C.11 Using GIS in an HER

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C.11.1 Uses of GIS and spatial data#

GIS is now widely used by HERs. Seeing HER data in a spatial context which can be interactively queried and edited has proved very useful. Advantages include:

- **Visualisation of data as spatial distributions (in either two or three dimensions)**: even a simple distribution (for example Iron Age settlements in Derbyshire) can provide a powerful aid to understanding or providing new insights into data. The ability to view a combination of datasets enhances this potential considerably (for example Neolithic settlements in relation to water courses, soils and contours).
- **Analysing spatial relationships between data**: for example finding all records of upstanding earthworks which lie on arable land. This enables interaction with data and helps to answer research questions (such as were the location of Bronze Age settlements influenced by proximity to, for example, natural resources, soils and water) .
- **Improved decision-making**: for example facilities to help identify sites that may be affected by a planning proposal by using 'buffer zones' - zones of fixed distance around a selected feature generated by the GIS.
- **Overcoming the limitations of paper maps**: for example editing, availability, currency, fragility, distortion, storage.
- **Data integration**: if a database is georeferenced, then a number of separate databases can be brought together in a common environment and viewed together.
- **Improving data quality**: through capturing geographic references directly; automating transfer of information (for example between GIS and text database); routines that check data integrity (for example point in polygon analysis to determine whether a grid reference falls within its assigned administrative boundaries).
- **Saving time**: through rapid availability of a wide range of sources of information. This is particularly true where wider institutional systems are available enabling access to non-archeological data sources as well as conventional HER data.

Figure 19: A GIS generated map showing Bronze Age barrows over Landscape Types and rivers in Hampshire (© Hampshire County Council 2007 and © Crown Copyright. All rights reserved. 100019181. 2007).

C.11.2 Linking GIS to text databases#

The databases used for the HER may allow the HER and GIS to be dynamically linked, or the HER may be run with a separate GIS which is updated separately to the HER.

Most HERs using GIS will also hold spatial data and other information in the HER databases described elsewhere in this guidance. An important consideration in setting up the GIS will be how to create a link to the HER database. The first step in this process might be to export data from the HER database and use it to create points in the GIS (see B.10.4). However, this layer will become out of date as new records are added to the HER. HER managers will also wish to use the GIS to check and correct the locations of existing records in the HER database.

Various approaches to the problem of keeping the two systems in step can be adopted:

- If the GIS is implemented as a separate system from the HER database then it may be periodically 'refreshed' with new data from the HER database. Any corrections that are made to site locations in the GIS will need to be exported (or manually copied) back to the text database.
- A dynamic link may be created between the HER database and the GIS using a communications protocol to enable grid co-ordinates and other information to be exchanged between the two systems.
- An approach that is not recommended for HERs would be to migrate all the existing HER data into the GIS and to scrap the existing text database. This is because few GIS products support complex data structures directly or offer the same flexibility in indexing or retrieval of information that is recommended for HER text databases.

Windows-based desktop GIS systems can be linked to external text databases using one of the following protocols: OLE (Object Linking and Embedding), DDE (Dynamic Data Exchange) or ODBC (Open Database Connectivity):

- **OLE** is a protocol and set of function calls that are incorporated into the Windows operating system. It allows programs to communicate with each other and is used extensively by Microsoft® to enable word processor, presentation, spreadsheet, database and other applications such as GIS to work together efficiently and exchange data. OLE is used to link or embed objects creating a compound document which can contain other documents: for example an Access form might contain a Word document, an Excel spreadsheet or a MapInfo workspace. Linking means that data is presented in the compound document but it is retrieved from its original file using the file name. Embedding means that data from the original file is incorporated into the compound document.
- **DDE** is another protocol that is incorporated into the Windows operating system which allows one application to exchange data or to trigger an action in another application. DDE is a protocol for manipulating applications programmatically and allows data to be extracted, macros or programs to be run or information to be listed. There is some overlap in functionality with OLE but DDE is older, less robust and a more basic method of enabling communications between different applications. DDE is used for programs that do not support OLE, for example to create links between databases and ArcView GIS. DDE is also used for controlling programs across a network (a function not currently supported by OLE).
- **ODBC** is a common language definition and a set of protocols that allows a database application held on a client machine to interact with a different database application held on a server across a network. For example, using ODBC, an Access database held on a work station can query and exchange data with an Oracle database on a network server. For this to happen, ODBC drivers that are appropriate for the application software need to be installed on both the client machine and the server machine.

C.11.3 Developing HER layers in the GIS#

The way information has been modelled in the HER text databases will have a significant influence on the way the spatial information is constructed. The current data model may be based on MIDAS (Lee 1998) or derived from earlier monument-focused systems. Different attributes or data fields from the text database will be referenced in the GIS and used to create different layers or themes. A problem that will need to be accounted for is that data may not be entirely consistently recorded throughout the database: for example a monument-focused database may have contained some information about events and the HER may be in the process of implementing the event-monument-source data model. In developing HER layers in the GIS the following will need to be considered:

- the initial data load from HER text database to GIS (see B.10.4)
- subsequent updates of the GIS layer (that is, with new records entered into the text database)
- subsequent updates of the text database (that is, with updates to grid references or new records imported from the GIS).

The ideal 'relationship' between text database and GIS is one in which data can be entered either through the GIS or through the text database, but this requires a close connection between the two systems. This is generally provided by a computer-generated record number (such as the HER number for monument records) which is used to link information held in data tables in the two systems. The HER text database will normally control the allocation of unique identifiers for monuments, events, sources and consultations. Users would go to the HER text database to create a new record and then, using an OLE or DDE link, go into the GIS to add or modify spatial data. With this type of link, core record details are copied from the text database into the GIS and spatial references are copied back from the GIS into the text database.

An even higher degree of integration between GIS and text database would allow users to start by creating a new record in the GIS. To achieve this the GIS needs to be able to activate the text database to generate the next unique identifier in the sequence.

When configuring the link between the GIS and the text database, users also need to consider what information will be passed between the two systems and specify appropriate rules for updating. Useful information to pass back from the GIS will include grid references, administrative boundaries and environmental features such as soils and geology. Useful information to pass from the text database will include monument type, period and building materials.

HER users also need to consider what information they wish to generate 'on the fly' in the GIS and what they wish to record directly in their text database. For example, a corporate GIS system may contain a large number of boundaries such as National Parks, Areas of Outstanding Natural Beauty (AONBs) and SSSIs Visual inspection of the GIS or a spatial query can readily identify which monuments lie within any of these boundaries without the information being directly attached to the monument records in the text database. HER managers are thus able to differentiate between important information about the monument status that they wish to appear on screen and in reports (for example scheduled status) and spatial queries that can be built up according to need in the GIS.

C.11.4 Mapping features on the GIS#

Mapped features representing the 'real world' are abstractions and symbols are used that can be readily understood or related to a key. For example, at a scale of 1:1 million, a city may be represented as a point - a completely abstract representation but one which is understandable and appropriate to the scale of mapping. Larger-scale maps generally use less abstract symbols, so for example at 1:10,000 the same city will be represented by the outlines of buildings, roads, gardens and so forth.

In GIS, features can be represented using points, lines, polygons and 'poly-lines' (a continuous line consisting of multiple lines joined together). All of these have their uses in representing archaeological and historic features. For example, points could be used to represent find spots and also perhaps to indicate the location of features where these are already shown on the map, for example points within building outlines. Points are also useful for showing site locations in distribution maps at scales where polygons and polylines simply would not be visible. Lines can be used to indicate linear features such as roads, canals and railways.

In deciding which shape to use, it is important to consider to what purpose the data will be put. If, as in many cases it will be, the aim is to indicate the extent of a monument or building, then polygons will be most useful. If the purpose is to show discrete find spots then points are more appropriate. The next issue is how and where these shapes are to be drawn and the accuracy that is required; the scale of the mapping available will affect the decision.

It is difficult to give detailed guidelines but the issues discussed below are worth taking into consideration.

Depiction of the extent of known boundaries#

Where the extent of the monument is known and especially where the monument or building is clearly visible, then there are advantages in showing the extent of the monument on the GIS. This enables users to see the monument or building in relation to other features in its landscape setting. Figure 20 shows an example of.the use of polygons to plot the early 19th century defences south of Chelmsford in relation to contours, thus allowing their topographical location to be understood.

Figure 20: A GIS layer showing the use of polygons to show the extent of the early 19th-century defences at Chelmsford. (© Essex County Council 2007and © Crown Copyright, All rights reserved. 100019602. 2007).

Conventions for depicting uncertain boundaries#

Where the extent is uncertain, then, as is often done with more conventional mapping, the boundary could be drawn using the nearest modern boundaries that enclose the known features (metadata should be recorded explaining why the polygon has been drawn in this way).

Uncertainty can also be represented by symbols. For example, solid lines might be used to represent known boundaries, while uncertain boundaries could be represented by broken (dotted) lines. Some GIS may allow 'mixed' symbols within a polygon (for example where only one boundary is uncertain), though in most, a separate line would need to be digitised over that part of the polygon.

Creating a GIS layer to show legally defined boundaries#

Many sites recorded in HERs require special consideration in land-use planning, for example sites that are afforded statutory protection, which may have a legally defined boundary showing the protected area (Figure 21). The protected area may differ from the full extent of the monument site, such as a monument site that survives partially as earthworks and partially as cropmarks, with the better preserved portion of the site being scheduled. For these reasons, it is recommended practice to create separate layers within the GIS depicting the extents of protected sites, for example a Scheduled Monument (SM) layer would be created for scheduled monuments. These can then be displayed over other polygons that might show features or monuments both lying within and outside the protected area. It is recommended that HERs should, where possible, obtain digital boundaries from the organisation responsible for maintaining them, for example scheduled monuments from English Heritage. It has been recently agreed in Scotland that the RCAHMS displays site polygons as known extents, while the HERs/SMRs display site polygons with buffer zones. The extent of those buffer zones and so forth are still being discussed but agreement should be reached by end of 2006.

Figure 21: Great Chesterford scheduled area (© Essex County Council 2007 and © Crown Copyright, All rights reserved. 100019602. 2007).

Scale of mapping against which data is captured or displayed#

It is important to be aware of the implications of the scale of mapping against which heritage objects are captured or displayed. Map making is a process of reducing complexity and maps are drawn in a way that emphasises important features while suppressing unimportant ones. This is the 'selection and simplified representation of detail appropriate to the scale and/or the purpose of a map' (ICA 1973). Thus, if the width of a road on a 1:1,000,000 map were to be accurately measured, its representation would be considerably wider than the a real-world width of the road. As roads are important features on maps they need to be emphasised and, as a result, on the map any adjacent features are shifted.

Because successively smaller scales of mapping are more generalised, an object whose position was captured against a small-scale map will, when displayed against a larger scale of map, appear to be in the wrong place (and vice versa). For example, the outline of a building captured against a 1:10,000 OS raster map will not be reliably displayed against 1:1,250 OS Landline because the digitised boundaries will not match the Landline boundaries. This effect is most marked when digitising from very small-scale mapping. For example, if Roman roads were digitised from a 1:1,000,000 map base, when displayed against a 1:10,000 map base, they might be up to 1 km away from their expected position. Thus, a dataset captured at small-scale is unsuitable for display against a detailed large-scale map.

Capturing archaeological and architectural boundaries#

As a general guide, 1:10,000 is the smallest scale of mapping against which the boundaries of archaeological monuments or features should be captured. For the outlines of detailed features, such as buildings, larger scale mapping such as 1:2,500 or 1:1,250 is preferable. Smaller scale mapping (for example 1:25,000 or 1:50,000) may be useful for capturing general area information (such as the bounding extent of a large field-walking survey).

In each case, it is essential that the scale chosen is related to the purpose to which the information will be put. Details of the scale of map used in data capture should be documented in metadata.

Accuracy of grid references for archaeological point data#

In archaeology it is common practice to record the location of features using six or eight-figure grid references, for example TQ 367425. This convention presents real problems when translated into GIS because these co-ordinates represent the bottom left-hand (or south-west) corner of a square. A six-figure grid reference actually represents a 100 metre square, while an eight-figure grid reference represents a 10 metre square. The actual location of the archaeological feature lies somewhere within the square, at an imprecisely defined and perhaps uncertain point.

If locations expressed as grid references are exported directly into a GIS and displayed as point data, the maps produced can be misleading. This is because the process of exporting the data can displace knowledge about the precision with which the grid references have been recorded.

For this reason 'padding' grid references with zeros added to the end of the numbers is a practice that can rarely be justified because, without supporting data, the process of exporting grid references from a text database into GIS can make it impossible to reconstruct whether the location of a find was generalised to the nearest major grid line, or fortuitously aligned with it.

HER managers can avoid the loss of this important information if the following measures are taken:

- ensuring that the HER text databases generally contain information relating to the site location, and recording both how the grid reference was derived and its precision. Points can be created in the HER's GIS based on grid references exported from monument records in HER text databases while retaining a link between the two systems. Data relating to the accuracy of the grid reference can be exported to the GIS alongside the grid references and used to select an appropriate symbol to depict the point.
- ensuring that metadata relating to the accuracy of the source of the locational information is recorded. If a site location is given to six or eight figures in a source but is depicted as a point accurate to 1m in the GIS, then the level of precision must be recorded in metadata.

C.11.5 A sample heritage GIS#

GIS systems are made up of 'layers' of information, which can be overlaid, combined and analysed to create new information. For example, the location of a number of archaeological sites could be compared to the location of aspects of the environment (Figure 22).

Figure 22: Examples of layers in a GIS.

These can then be used to identify sites which lie within the boundaries of particular soil types, creating new information (very useful, for example, in identifying impacts of agri-environmental schemes, set-aside, and so forth) (Figure 23).

Figure 23: A new GIS layer: archaeological sites on arable land.