultural heritage has been initiated (Kulturarvsstyrelsen 2003). The urban medieval archaeology is now considered as a valuable and unique resource. These areas of cultural heritage are not objects of legal protection, but rather areas recognised and flagged for their archaeological value and quality where modern interference should be prevented. Archaeological considerations should be included in town planning – a factor, which the new Danish Museum Act of 2001 takes into account (Museum Act 2001:Chapter 8).

The programme includes all sorts of different archaeological features by mapping their geographical extent for display on the Web site of DKC, the Danish National Record of Sites and Monuments. This brings us to the topic of this paper, which is the digital mapping of urban archaeological excavations and modelling the remains of urban archaeological deposits.

2 Handling the pressure of development on urban archaeology

Until recently archaeological excavations have been carried out prior to construction works with substantial sacrifices for both the developer's finances (or government funds) and the archaeological remains – particularly in urban locations. Modern urban development moreover usually has a higher priority than archaeological remains. Well-informed decisions concerning the archaeological remains prior to development planning and constructions are therefore crucial. Understanding and knowledge of the particular towns history and archaeological development are of course a common task for the local archaeologist, but often not much is known about archaeological survival on-site until the digging begins (Note 2). The local curators need to have strategies for the urban archaeological resource in competition and co-operation with the development plans. The strategy should be shaped by archaeological knowledge and research priorities based on assessments of the urban archaeology and a map or model of the archaeology and the deposits survival and conditions. The strategy, assessment and deposit map form the framework of the local site evaluations, producing a more detailed picture ahead of excavation works. The choice of excavation site and excavation strategy would then more heavily depend on the site context, research programme and archaeological strategy, rather than mere budgets, and the urban archaeologist can better defend his judgments and efforts.

3 Predicting the archaeological resource

Prediction of archaeological settlements and deposits in the open landscape and the crowded city is not novel. Particularly the landscape-wide applications are widespread in North America and to some extent in Europe and other continents, e.g. Highway projects in Slovenia (CAA 2000) and the Netherlands. Prediction of urban archaeological deposits is slightly more rare, although introduced early in United Kingdom and France on an analogue basis. The techniques and concepts of deposit prediction matured since the 1970's along with the awareness of their dangers and problems, which are still under discussion, though not always acknowledged in more modern projects (Miller 1997:33). The first projects by British researchers include *The Future of London's Past* by Biddle *et al* and research by Martin Carver (Carver 1983), both emphasising the importance of the three-dimensional body of deposits representing the archaeology rather than isolated monuments and the usual two-dimensional plane recording approach. The development in the recent decades of the GIS software, and desktop GIS packages, to model and spatially analyse terrain data in pseudo-3D has emphasised the three-dimensional methodology. As Paul Miller points out: "The data we model does not exist on a two-dimensional plane, but in a three dimensional world where the

extremes of topography have a significant effect upon the use of space both now and in the past" (Miller 1997:100).

Estimation of urban deposits usually has a different ambition than prediction on landscape level; the aim is often to assess the deposit distribution and accumulation and the topography of a known urban settlement – e.g. Roman London or York.

Landscape predictive modelling is often based on the calculation of probability of the location of certain phenomena and deduction from known situations to more or less unknown wider contexts (Andresen, pers.comm.). Modelling in urban environments is not less environmentally deterministic than traditional landscape predictive modelling: the predominant data sources are known archaeological excavations and boreholes, and the aim is the calculation via interpolation of deposit volume, accumulation and survival for the perception of the general nature of the subsurface stratification (Carver 1983:341, 369). The detailed knowledge of depth and quality of deposits and structures is important to measure the expected impact on archaeology from developments, prior to urban site evaluation (Richards 1990:32, Carver 1983).

Archaeological predictive modelling is often viewed with scepticism as a problematical pursuit offering no alternative for archaeological investigation and research whatsoever (Carver 1983:341). Prediction and interpolation is naturally a best guess and one can never produce an exact result, which depends on a number of variables such as quality and distribution of sources, local variations in terrain, methods of calculation, the use of algorithms and so forth. Particularly if the model avoids areas of archaeological importance, scepticism is provoked – often rightly – and as Martin Carver highlights that "emphasis of these exercises is always on the positive rather than the negative results" and "no archaeological map, can or should be taken as complete" (Carver 1983:369). However deposit interpolation and computation in urban environs does have its justification when used properly and consciously for the benefit rather than to the detriment and negligence of the archaeological resource, particularly as a tool for assessing the resource and formation of strategies for its preservation and investigation. Examples from United Kingdom will illustrate this approach in the following chapters.

Mapping urban archaeology in England: UAD and YAA

1 The Urban Archaeological Database programme

The necessity of strategies for urban archaeology through assessments, mapping and recording the archaeological features and deposits, has been recognised at a national level in England. This has been accomplished through the English Heritage (EH) programme Urban Archaeological Databases (UAD), which is still in progress, as part of EH's 'Forward Strategy'. Via the UAD programme the archaeology of 30 towns of chronological depth, good preservation and clear development pressures have been GIS-mapped and recorded intensively and a larger number of less significant towns have been extensively investigated (English Heritage 2001, Thomas, pers.comm.). The GIS and databases form the starting point for new and repetitive assessments of the urban archaeology preceding the development of strategies for preservation of the archaeological resource and its role in the modern urban environment.

In the UAD structure the urban archaeology is considered as a collection of monuments following the Event-Monument partition designed for the Colchester proto-UAD and now utilised in the recent SMR (Sites and Monument Records) database structure (Thomas, pers.comm., Hopkinson 2002:18). The UADs incorporates from time-to-time relatively simple maps of the distribution of deposits, but seldom by a full-scale deposit model.

2 The York studies

The York Archaeological Assessment (YAA) project was a pilot project of EH and York City Council prior to the UAD programme, but the approach of YAA is different. The town is perceived more holistic as a undivided and integrated, although disparate, entity with the main focus on the distribution and quality of deposits rather than a number separated monuments – a concept based on research by Martin O.H. Carver (Oxley, pers.comm., Carver 1983, Richards 1990). York is of course renowned for exceptionally well-preserved archaeological features and stratification, such as the situation the Coppergate excavation revealed for the Viking remains. The YAA embodied in a collection of data in a dBaseIII+ database package and a series of digital map layers produced with Unimap software, the archaeological development and characteristics, including a 'four dimensional' model of the topography of deposits. Furthermore recommendations for construction designs for minimal damage to the remains and suggestions for archaeological research and preservation strategies were proposed in the report (Ove Arup et al. 1991).

With his PhD thesis in 1997 from University of York Paul Miller enhanced value of The York Archaeological Assessment project adding supplementary technical and conceptual discussions on the capabilities of applying GIS methodologies to study the multi-dimensional and multi-temporal sequence of deposits in the city. This was a town-wide approach to obtain a broader perspective of the town, in particular its Roman parts, to be further exploited in urban archaeological research and management (Miller 1997).

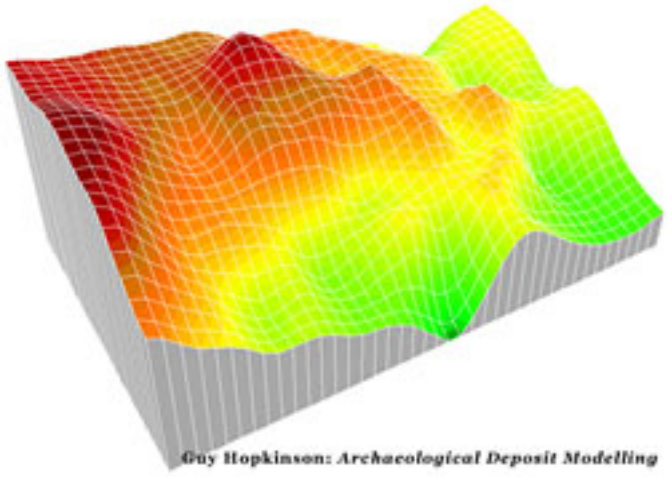

Figure 2: Deposit Model (Hopkinson 2002)

The nature of the YAA material makes it useful at an all-purpose level for curators and researchers for the town as a whole. However, recent studies in York by Guy Hopkinson have addressed the deposit analysis and modelling from a task-based perspective in the hands on the contracting archaeologists in archaeological site evaluations (Hopkinson 2002). Data from the urban database were drawn on and enhanced with supplementary borehole data and a context-based data structure, as more detailed analyses were required. Hopkinson points out that any new site evaluation might ask new questions of the material, which the existing data set might not be suitable for. Conversely much of the detailed site evaluation data will be superfluous to the scope of the urban database and GIS (Hopkinson 2002:19).

The Odense Studies: Odense ByGIS – Urban GIS and Deposit Model

Odense, situated centrally as the main town on the island of Funen, is the third largest city in present Denmark after the capital Copenhagen and Aarhus. The earliest written and archaeological sources date back to the late Viking (Christian) period identified as the residential town of a bishop and including a Viking circular fortress and structures of civil habitation, trade and craftsmanship. In the Medieval period (c. 1060 – 1550) the town develops into a characteristic medieval town including a cathedral, a bishop's palace, clerical and civil institutions, churches, a town ditch and mound, street plan and marketplaces and houses for habitation, trade and craftsmen.

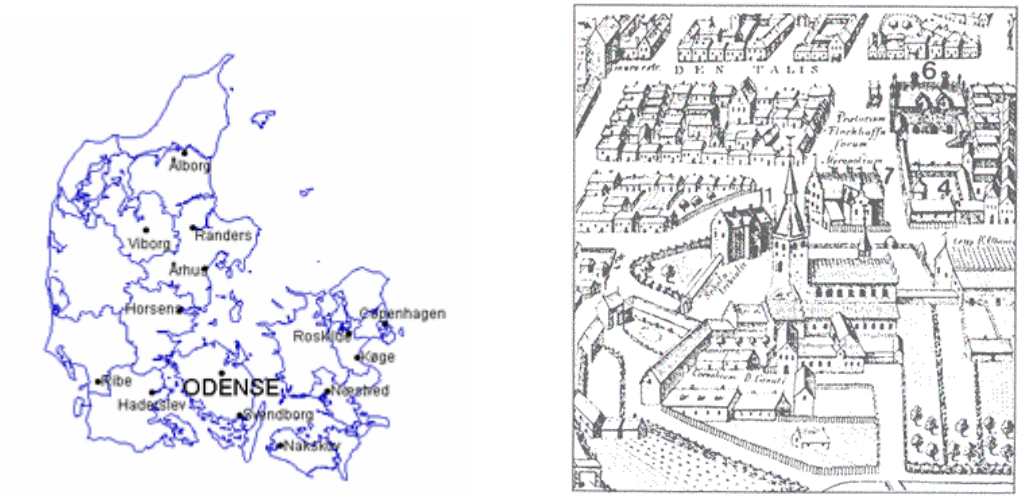

Figure 3: City of Odense on a map of Denmark and a section from the 1593 prospect by Braun & Hogenberg

The archaeology of Odense is managed, conducted and archived through the decades by the Odense Bys Museer (Odense City Museums) archaeological unit. In recent years a database and Internet-GIS system 'ArkData' has been developed for the recording and mapping of new excavations using MS SQL Server and MapInfo's MapXtreme server based software (Odense Bys Museer 2001).

The author's MSc dissertation 'Odense ByGIS' was the first project to deal digitally with the archaeological excavations of Odense producing a relatively straightforward database and GIS handling of the excavations and their basic information for curatorial use (Zinglersen 2001). The dissertation from University of Newcastle upon Tyne was finished in 2001 forming a part of my MA degree from University of Aarhus, Denmark, which is still in progress. The topic of my current MA dissertation resumes that of the preceding dissertation, but now includes the area

of deposit modelling and mapping of the urban archaeological resource as discussed in the preceding chapters.

1 The first project: Mapping the antiquarian events basically – the Newcastle Dissertation

The initial stage of the Odense ByGIS (or urban GIS) was formed by my dissertation for the Master of Science degree. The project deals with the antiquarian events: boreholes, watching briefs, excavations, trial trenches etc. and their data of administrative and interpretative nature, approximating to what in England would be termed a UAD, though just slightly more basic. The system was intended to assist the curator in managing the archaeological investigations by providing him with the basic information and a geographical overview for the initial site evaluation prior to examination of the extensive analogue archive.

A number of criteria were established for the system: Implementation should be relatively easy as should maintenance of data and the system; it should have a short production period and contain only basic information mainly from existing digital data. Furthermore it should be easily adopted by other museums.

The system consists of a MapInfo and a MS Access application – the software packages in use at the archaeological unit. The Access database are holding, managing, modifying and sorting the records with their information and values, and then distributes the results as flat tables to MapInfo automatically. MapInfo displays the data connected to the digitalised spatial entities, together with a series of map overlays.

The MS Access software package holds two databases: investigations and listed buildings. The excavation database draws information from an existing database on find reports, containing basic information such as record id, id number relating to a national identifier, year of registration, name of location and excavation site, date of antiquarian event, type of investigation (e.g. borehole or excavation), category of finds from the investigation and an abstract of the results, among others. The existing database is modified through a number of queries into a more compact and readable table to be exported automatically to MapInfo. Excavation limits are digitised or converted from paper or digital plans; and then transferred into a general map and related to the exported database records to be queried in MapInfo by the archaeologist.

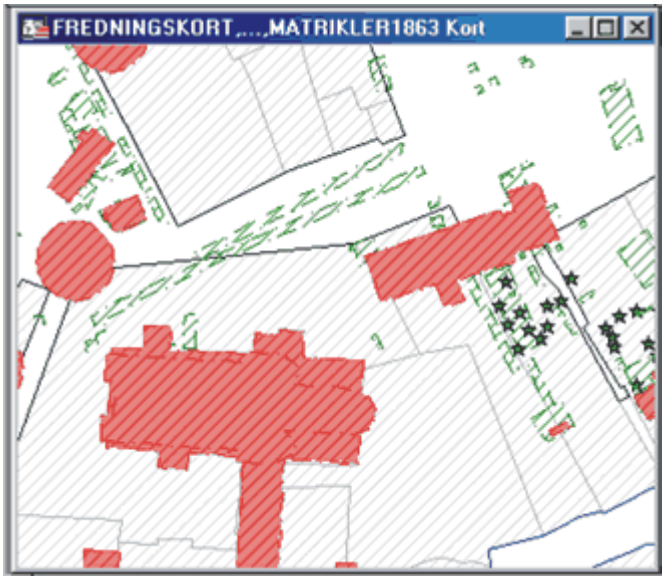

Figure 4: Excavation trenches (green) and listed buildings (red) in central Odense

The database on listed buildings which contains information on the large number of statutory protected listed buildings beneath and above present street level is managed on a national level by the Department of Environment/ the Administration of Cultural Heritage. The database holds the attribute information on each monument such as the street name, the land parcel ID, record no., status of protection, a description of the structure and the state of preservation. Again, the database is automatically exported to MapInfo and linked.

A number of map overlays have been created in MapInfo utilising digital maps or digitised analogue maps. A historical map from 1863 has been digitised showing land parcels and streets used as the primary background map for the GIS besides the modern digital map from the Odense City Council. In addition a number of thematic maps such as maps of wetland areas and streams, contour map, geological maps, location of secular institutions (courthouse, town hall, guild halls etc) and ecclesiastic institutions (e.g. monasteries, property and parish churches) have been digitised. They support the curator in site evaluation, interpretation and publication.

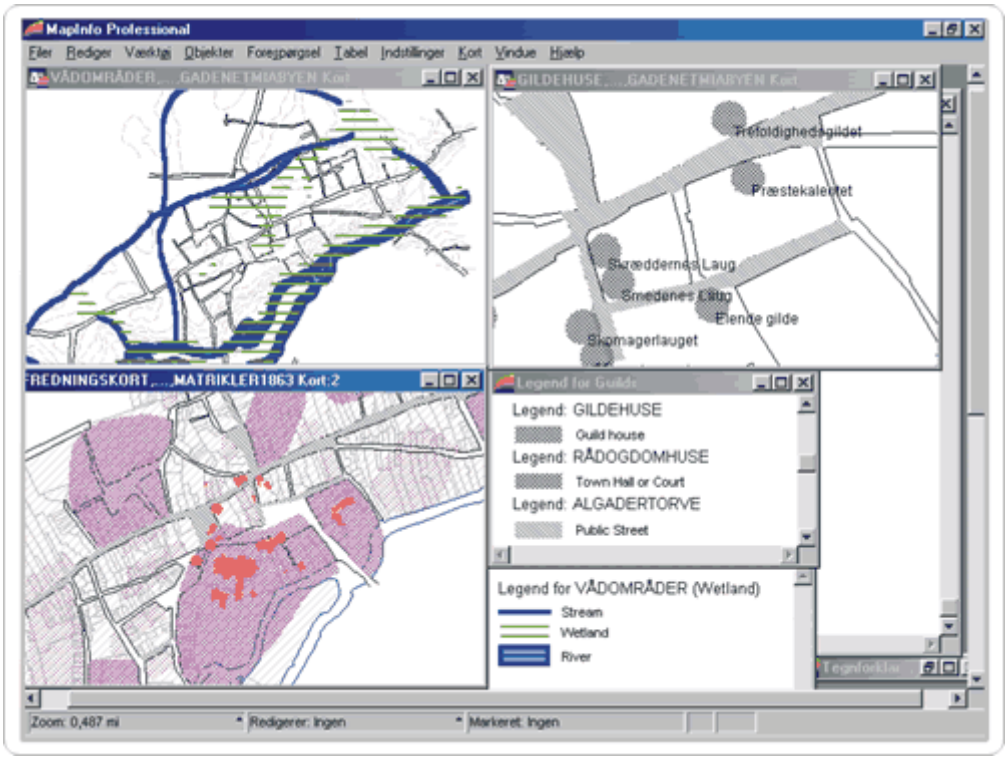

Figure 5: Thematical maps showing the general picture. From left to right: Wetland areas, secular and ecclesiastical institutions

The aim of the 'Odense ByGIS' system is to provide the curator with a GIS and database for the display, querying and management of geographical and attribution information on the preceding archaeological investigations and the listed buildings in the town for site evaluation and interpretation. The system is designed for a basic level of information for relatively fast and cheap implementation in the organisation using existing information. The project is currently only submitted as a dissertation from the University of Newcastle upon Tyne, being a pilot study for further implementation, hopefully to be realised within a short time. It is planned to improve the system by adding a database on written sources including estate tax registers.

Furthermore a new project by the author concerning Deposit Modelling is currently in progress. The work, carried out as a MA dissertation from University of Aarhus, will be an enhancement of the urban GIS mapping and modelling of the cultural resource of medieval Odense; a project to be explained in the following chapter.

2 The new project: Deposit Modelling and prediction – the Aarhus Dissertation

Inspired by the Danish national programme on cultural heritage areas and by the English Heritage and York projects my MA thesis from University of Aarhus deals with the matters of archaeological resources in the field of urban archaeological deposit modelling, prediction and preservation using GIS.

The prime ambition of the project is to enhance the discussion in Denmark on the priorities of urban archaeology and the understanding on the three- and four-dimensional development of the medieval town. Initially the result of the project should provide the Odense Bys Museer with an enhanced GIS tool for mapping, recording and managing the archaeological resource to be used for instant planning of efforts, priorities and strategies in the urban archaeological operations and for further research on the subject. For the benefit of future projects, the project should identify the advantages and limitations of Deposit Modelling in urban environments and the technical and theoretical methodologies to be applied.

The detailed study will answer the questions on how to digitally record, map and model the resource using different sources; on how to take advantage of the modelling and mapping results in the research, the management and preservation of in urban archaeology in practice, particularly in the estimation of deposit volume and character in site evaluations.

Data acquisition and estimation of data quality will be the initial concern. The types of sources to be included in the deposit model will first of all be information from archaeological investigations: the existing GIS-data from the Newcastle dissertation project, excavation plans and data, boreholes, watching briefs and other surveys; secondly the City Council's borehole data, modern digital maps, geological maps and possible cellar surveys. Each type of data source needs to be handled individually including its own variety of inaccuracies, biases and oddities. These issues must be recorded and mapped as metadata, so their expected effect on the model can be documented. The similarities of the sources will be combined for a common sampling method to the extent that it is possible.

The next issue is the calculation of terrain model(s) of the deposits. A range (Triangulations, Krigings, and Inverse Distance Weighting etc.) of interpolation methods will be considered for their usefulness on the data set and for the required results. The interpolation methods will be applied on the data set on this background either singularly or in combinations and the result tested with spatial statistics.

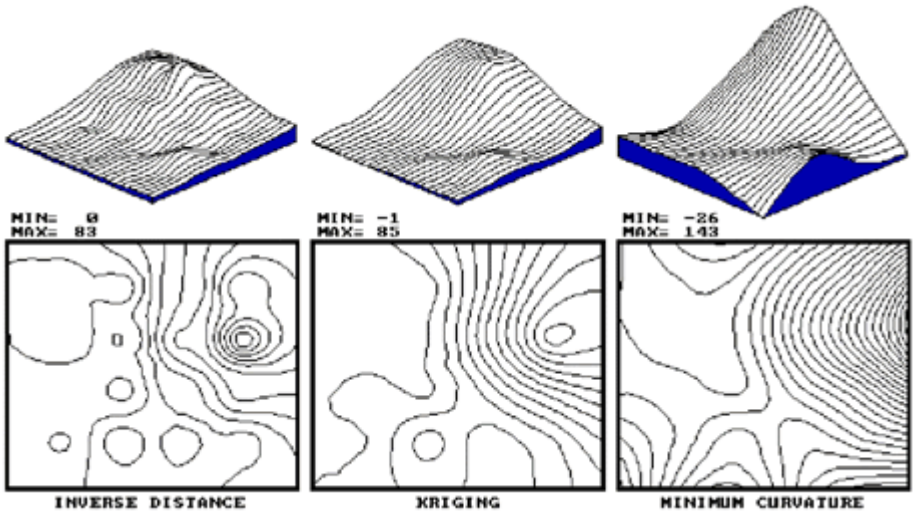

Figure 6: Different interpolation algorithms and their results

The resulting models and maps should preferably display the predicted capacity and state of preservation of the urban medieval archaeological deposits, and give a general presumption of the correlation between the distribution of deposits and the topography and development of the medieval town as outset for more detailed future studies.

Summary

The urban archaeology is a valuable and vital element of the heritage of a city and should be managed properly. Well-informed strategies and decisions on the basis of quantitative, qualitative and geographical studies are essential.

The present piece of writing has dealt with the issues of mapping and predicting the urban archaeological resource with references to the efforts of the Danish National Cultural Heritage Agency, the English Heritage's Urban Archaeological Database programme and the studies from University of York.

The National Cultural Heritage Agency last year initiated a campaign of mapping the areas of cultural heritage in Denmark, including the 70 medieval cities for display on the DKC website, and in the UK English Heritage has since the early 1990's directed the GIS mapping of the urban archaeological archives through Urban Archaeological Database (UAD) programme.

While the UAD programme utilises the Event-Monument structure similar to the SMR databases, the York approach proved to be different, perceiving the urban environment

holistically with emphasis on a predictive and explanatory deposit and terrain model estimating the quantity and quality of the strata.

The objective of urban predictive models is another than landscape predictive models: estimation of deposit distribution, accumulation and survival as well as the modelling of the urban topography. Urban archaeological prediction is as such not less environmentally deterministic than landscape models, the predominant data sources being archaeological investigations and boreholes. But often, detailed knowledge of depth and quality of deposits and structures is viewed as important for the assessment of the archaeological impact on modern development plans.

However, predictive modelling is generally regarded with scepticism as a problematical pursuit and it is obviously merely an educated guess and not an exact result. But predictive modelling in urban environs can be justified when used consciously bearing in mind the factors influencing the model, particularly for well-defined site evaluations.

The Odense studies comprising my MSc and MA dissertations from University of Newcastle and University of Aarhus respectively, include firstly a basic GIS for managing the archaeological investigations in Odense City and secondly a predictive deposit model; the latter currently at the stage of preparation. The projects are expected to support the decision-making process on the priorities of the urban archaeology and site evaluations and improve the understanding of the three- and four-dimensional development of the medieval city centre.

The first part of the scheme 'Odense ByGIS' carried out as a MSc dissertation was a straightforward application using MapInfo and MS Access containing only basic information mainly from existing digital data of archaeological investigations and listed buildings together with various map overlays: historical map from 1863 and different thematic maps.

The second part of the scheme includes a deposit terrain and volume model of the city centre interpolated from existing data from boreholes and excavations primarily. The project introduces the identification of advantages and limitations of Deposit Modelling including evaluation of data quality and quantity and choice of technical and theoretical methods, hereunder interpolation and statistical calculations. The UK experiences will be drawn upon. The aim is to map the predicted capacity and state of preservation of the urban medieval archaeological deposits, and give a general presumption of the correlation between the distribution of deposits and the topography of the medieval town future studies.

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I wish also to acknowledge Roger Thomas (English Heritage), David Jamieson (MoLAS), Julian Richards (University of York/ ADS) and John Oxley (York City Council) for their kind help and sound advice. I also owe a dept of gratitude to Dominic Powlesland and Guy Hopkinson (Landscape Research Centre) for their excellent hospitality and pleasant and interesting company during my visit in England Spring 2003.

Notes

1. The author is currently MA student of Department of Medieval Archaeology at University of Aarhus and holds an MSc in 'GIS and Archaeology' from University of Newcastle upon Tyne. The MSc dissertation dealt with the construction of a straightforward GIS tool for managing the excavations of Odense; the MA dissertation in progress deals with Deposit Modelling and Preservation in Odense.
2. Archaeological investigations in Denmark are managed, conducted and recorded by the Department of Culture through the National Cultural Heritage Agency – and in practice by the local museums. The local museums are governmental approved institutions employing one or more archaeologists to take care of every part of the archaeological work. The current Museums Act introduces the 'Developer's Pay' principle to Danish archaeology. Concluding the site evaluation and trial trenches etc., the museum estimates the expenses of the following investigations and excavation for the developer or building owner - an estimation to be kept.

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