

# **The Use of Geographic Information Systems, Relational Database Management Systems and Document Management Systems in the Management of Heritage Data**

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This paper deals with the use of Geographical Information Systems (GIS), Relational Database Management Systems (RDBMS) and Document Management Systems (DMS) in the management of heritage data, particularly data related to wildlife, archaeological and architectural conservation. The views contained derive in the main from the authors experience of designing and implementing such systems over an eleven year period in the Department of Arts, Heritage, Gaeltacht and the Islands in Ireland.

This paper is divided into three parts:

- Part 1, which constitutes the major part of this paper, provides an overview of the Heritage functions of the Department of Arts, Heritage, Gaeltacht and the Islands together with a description of the database systems, Geographical Information Systems and document management systems in operation to handle the very large amount of data for which the Department is responsible.
- Part 2 briefly details plans for the migration of both attribute data and spatial data to a spatially enabled relational database management system (RDBMS) and the dissemination of this data by means of a fully interactive intranet / internet system.
- Part 3 examines some of the problems and issues involved in managing heritage data in a broader European context.

## **1. AN OVERVIEW OF THE HERITAGE FUNCTIONS OF THE DEPARTMENT OF ARTS, HERITAGE, GAELTACHT AND THE ISLANDS.**

The Department of Arts, Heritage, Gaeltacht and the Islands is the government ministry responsible for heritage conservation in Ireland, together with the arts, broadcasting, cinema, cultural institutions (National Museum, National Art Galleries, National Library, etc.), the Irish language and offshore island development.

**Dúchas – the Heritage Service**, is a division within the Department that deals with the heritage functions. Its brief covers three main areas:

1. Nature and Wildlife conservation
2. Architectural conservation
3. Archaeological conservation

This paper will deal mainly with the operations of Dúchas with some aspects of Irish language and placenames policy also being included.

### **1.1 Nature and Wildlife Conservation**

Nature and Wildlife conservation is the responsibility of the National Parks and Wildlife Division. It manages the following data sets:

1. **Special Areas of Conservation (SACs).** These were established under the 1992 Habitats Directive of the Council of the EU for the conservation of natural and semi-natural habitats and species of flora and fauna.
2. **Special Protection Areas (SPAs)** for the protection of birds, established under the Birds Directive of the EU in 1979.
3. **Natural Heritage Areas (NHAs)** established under Irish law, similar in general principle to the SACs but covering a somewhat larger geographic area.
4. **National Parks.** Six major state owned National Parks exist in Ireland: Glenveagh in Co. Donegal, Connemara in Co. Galway, Owenduff in Co. Mayo, The Burren in Co. Clare, Kilarney in Co. Kerry, and the Wicklow Mountains in Co. Wicklow.
5. **Statutory Nature Reserves:** These are relatively small land areas, very often forest or previously afforested areas which are maintained as protected nature reserves.

The database structure for the NHA / SAC database is given in Appendix 1.

## 2. ARCHITECTURAL AND ARCHAEOLOGICAL CONSERVATION

Both Architectural Protection and Archaeological Conservation are the responsibility of the National Monuments and Architectural Protection Division (NMAP).

### 2.1 Archaeological Conservation

Within this division archaeology is dealt with by the National Monuments service operation under the National Monuments Acts, 1930 - 1994, with two sections, the Archaeological Survey of Ireland and the Archaeological Archive being primarily involved.

#### 2.1.1 Legal Basis

Archaeological monument listing and protection is dealt with in the Republic of Ireland under four Acts of the Oireachtas (Parliament)

- The National Monuments Act 1930
- The National Monuments (amendment) Act 1954
- The National Monuments (amendment) Act 1987
- The National Monuments (amendment) Act 1994

The National Monuments (amendment) Act, 1994, section 12 defines "the Record of Monuments and Places" as the primary statutory record of archaeological sites in the Republic of Ireland. It directs the Department to....

"establish and maintain a record of monuments and places where they believe there are monuments and the record shall be comprised of a list of monuments and such places and a map or maps showing each monument and such place in respect of each county in the State"

Owners of such Recorded Monuments and Places must give written notice of two months to Dúchas of their intention to carry out any work affecting the monument, giving the opportunity to Dúchas to use other legislative means to protect the monument if they see fit.

The information in the Record of Monuments and Places is derived from the non-statutory Sites and Monuments Records previously issued by the National Monuments and Historic Properties Service of Dúchas. Initially, this survey was carried out from cartographic, air photo and documentary sources over a period of years. Subsequently, detailed field work was undertaken to verify the initial survey and this revised data was then used in the

production of County Archaeological Inventories which are being published in book format. This latter work is ongoing.

### 2.1.2 Recording Units

For the purposes of the Record of Monuments and Places a thesaurus of monument classifications and descriptions has been drawn up comprising approximately 800 classification types. These cover all entities which fall within the definition of a monument as set out in the 1987 Act. The existence of a feature corresponding to any one of these descriptions constitutes an Archaeological Entity and a unique record for each such entity is recorded in the database with the following attributes:

- ENTITY\_ID Unique identifier
- CLASSCODE Classification
- NAT\_GRID\_E National Grid Easting
- NAT\_GRID\_N National Grid Northing
- HEIGHT\_OD Height above datum
- NOTES Short descriptive text
- LAST\_VISIT Date of last visit
- VISITED\_BY Officer who made last inspection.

The relationship of any entity with another is defined using a "Relate" look-up table setting out whether any particular entity is "Part of" or "Contains" or "is related to" any other entity.

Separate "many to many" linked tables define the following items and their relationship with the archaeological entities:

- **TOWNLAND** TABLE - Administrative units (Townlands)
- **SMR** TABLE - Map sheet specific data (Old SMR no. , Map sheet no., sheet co-ordinates, sub-sheet no. etc.)
- **SUBCLASS** TABLE - Description qualifiers (shape, material, construction, dimensions, etc.)

It should be noted that the monument numbering system, which was used for the now superseded Sites and Monuments Record, has been maintained by incorporating it in the map sheet specific data. This system numbered the sites within each sheet, leading to duplication of site identifiers.

The database structure showing tables and linkages is given in Appendix 2.

### 2.1.3 Geo-referencing

Each archaeological entity is spatially referenced to a point location on Irish National Grid (Transverse Mercator projection on Airy Modified Ellipsoid, with an origin at 8 degrees West and 53 degrees 30 minutes North). The co-ordinates are stored as fields in the database and ArcView Event Themes or ArcInfo point coverages are generated as required for mapping purposes.

The other major form of spatial referencing used is the association of all sites with the relevant smallest administrative territorial divisions in the state, i.e. townlands. The territory of the state is divided into some 60,000 such mapped townland divisions.

Constraint areas, i.e. the extents around each monument which are subject to the restrictions and protection of the National Monuments Acts, are delineated as mapped polygons in an ArcInfo polygon coverage. These constraint areas are not referentially related

to the archaeological entities and any given polygon may contain one or more entity locations depending on circumstances.

The following data sets are managed in the archaeological area :

1. **The Register of Sites and Places / Sites and Monuments Record:** comprising some one hundred and twenty thousand sites throughout Ireland and already described in detail above.
2. **The Register of National Monuments in State Care:** comprising over eight hundred major archaeological monuments in state ownership or state guardianship under the National Monument Acts.
3. **Preservation Order list:** This includes sites which, though not in the ownership of the state, are specifically protected under legislation from being damaged or interfered with by the legal owners of the land.
4. **Excavation Register:** Dúchas – the Heritage Service is the licencing authority for all archaeological excavation, which can only be carried out by qualified and registered archaeologists who are individually licenced for specific excavations. The register maintains details of all excavations carried out in Ireland together with a large archive of excavation reports. Excavations at the moment, exceed 1000 per annum.
5. **Historic Wrecks Register:** This register records every historic shipwreck that has occurred within Irish territorial waters.

Related to the above data sets, but particularly the Register of Sites and Places, a very large documentary archive of source material is maintained. This includes books, journals, reports, original files and documents, drawings, surveys, photographs, etc.

Recently attention has been focussed on the question of historical and archaeological landscapes. GIS mapping for these landscapes have been prepared.

#### 2.1.4 Architectural Protection

Architectural protection is the responsibility of the National Inventory of Architectural Heritage (NIAH) operating under the Architectural Heritage (National Inventory ) and Historic Monuments (Miscellaneous Provisions) Act 1999. NMAP is also a designated body for consultation under the Local Government (Planning and Development) Acts.

NIAH maintain a documentary architectural archive of similar size and scope to that operated by National Monuments in archaeological area. Its primary data sets are:

1. **The Interim County Surveys:** This survey covers all buildings within a specific county (counties are the primary unit of local government in Ireland. There are 27 counties grouped into 9 planning regions within the State.
2. **The Town Surveys:** These are surveys record the buildings of individual towns throughout Ireland.

The database structure for the NIAH database is shown in Appendix 3.

## 2.2 Other Archives and Activities.

In addition to the above, there are the following:

- **A Photographic Archive:** comprising many hundreds of thousands of photographs in all formats dating from the 1920s to the present and pertaining to all aspects of heritage.
- **A Map, Aerial Photography and Geographic Data Archive** is maintained by the GIS Unit. This involves a large database of digital mapping covering the whole area of the state at 1:1,000,000 1:250,000 1:100,000 1:50,000 1:10,000 scales plus mapping for

urban areas at 1:15,000 1:5,000 1:2,500 and 1:1,000 scales. Aerial photography at 1:40,000 and 1:30,000 scales, together with a wide range of geographical and classificational data sets such as administrative areas, street gazetteers, site type thesauri, etc.

- **A Development Applications Section**, which has been formed to co-ordinate the response of all the heritage services with regard to Dúchas responsibilities in relations to Local Government urban and rural planning controls and development.

### **2.2.1 Gaeltacht and the Irish Language**

The Department also maintains Two major data sets in connection with its responsibilities in this area:

1. **Gaeltacht Boundaries:** the mapped boundaries of those areas within the state designated as Gaeltacht area, i.e. areas where the Irish language is the everyday spoken language of the community.
2. **Placenames:** Official lists and gazetteers of the placenames of all administrative areas within the state, including over 60,000 townlands, district electoral divisions, civil parishes, baronies, counties, provinces, towns and cities.

### **2.3 Data Management**

The information technology requirements for managing all three areas of responsibility involve common systems i.e. all areas of conservation are managed using common hardware platforms and software, although separate divisions are involved in each individual area of responsibility.

#### **2.3.1 Databases**

Despite the size and number of databases involved in the data sets outlined above, it has been possible to manage them adequately using standard Microsoft ACCESS software. This has been achieved by maintaining each data set as a separate database. Small specialist teams with direct responsibility for content management of each data set are provided with customised screen based forms and reports to allow them to input, manage and edit the data and provide all necessary material for publication in the form of printed registers, etc. The system operates on NT servers on a local area network in a Windows 2000 environment.

#### **2.3.2 Digital Mapping**

In addition to the databases, each data set includes a range of mapped data. This mapping is managed using ESRI GIS software consisting of 8 ArcInfo licences, 4 running on Sun Unix workstations and 4 on PC NT workstations, and some 20 copies of ArcView. ERDAS Imagine software coupled with MrSid compression software provides aerial photogrammetry and remote sensing facilities coupled with a Zeiss P33 analytical photogrammetrical plotter. The base mapping for all projects is 1:10,000 raster digital mapping provided by the Ordnance Survey (The National Mapping Agency)

Each major division within the Department have a small team of GIS technicians to deal with their own GIS mapping requirements and central support and co-ordination is provided by a GIS Unit associated with the Department's IT and Corporate Services Division.

The map structure for each data set is very simple, consisting in most cases of a polygon coverage indicating the areal extent of the feature involved and one or more point coverages providing spatially located tags or labels to which database records of individual entities or occurrences can be linked. All digitising is carried out "heads-up" by our own technicians in-house.

### **2.3.3 Document Management**

Reference has already been made to the very large documentary archives which accompany most of the major data sets. These are in the process of being scanned by a specialist contractor and are being incorporated as part of the digital database by means of a document management system (DMS). In excess of 2,000,000 documents are involved in the Archaeological Survey archive, including A4 and A3 documents, manuscript material, large scale drawings and historic maps, black+white and colour photography, etc. This project has been completed and work is now continuing on the photographic archive and the excavation reports.

### **2.4 Dissemination and Presentation of Data**

The large resource of electronic data stored in the above described relational databases, GIS mapping, and document management system is distributed in a number of different ways:

1. Both the GIS Unit and the specialist GIS staff located in the operational divisions provide large amounts of customised paper mapping which is needed by the staff of the Department in carrying out their responsibilities.
2. For the Department's staff in general the data can be accessed through a customised GIS browser designed in Visual Basic which incorporates ESRI's MapObjects functionality for spatial enablement. This provides a simple interface to all of the Department's holding of map, attribute data and facsimile scanned documents in a fully integrated manner, with all the necessary tools for querying and searching and displaying the data. Samba communications software is used for Unix / PC integration. This caters for the major part of the day to day information needs of those staff members in the Department's Dublin offices, totalling some 120 users.
3. For specialist users, or those who need to carry out more detailed analysis of the data sets, ArcView Desktop GIS has been provided to around 30 staff within the Department. Source data can be accessed from the servers and down-loaded to the users PC, and worked on locally.
4. For remote users, i.e. those staff members not connected to the Department's Local Area Network, outside agencies such as Planning Authorities, Planning consultants, the utilities, the Environmental Protection Agency, National Forestry Agency, etc. and interested members of the public, the majority of the Dúchas data sets have been made available on a data download website. This website ([w.heritagedata.ie](http://www.heritagedata.ie)) allows the GIS mapping and attribute data sets to be downloaded to the user's system where it can be viewed, integrated and analysed in any way that the user wishes.

## **3. PROPOSALS FOR UPGRADING THE EXISTING SYSTEM**

The present heritage information systems has a number of serious limitations:

It provided an on-line interactive service only to those operating on the department's local area network linking the Dublin offices.

It has serious defects with regard to user numbers and security.

It is not structured to facilitate a full inter / intranet based service.

The Department proposed to remedy these shortcomings by migrating all databases to a full RDBMS such as Oracle. Spatial enablement will be provided using ArcSDE to allow the the full range of ESRI GIS software tools such as ArcInfo, ArcView, etc. to operate on spatial data stored in the form of Geodatabases within the RDBMS. This will apply the power, flexibility and security of RDBMS technology all our data, including mapping. The mapping will be served to internet / intranet users using ArcIMS software.

## **4. SOME ISSUES FACING EUROPEAN HERITAGE GIS USERS**

### **4.1 Spatial Data Infrastructure**

A common problem for European heritage agencies using GIS and geographic information is the lack of a European spatial data infrastructure, and in many cases the absence of even a national spatial data infrastructure. This is a matter which has been addressed extensively in other parts of the world, notably the US, Canada and Australia. The reasons for this may stem from very different governmental attitude to mapping resources created by the state. A brief look at the Irish situation will illustrate the point.

A major constraint on the expansion of our Department's GIS activity is the availability of suitable background mapping for use both internally and on the internet at a reasonable cost. For internal purposes we use mapping at 1:10,000 scale supplied by the Ordnance Survey, the National Mapping Agency (NMA), as our primary base mapping layer. This mapping is in raster format and is many years out of date. No up-to-date vector substitute is yet available and even if such mapping were to become available there is no guarantee that it could be acquired at an affordable price. The National Mapping Agency follow a policy of maximisation of profit and full cost recovery wherever possible, with ongoing leasing royalties being charged annually for the use of the mapping, even when no further service or product is being given. This makes it extremely difficult for agencies such as our Department, which operates on a non-commercial government service basis, to justify the costs of the background mapping required for our projects.

This question of national mapping costs would seem to be an issue right across the European Union, where NMAs operate a high cost policy in contradistinction to the US policy of treating national mapping as a common resource, which once paid for by the taxpayer is not paid for over and over again by subsequent users. The American approach is based on an economic perspective which see the financial return to the state in terms of the vast range of wealth and tax generating activity which is activated by the availability of inexpensive geo-information rather than by the direct sale of the mapping. It is an issue which is being addressed by EUROGI the European umbrella group for geographic information and by the various national GI organisations, but without a great deal of success. It poses a continuing obstruction to progress in GIS technology in Europe.

A number of European states have carried out some initiatives in the area of national spatial data infrastructure. In the United Kingdom, their Ordnance Survey have embarked on a Digital National Framework (DNF) which provides a system of unique identifiers, which are applied to every feature polygon within their national digital mapping (Building, land parcel, field, road section, etc.) This allows users to reference attribute data to these topographic identifiers and so provide common spatial referencing across an very large range of activities, without the need for direct access to large amount of expensive digital mapping. The Netherlands has taken a different approach by providing a 1:10,000 national topographical map in digital form as a freely available base to a national spatial data infrastructure. There are of course other possible approaches to spatial data infrastructure. It would be nice if a common system of spatial infrastructure was to be made available across the member states of the EU and the applicant states, to a common standard. Projects such as the CORINE project for landuse, the ETRF89 common European geodetic framework and SABE (Seamless Administrative Boundaries of Europe) are steps in this direction but there is still a long road to travel. Eurogeographics, representing the national mapping agencies of some 37 European countries, are current engaged in producing a EuroGlobal map to a common specification at 1:1,000,000 scale. They are considering the possibility of a EuroRegio Map at 1:250,000 but no decision has been made. Whether common mapping at the level of resolution (1:10,000 ?) required by heritage projects, will ever become available, is extremely doubtful.

## 4.2 Open Systems

Despite the considerable advances towards open systems by the GIS hardware and software manufacturers assisted by organisations such as the Open GIS Consortium (OGC) and the international standards authority many GIS are mutually exclusive. Conversion of data between systems poses no great problem, but interoperability across platforms and across formats is still a major outstanding issue. One of the major initiatives being championed by OGC is the promotion of GML a geographic extension of XML which enables the interchange of spatial information and the construction of distributed spatial relationships, and may well provide an internet based replacement to existing inadequate and proprietary data exchange formats for geodata such as DXF and ESRI's .e00 or peculiarly national exchange formats such as the UK's NTF.

## 4.3 Heritage Entity Classification Systems

Particular problems exist in the area of data exchange and the integration of data from different countries or even different organisations within the same country because of the variation in the ways that the same entity may be classified by each separate authority. Lewis Carroll in his childrens' story "Alice through the Looking Glass" had Humpty Dumpty as saying, when challenged about his strange use of language – "It means just what I choose it to mean - neither more nor less". The guardians of our cultural heritage are very often given to the same attitude when applying codes or technical definitions to specific cultural entities. The geographic extent of historical cultures are not necessarily co-terminus with the state or administrative boundaries of the organisations which care for the cultural artifacts today. Equally, Europe throughout its long history of political diversity has shared a remarkable cultural unity, with national styles being nothing more than regional variations of a common theme. This can lead to entities, which though identical in their original context, being identified and coded differently by conservation authorities in separate jurisdictions. Even in a geographic extent as small as the island of Ireland this has happened, with archaeological entities being defined and coded differently in the respective Sites and Monuments databases of Ireland and Northern Ireland, despite the fact that in pre-history and indeed up until the early years of the twentieth century no political division existed.

I know that initiatives are being undertaken in the area of archaeology to address this problem. Two such approaches spring to mind: HEIRNET in the UK and the work being done by CIDOC internationally. However this is an area that requires intensive research and co-ordination if full benefit is to be derived from the vast range of archaeological and architectural data stored in databases across Europe.

## 4.4 Metadata

The question of metadata is a related subject of considerable importance. Without accurate metadata data sets lose a great deal of their value in the context of data exchange and data re-use. In the realm of metadata the Dublin Core Metadata Initiative provides the key international focus. The problem is, however, that not all generators of cultural databases provide metadata conforming to this template, if indeed they provide metadata at all. Also the degree of "findability" of suitable data depend on a structured and commonly agreed format for metadatabases in the various areas of cultural activity. In the case of our own Department's data sets, we post metadata on our own website in association with the data to which it applies. We also post our metadata on the national metadatabase (GEOID) managed by the Irish Organisation for Geographic Information (IRLOGI) and in addition we are in communication with our British colleagues in HEIRNET, regarding the dissemination of our data through their metadata resources. Despite this, a great many potential users of our data are either unaware of its existence or, if they know about it, still have trouble in actually locating and acquiring it.

In many ways metadata shares the same problems as data sourcing on the Internet in general. Without a legally imposed or agreed over-arching authority committed to maintaining unique metadatabases within any given science or academic discipline, metadatabases will continue to proliferate as groups of dataholders attempt to solve their problems of data



interchange. Inevitably, a situation is reached where users need a new metadatabase of metadatabases to provide them with a guide to the range of overlapping and partial databases available.