RECORDING, MONITORING AND MANAGING THE CONSERVATION OF HISTORIC SITES: A NEW APPLICATION FOR BGS SIGMA

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Abstract

Historic Environment Scotland (HES), a non-departmental public body of the Scottish Government charged with safeguarding the nation's historic environment, is directly responsible for 335 sites of national significance, most of which are built from stone. Similar to other heritage organisations, HES needs a system that can store and present conservation and maintenance information for historic sites; ideally, the same system could be used to plan effective programmes of maintenance and repair. To meet this need, the British Geological Survey (BGS) has worked with HES to develop an integrated digital site assessment system that provides a refined survey process for stone-built (and other) historic sites. Based on the BGS System for Integrated Geoscience Mapping (BGS▪SIGMA)—an integrated workflow underpinned by a geo-spatial platform for data capture and interpretation—the system is built on top of ESRI's ArcGIS software, and underpinned by a relational database. Users can populate custom-built data entry forms to record maintenance issues and repair specifications for architectural elements ranging from individual blocks of stone to entire building elevations. Photographs, sketches, and digital documents can be linked to architectural elements to enhance the usability of the data. Predetermined data fields and supporting dictionaries constrain the input parameters to ensure a high degree of consistency and facilitate data extraction and querying. Presenting the data within a GIS provides a versatile planning tool for scheduling works, specifying materials, identifying skills needed for repairs, and allocating resources. The overall condition of a site can be monitored accurately over time by repeating the survey at regular intervals (e.g. every 5 years). Other datasets can be linked to the database and other geospatially referenced datasets can be superimposed in GIS, adding considerably to the scope and utility of the system. The system can be applied to any geospatially referenced object in a wide range of situations thus providing many potential applications in conservation, archaeology and related fields.

Keywords: heritage management, conservation, maintenance and repair, geospatial data capture.

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1 Introduction

Many heritage organisations are responsible for conserving and maintaining historic built sites. In Scotland, under the “Historic Environment Scotland Act” (2014), Historic Environment Scotland (HES; a new non-departmental public body) was established to take over the functions of Historic Scotland and the Royal Commission on the Ancient and Historic Monuments of Scotland. Under the Act, the new organisation is required to monitor and report on the condition of properties in the care of Scottish Ministers (referred to as the ‘HES Estate’ in this paper). The HES Estate comprises 335 sites of national significance, most of which are built from stone.

Historically, HES architects undertook detailed analogue condition assessments for each historic site across the HES Estate. The aim of the condition assessment was to inform and prioritise the conservation work at individual historic sites and across the entire HES Estate. The output format was typically a Microsoft Word document. This method of data capture and delivery has made any subsequent interrogation of the data captured for individual or multiple sites extremely difficult and time consuming, both in terms of condition or conservation work done and by whom or when. Today, HES needs a system that can store and present conservation and maintenance information for historic sites; ideally, the same system could be used to make the process of recording data more efficient and more consistent, and plan effective programmes of maintenance and repair.

Property asset management systems with monitoring schemes and planning tools have been in existence for decades. However, these systems are most suitable for the management of non-historic assets and are generally based on ‘obsolescence’ (i.e. repairs and replacement based on fashion and usefulness rather than perpetuity (Historic Environment Scotland 2015)). Some heritage asset management systems do exist. For example, ‘The Museum System’ was designed for museum collections and archives management, but was not intended for use with built sites; and ‘Tribal’ was recently specified by Historic England for managing its historic estate. However, none of the available asset management systems (for heritage assets or otherwise) seem to provide a means of interrogating the data recorded at a particular site on a particular date, or comparing the data amassed over a period of time. It is also apparent that it is challenging to keep many asset management systems up to date, mainly due to complexities of data entry.

To address these issues, the British Geological Survey (BGS) has worked with HES to research and develop an integrated digital site assessment system that provides a refined survey process for stone-built (and other) historic sites. Based on the BGS System for Integrated Geoscience Mapping (BGS▪SIGMA)—an integrated workflow underpinned by a geo-spatial platform for data capture and interpretation—the system is built on top of ESRI’s ArcGIS software, and is underpinned by a relational database. The system is capable of generating indicators of urgency and risk for conservation and maintenance issues across the HES Estate and is currently assisting with the preparation of a methodology for monitoring and reporting the condition of the Estate to Scottish Ministers.

2 Historic Environment Scotland SIGMA application

The System for Integrated Geoscience Mapping (BGS▪SIGMA) is a digital tool that was initially developed by BGS to facilitate the collection of digital data during geological field surveys and the interpretation of this data once back in the office. BGS▪SIGMA is a suite of fully customised ArcGIS tools and data entry forms that store data in a fully relational geodatabase. Within BGS it is the default toolkit for projects requiring geological data acquisition in the field. Data are currently captured using 'ruggedized' Panasonic Toughbooks and Toughpads. BGS▪SIGMA is designed to allow a wide range of geological and other data to be captured quickly and consistently. Separate modules are tailored to different types of survey (e.g. geological mapping and borehole logging activities).

Building on the existing BGS▪SIGMA toolkit, a prototype field-based site assessment system has been developed recently by BGS to store and present conservation and maintenance information for the historic sites within the HES Estate. Data capture modules specific to HES requirements are included in the prototype, which currently is referred to as 'HES•SIGMA'. HES•SIGMA has been developed using ESRI ArcGIS 10.1 software with an underlying Microsoft Access personal geodatabase.

BGS implemented the following to develop HES•SIGMA:

1. Unique GIS layers (feature classes), attributes and dictionaries within the personal geodatabase.
2. Modifications to existing BGS▪SIGMA forms and modules to facilitate HES data entry.
3. New custom forms for capturing condition survey items and associated maintenance actions data which are stored in the personal geodatabase.
4. Report output tool for exporting all recorded data.

The application module consists of a database of hierarchically arranged attribute fields, many of which are supported by dictionaries of defined terms that guide and constrain the way they can be populated. A simplified representation of the hierarchical structure of HES•SIGMA is shown in Figure 1 and screenshots of the HES•SIGMA forms with predetermined data fields and supporting dictionaries are presented in Figure 2. Further explanation of these is provided by means of the case study presented in the following section.

Capturing accurate survey data for historic sites in a concise, consistent way is made difficult due to the fact that built sites vary enormously in many ways, including their physical attributes, materials and construction history. For example, an effective data capture system needs to be able to accommodate any type of built structure (e.g. buildings, monuments, bridges, paved areas) and, for buildings alone, it needs to be able to deal with any number of façades, roof pitches and corresponding architectural elements (walling, dressings, chimneys, carvings, etc.).

The key features of HES•SIGMA are:

- Individual architectural elements are recorded as separate entities associated to individual sites (e.g. buildings) and are fully linked to the site which they belong by means of a unique identifier, GPS location and data fields with supporting 'site hierarchy' dictionaries.
- Predetermined data fields and supporting dictionaries guide and restrict the range of conservation and maintenance properties that can be recorded, ensuring a high degree of consistency in the dataset.

- Conservation and maintenance properties can be recorded for the different architectural elements of an individual site.
- Once the survey is complete, the recorded data can be interrogated directly in the database or visualized within a Geographic Information System (GIS).
- A report generator tool enables the data to be output in the form of tailored Microsoft Word documents, thus suiting any project requirement.

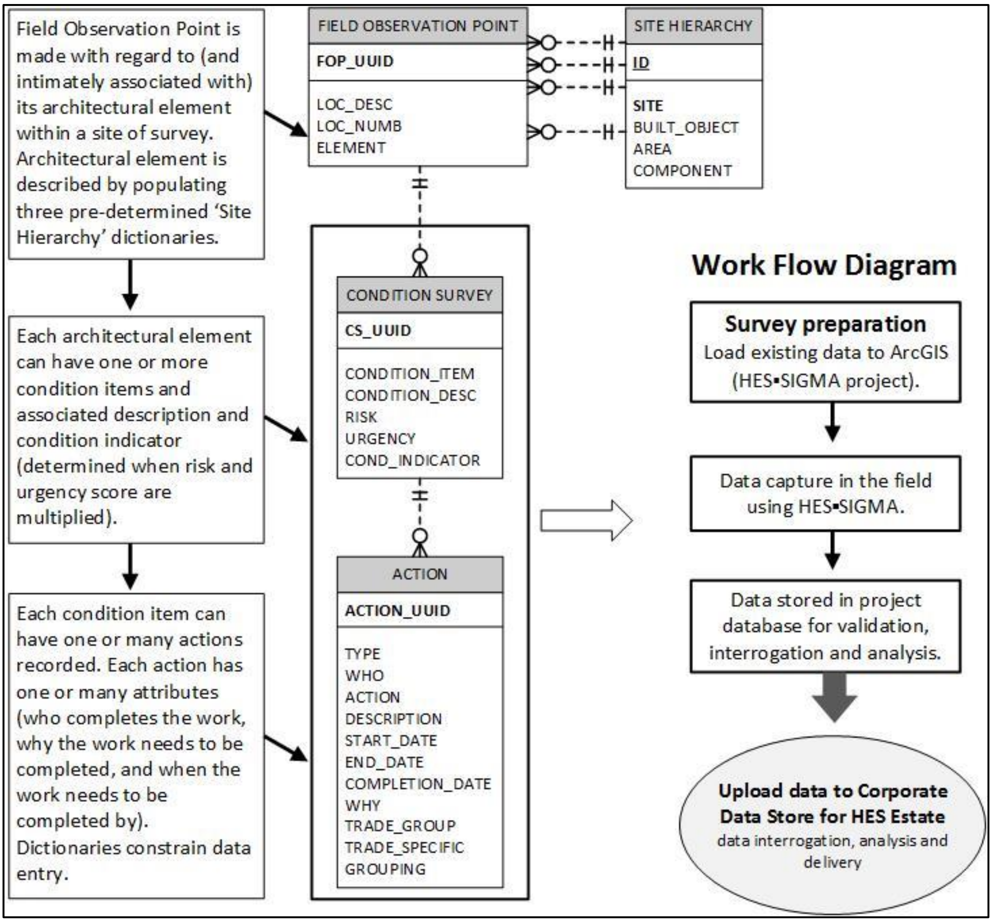

Figure 1: 'Integrated Logical' and 'Work Flow' diagrams for HES•SIGMA. The former defines the relationship of the data elements in HES•SIGMA and their underlying structures, while the latter sets out the process of population and data delivery.

The combined database-GIS approach provides a convenient means of systematically recording, storing, updating, interrogating and displaying a wide range of spatially referenced data. In its GIS form the dataset can be presented as tabulations, statistical results, or on a map. Queries can be used to quickly select, organise and view subsets of data, or to compare and contrast different aspects of the data, thereby providing a powerful and versatile planning tool.

The digital, hierarchical method of data capture and storage has two important advantages over traditional 'analogue' methods: (i) the predetermined hierarchy of fields and the supporting dictionaries ensure a high degree of consistency in the dataset; (ii) data recorded for single attributes or combinations of attributes can be selected and manipulated easily, allowing statistical and/or geospatial patterns to be drawn from the data.

3 Craigmillar Castle case study

Craigmillar Castle (part of the HES Estate) provides a useful case study to demonstrate the utility and GIS output of HES•SIGMA. The castle, which now lies within the city of Edinburgh, is an early 15th century L-plan towerhouse with later extensions, curtain walls and ancillary buildings, and is constructed mainly of local stone from the Carboniferous Kinnesswood Formation. BGS has hosted workshops with future users of the new system at Craigmillar Castle to ensure the application modules fulfil the needs of HES. The survey data captured during these workshops and the resulting HES•SIGMA outputs form the basis of th

Data captured as part of a survey must inform and help prioritise conservation work at individual sites, and also across the whole of the HES Estate. HES•SIGMA generates a form for the user to record the condition and maintenance issues for a historic site and the actions that must be taken to remedy each issue. Once the survey is complete, it is followed by a process of interrogation and interpretation from which the user is able to plan effective programmes of maintenance and repair.

3.1 The survey

The HES•SIGMA data capture modules were designed to accommodate a wide range of historic site types (e.g. roofed and unroofed structures, standing stones, carved stones, field monuments). Prior to survey, 'baseline data' are collated and loaded to a HES•SIGMA project for the site. This includes any 2-dimensional data that can be used in GIS (e.g. site boundaries, plans, national topographic survey maps (past and present), aerial photographs, past survey documentation). Incorporation of baseline data allows the user to take any additional information into the field that may assist them with the survey.

For each site, observations relating to condition and maintenance issues are recorded against architectural elements and stored in the project database. Prior to recording observations, the location of the architectural element is identified by clicking on the desired position within the site polygon (in this case Craigmillar Castle) to create a new 'field observation point' (FOP). Once the FOP has been created, the 'Switchboard' form (Fig. 2a) automatically opens allowing the user to enter additional location information using 'site hierarchy dictionaries'.

Figure 2: HES SIGMA forms (clockwise from left to right): (a) 'Switchboard' form; (b) 'Condition Survey' form and; (c) 'Condition Actions' form.

'Site hierarchy dictionaries' are prepared for each historic site to ensure consistency across the dataset and between users, and to provide the ability to monitor maintenance issues on the same architectural element over a period of time. This also allows for data sorting, querying and statistical analysis upon survey completion.

The 'Switchboard' form (Fig. 2a) is the primary access point for recording detailed data within the system. On this form location information and architectural element descriptions are entered; photographs, sketches and samples (e.g. stone, mortar) can be attributed to the architectural element described; and access to the more detailed data entry forms for recording condition and maintenance 'issues' is provided.

'Description', 'Risk', 'Urgency' and 'Condition Indicator' observations on condition and maintenance issues are attributed to each architectural element in the 'Condition Survey' form (Fig. 2b). More than one condition can be captured if necessary.

‘Actions’ can also be recorded against each observation on the ‘Condition Survey’ form. A dictionary of pre-defined terms constrains the actions required based on what stage in the repair process the work is in (i.e. monitor and review, develop proposals, works, obtain budget costs). The action can be further described, and a date can be assigned upon completion of the action.

Details of who will complete the action, what specialist skills are required and why the action needs to be completed (e.g. routine conservation, maintenance) are entered in the ‘Condition Actions’ form (Fig. 2c). A timescale for inspection of works may also be attributed to the observation in this form. These data can be entered either in the field or back in the office.

HES•SIGMA has no limitation on the number of architectural elements that can be recorded or observation data that can be attributed to specific architectural elements. All entered data are displayed in a ‘data grid’ on the bottom of the Condition Survey form and Condition Actions form for easy viewing.

3.2 Data outputs and uses

Data entered in the field can be immediately viewed in GIS for interpretation. Once field work is complete, the captured data can be utilised in the office for site-wide interpretation, then validated and loaded to a corporate database for estate-wide analysis and data delivery. With data in the corporate database, analysis on one, many, or all historic site(s) can be undertaken. The conceptual work flow diagram for HES•SIGMA is presented in Figure 1.

If the data are uploaded to a central database it is easy to quantify the number of observations at any given site, and identify what the risk and urgency associated with any of these observations are, what actions are required, who needs to complete the actions and within what time scale. Data gathered using HES•SIGMA provide crucial information that can be used by architects, for example, when planning work on a historic site. The data allow users to assess and plan programmes of works for a single site and across an entire estate.

In GIS, users are able to use baseline data in conjunction with collected data relevant to the site to assist in data interrogation and to produce useful datasets for architects and tradesmen.

Another key functionality within HES▪SIGMA is the ‘Report Generator’ tool. This tool creates a formatted Microsoft Word document containing all entered data for a single site or multiple sites. The output can be adapted to suit project requirements.

4 Conclusion

A system that can store and present conservation and maintenance information for historic sites is being developed for Historic Environment Scotland (based on the BGS System for Integrated GeoScience Mapping [BGS▪SIGMA]). The system, referred to as HES▪SIGMA, allows for a wide range of attributes describing condition to be linked to individual architectural elements within single geospatially referenced sites, rapidly and consistently, in a digital, hierarchical form, in the field. The system is designed to facilitate more effective planning of programmes of maintenance and repair.

The fully relational capability of HES▪SIGMA, with data fields and predetermined dictionaries, allows subsets of the data to be queried and analysed. The results can be presented in either statistical or map form in GIS, thereby providing a powerful and versatile planning tool.

This approach provides the flexibility required for surveying historic sites. The resulting datasets provide crucial information that can be used by architects for planning programmes of conservation works for single sites or entire estates. A range of expertise is needed to fully populate the module; however, the data can be presented in a user-friendly visual manner as a GIS map or in the form of a Microsoft Word document using the built-in Report Generator tool. Additionally, the spatially referenced digital data can easily be interrogated through queries and converted into statistical form due to the use of pre-determined, hierarchical fields and supporting dictionaries, which ensure a high degree of accuracy and consistency in the dataset. Other spatially referenced data can be imported into a GIS for comparison and further analysis.

HES will use this newly developed survey methodology to ensure a consistency of approach and provide a means to store and present conservation information for historic sites included in the HES Estate. The system will allow HES to plan effective programmes of maintenance and repair works, and to monitor the condition of the Estate over an extended period of time. HES▪SIGMA will provide a means of reporting on the condition of the Estate to the Scottish Government and to its members. With further development, HES▪SIGMA could be applied across the heritage sector as a planning and management tool for the wider historic built environment.

5 Acknowledgements

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6 References

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