Knowledge and CNR GIS for Cultural Heritage

Patrizia Tartara
Consiglio Nazionale delle Ricerche - Ufficio Sistemi Informativi Territoriali per i Beni Culturali
Piazzale Aldo Moro 7, 00185 Roma, tel. (06)49937425, mobile 339-6109838
e-mail: patrizia.tartara@cnr.it

Abstract

“Knowledge” of all kinds of evidence is important for scientists and researchers but it is also necessary for the protection and development of territory. It is, at the same time, the requisite basis for the right management of the territory and correct planning as it is also support for competent territorial administrations. This paper describes how the Italian National GIS for Cultural Heritage collects, records and presents archaeological and environmental data from several Regions for use in planning and other management regimes.

Keywords: Ancient Topography, Survey, Aerial Monitoring, GIS Related to Data Base, Digital Cartography.

Introduction

The Sistema Informativo Territoriale per i Beni Culturali (SIT) of the Italian national territory, or GIS for Cultural Heritage, has been realised by researchers at CNR and at the Università del Salento. The aim is to support the research, protection, and management of cultural heritage. As a focus, it uses geographical positioned information for knowledge, preservation and to increase the value of the territorial cultural heritage. It is a very valuable and useful tool for gathering, updating, processing and consulting all available Cultural Heritage and Environmental Data from surveys, aerial monitoring, research, finalised cartography, bibliographical and archival materials. Such information, easily accessible, is essential for the properly planned conservation and management of the historic and environment and landscape.

In addition to the scientific data, the GIS for Cultural Heritage uses for geographical positioning widely available and highly detailed maps as well as maps of the IGM (Istituto Geografico Militare) existing in both digital and raster. Therefore the system is a very articulate and rigorous work based on the collection and organisation of many different geographical data sources.

Hundreds of thousands of individual data records are collected into this system, documenting many regions such as Latium, Puglia, Campania and Abruzzo. The Università di Siena, Seconda Università di Napoli and the Sapienza Università di Roma (collaborating with CNR and Università del Salento) are responsible for the collection and management of the data that concern Tuscany, Campania, Basilicata and the city of Rome.

“GIS for Cultural Heritage”

At present, the research has been developed on the several regions mentioned above (fig. 1). The general cartographic framework (vector grid) consists of 1. administrative boundaries; 2. official maps (IGM 100.000, 25.000, etc.), regional, provincial or municipal technical maps (C.T.R. 10.000 scale, etc.); and 3. environmental, monumental and archaeological prescriptions. Each of these has its own related Database. The SIT is aligned with the general codes and national and international cartographic framework based on military standards formalised by NATO and with up-to-date European criteria. The GIS is also able to accept and continuously update cartographic data, both
Fig. 1  a- CNR GIS for Cultural Heritage: map with actual Data.  B- Query on a restriction area: text of the Ministerial Decree.  c- Samples of technical maps.
Fig. 2  a- Vector Data: visibility of the territory survey.  b- Colors codify of visibility and archaeological evidences codify.  c- Veii: numerical codified cartography.  d- SIT for Cultural Heritage: sample with cartography, project, evidences, visibility, restriction.
numerical and encoded, in the various frames of reference.

The CNR-(S.I.T.) GIS for Cultural Heritage Laboratory supports both research and service activities. In terms of research, it is essential to maintain continuous updating by following foreseeable technological development of software notably for dialogue between different systems. Data transfer is an element of great importance for Public Administration and particularly for authorities in charge of territorial management and security such as Carabinieri, Guardia di Finanza, Protezione Civile, Soprintendenze and Regional and Provincial Technical Departments; these are already partially interfaced with research groups. Attention must be even further given to holding the top position in Systems updating and to follow the international research survey even with the Military Structures working in this sector (Istituto Geografico Militare, Centro Informazioni Geotopografiche dell’Aeronautica Militare, etc.).

The GIS is based on the complete cadastre of the “sites” identified by gathering all data from bibliography, archives, previous research or projects and, above all, by detailed systematic survey. The latter, in particular, is performed by specialists in archaeological topography and landscape archaeology and carried out in the case studies of the areas. The system is progressively implemented with the outcomes of systematic topographical research activity of the Consiglio Nazionale delle Ricerche [CNR, the Università del Salento, of the Doctorate of Ancient Topography (associated centres: Università del Salento, Sapienza Università di Roma, Università degli Studi della Tuscia and Università degli Studi di Salerno) and other related universities.

The GIS is a product of public research and has been realised with the primary objective of enlarging scientific knowledge, particularly about archaeological heritage. Therefore it is primarily focused on the knowledge of the distribution and extent of the material heritage of ancient cities and territories. It sits on georeferenced cartographic bases, a standardised technological environment for exchanging data shared by many administrations and public institutions (e.g. Ministry of Education, Ministry of Cultural Heritage, regions, provinces, municipalities, institutions in charge of protection and management of the national territory, and groups of the Carabinieri and Guardia di Finanza for Protection of Cultural Heritage); it is also compatible to planning. The advantages of the organising and the application of functional criteria for management and funding that spring from a unitary system are evident; the system is usable at all levels (cadastre, networks and services management, census, territory planning and agricultural management, etc.), by all kind of local administrations and even by foreign administrations (by applying and modifying it with their own practices).

Laboratory analysis, survey and updating all use both historic and modern aerial imagery. Historical photographs include those taken in the first two decades of the twentieth century, images taken during the Second World War by Italian, British, American and German air forces, the IGM basic flights of the Fifties and the images by private companies of photogrammetry, etc. Modern imagery includes air surveys both thematic and systematic and the most recent digital satellite images or images by band-spectrum sensors.

For monuments, a database has been created relating to tri-dimensional mapping. Data on movable properties (related to the find-spot or to the state of preservation) can also be inserted into the system in a first “fast modality” (to satisfy the demand of primary knowledge and the management of a large amount of objects preserved in repositories) and later in an “analytical mode”.

Extreme rigour is the basic point for data accuracy, particularly for geographic data. There are 4 operating levels in the structure of the system.

1. Project: a detailed analysis of urban centres or large compounds placed on digital cartographies suitably supported by analytical photogrammetry or digital finalised restitutions.
2. Superior Unit: deduced from direct analysis or derived from bibliography. Large areas or complexes (e.g. cities, inhabited places, large compounds, roads network, infrastructures, etc.) consisting of set of Units.
Fig. 3  a- Veii: particular of the numeric cartography.  b- Veii: 3D.  c- Cavallino: vector cartography.  d- Cerveteri: mosaico of IGM 1930 glass slides of Monte Abbadone necropolis and restitution of the traces.  d- Arpi: restitution of the traces on the vector cartography.
Fig. 4  a- Sample of UTS.  b- Particular of UTS query.  c- SIT for Cultural Heritage: Main List of the evidences into the Data Base.  d- DB: the first page with a classified "object".  e- Sample of the "localization" page of the DB.
3. **Unit**: deduced from direct analysis of the territory (e.g. by survey) and entered into the system with precise real measurements, descriptions and other detailed information.

4. **Level**: with toponymic or sources information, dimensions, etc.

   All information recorded on digital maps is joined to databases generated for the specific purpose of the direct systematic analysis of the territory (survey).

The database of the GIS is organised as a function of territorial data; it contains specific information on heritage remains, on environmental context, and condition and character of the evidence. All these actions are related to vector mapping on the different cartographies and to the representation of terrain and visibility conditions (fig. 2).

"Form" consists of a description, in several pages, of the heritage item that includes information on location, land cover and vegetation, soil type, visibility, the type of archaeological fragments present and the fragments’ chronology and interpretation, etc. The nature of the documentation is included, for example, as to whether the site is known from survey, secondary literature, or excavations (authorised or clandestine). Photographs, reliefs, sketches, drawings, scraps of maps, etc. can be attached to each Form and all information is positioned and drawn on vector cartography. Examples:

1. **Projects** - for example, the vector cartographies of Veii (north of Rome) or Cavallino (south of Lecce) were realised on purpose (fig. 3). This kind of cartography is realised for ancient cities where different kinds of information (geographical or textual) are inserted and can be used for queries. Each element has three dimensions: x, y, z and is coded according to its meaning: contour line, building, hut, fence (metal, or brick, or stone fence), road, track, electric line, hedge, tree, archaeological evidence and trace or cropmark, etc.

2. **Superior Unit** - for example, the route of the Via Appia crossing several Regions, consisting of many Units or single points of archaeological evidence. Another example is the ancient city of Caer (nowadays Cerveteri, north west of Rome) with its territory: Unit as farms, villas, quarries, etc., and Superior Unit as necropolis, roads network, ports, the sanctuary of Pyrgi (today Castle of Santa Severa). Other examples are the numerous ancient aqueducts of Latium and the numerous Units along their routes (structural elements or traces). The Superior Unit consists of many Units related to an upper level container of the same context.

3. **Unit** - for example, the evidence found during survey or from bibliography or archives. Numerous pages help the description of the evidence and of the environment where it was found; examples of Data Base pages are shown in fig. 4. On the first page is the object (the archaeological evidence), then the interpretation of it (which can be changed, if needed), the kind and level of risk to which it could be subject, its condition and state of preservation, measurements, etc. There is data on location and the maps and photographs which show it, and pages (using drop down menus) for recording soil details (which give the opportunity to translate the information in different coloured areas on the digital maps: white and three shades of green for kind of visibility of the fields, two nuances of yellow for soil destruction and tobacco colour for quarries, grey for urbanisation, etc.), fragments (with the possibility to quantify them for each class), chronology (with the ability to specify historical periods or centuries) and last, but not least, documentation. Each site is measured with precision. Sometimes it is necessary to make a relief, but always it is important to take photographs. (fig. 4)

The database gives the opportunity to add photographs, sketches and reliefs with footnotes as well as the text in full with the possibility to print it entirely or the possibility to print only the data grid inserted.

Both the “database” and the “digital cartographic grid” can be interrogated in very complex ways and the results displayed in real time on both grids (as Unit localised on the map or vice
Fig. 5 a- Sample of query related to the path of the aqueducts of Puglia with a buffer zone of respect; b- Particular of the query: in red the archaeological evidences; c- The Royal Sheep Track in Abruzzo [sample of Data from historical air photograph] in a photograph of the Royal Air Force 1944; d- Traces of tumulo tombs in a recent oblique photograph taken during a monitoring flight with the Carabinieri Helicopter Group of Pratica di Mare; e- Sample of cartography, 1:10,000 scale, with codified visibility and evidences.
versa). Queries can insist on a `respect area (on demand) around the evidence of interest: it will be possible to create a "buffer zone" – often used for landscape or environment protection and restrictions.

Historical aerial photographs are a highly important source of data and are preserved in both public and private archives. From the first photographs taken by balloons at the end of the nineteenth century, through later 13x18 glass slides and modern aerophotogrammetric strips, all the way to satellite images, it is possible to gather large amounts of information just with photointerpretation (fig. 5). They are particularly useful for historical landscape information, especially images taken before the great power of modern agricultural machinery began to change the landscape.

The rigorous geographical positioning of identified traces is absolutely important, as it is to draw sites at the correct size. They will even be useful in creating restrictions for the Administration of Cultural Heritage Ministry and have such precision as to avoid claims by owners.

As well as its – knowledge and research aims, the GIS has a role to play in territorial planning and management, for both private and public works. Inadequate knowledge of archaeological and environmental matters or concerning historical centres (especially those of smaller urban settlements) or in the case of environmental heritage, wetlands or a small river or marsh or particular niche trees and significant plants, all these can cause problems or delay work, with a great waste of time and money. Very often the planning of infrastructure or a new urban enlargement or even just a single building does not take into account knowledge of what exists in the subsoil: it follows that, for example, any archaeological element can lead to a "stop work" and to a subsequent dig investigation pending final approval, or to a prohibition of further work or just to a request for project variation. All those things are a useless cause of a waste of energy, time and money. All the information gathered into the GIS will provide the essential guide needed for planning and management.