MULTIMEDIA DATABASE FOR THE HERITAGE INFORMATION SYSTEM OF THE ANCYRA PROJECT

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ABSTRACT:

This research sets the objective to create an Heritage Information System (HIS) to access, in simple way, to different types of documentation related to the cultural heritage (cards, images, drawings, 3D models and so on) by a database catalogued according to the standard criteria (national and international). This task has to satisfy many demands: to localize the object in the geographical context, to describe it by means of two and three-dimensional models, and, in the same time, to connect every available documentation with the spatial datum.
We present the organization in a database of many documents about the Temple of August in Ankara, inside the Ancyra Project, an initiative promoted in collaboration with the University of Trieste (Italy). An example of scientific interdisciplinary competences and advanced technologies, finalized to the recovery and the maintenance of one of the most important monuments of the Roman civilization in Turkey. The monument was inserted into the list of the hundred monuments to be saved in the world by the World Monuments Watch, as cultural patrimony of the humanity. The Ancyra Project has produced a notable quantity of material in different form: textual, graphical and as well as in multimedia form. In the Heritage Information System of the Temple, we tested the data structure in conformity with the national standard MA-CA card (Archaeological Monument-Archaeological Complex) provided by the Central Institute for the Catalogue and Documentation (ICCD) of the MIBAC (Italian Official Ministery of the Cultural Heritage). At the same time we considered the possibility to connect this card with the international standard Object-id card.
Last but not least, in order to make visible and distribute the information related to the Ancyra Project we have published the three-dimensional model of the Temple in Google Earth. This is a program that joins online the functionalities of the three-dimensional display with the characteristics of a GIS, allowing to explore the object on the Earth in a fast, accurate way and with a very up-to-date and available free maps and remote sensing images, unimaginable few years ago.

1. INTRODUCTION

The knowledge and the documentation are essential and very important to protect and to promote the Cultural Heritage. Cataloguing in standard format of every available data allows to decide the priorities and the type of actions for the maintenance and the restoration of the objects, the museum activities and the distribution of the cultural services, limiting the thefts and the clandestine commerce of the finds and allowing also to claim the ownership of the objects.
This research sets the objective for creating an Heritage Information System (HIS) to access, in simple way, to different types of documentation related to the cultural heritage (cards, images, drawings, 3D models and so on) by a database catalogued according to the standard criteria (national and international). This task has to satisfy many demands: to localize the object in the geographical context, to describe it by means of two and three-dimensional models, and, at the same time, to connect every available documentation with the spatial datum. Moreover the archaeological heritage has the necessity to report spatially a great quantity of data related to finds, sites, settlements and territories.
Georeferencing the cultural object allows to acquire its relationships with the environmental and human elements, and with the other heritage goods close to it, offering the best and the most aware knowledge of themselves. This particular requirements are satisfied by means of GIS.
We present the organization in a database of many documents about the Temple of August in Ankara, related to the Ancyra Project, an initiative promoted in collaboration with the University of Trieste (Italy). This project is an example of scientific interdisciplinary competences and advanced technologies, finalized to the recovery and the maintenance of one of the most important monuments of the Roman civilization in Turkey (Botteri, 1999). After the first years of research and the publication of the preliminary results, in October 2001 the monument was inserted into the list of one hundred monuments to save in the world by the World Monuments Watch, as cultural patrimony of the humanity. The Ancyra Project has produced a notable quantity of material in different form: textual, graphical and as well as in multimedia form (Botteri et al, 2003).
Our contribution at this Project was to develop a Heritage Information System about the Temple, using commercial GIS software. In this system every catalogued document is geographically related to the database and it is possible to visualize the different 2D and 3D representations of the architectural structures of the Temple using also Hypertexts. The database is connected to the GIS by some tools implemented in Visual Basic code on purpose developed.
The data were structured in conformity with the national standard MA-CA card (Archaeological Monument-Archaeological Complex) provided by the Central Institute for the Cataloguing and the Documentation (ICCD) of the MIBAC (Italian Official Ministery of the Cultural Heritage). Furthermore we considered the Object-id Card. It is an international standard for describing cultural objects. The Object Id project was initiated by the J. Paul Getty Trust in

1993 and the standard was launched in 1997. It is being promoted by major law enforcement agencies, including the FBI, Scotland Yard and Interpol, UNESCO, museums, cultural heritage organizations, art trade and art appraisal organizations and insurance companies. The Object Id Project helps to fight the illegal appropriation of art objects by facilitating documentation of cultural property.
Finally to make visible and distribute the information related to the Ancyra Project we have published the three-dimensional model of the Temple in Google Earth. This is a program that joins online the functionalities of the three-dimensional display with the characteristics of a GIS, allowing to explore the object on the Earth in a fast, accurate way and with a very up-to-date and available free maps and remote sensing images, up to a little time ago unimaginable.

2. THE HERITAGE INFORMATION SYSTEM (HIS)

The documentation of archaeological sites and monuments plays an essential role in promoting the understanding, conservation and preservation of the archaeological heritage.
Cultural heritage represents the best field of work where to make research and to develop scientific applications and innovative techniques, to define methodologies and to set systems for the survey, representation and data management of objects very complex too. Generally the complex objects at different resolution involve the semantic knowledge of the method of representation and of the objects themselves. In this sense the progress in the debugging of systems and methods can become very useful to various disciplines and application fields. Furthermore we have to point out the activities, at the international level, of UNESCO itself with the ICCROM2. We have in fact to emphasize that although the last decades have been technologically improved in the field of the computer science and telecommunications, many problems related to the automation of the surveying, analysis, knowledge and representation of complex objects have not been resolved yet. Even today one catalogues by means to the "traditional" type.
The present contribution wants to deal with the problem of the survey and the cataloguing of the cultural heritage by the use of new tools and format for the acquisition, management and representation of the data providing the web diffusion too.
With the birth of the GIS, the utopia of the historical cartography was concretized to represent almost in real time the evolution of the landscape and of the man, with the possibility to reconstruct the ancient world environment for archaeological studies.
In fact the most important function of a GIS is the ability to visualize, to question and to cross the data, creating new contexts and new information.
The fast evolution of the digital technologies for close range and remote sensing survey has generated in short time the demand to create special tools for the analyses and data management. The archaeology has immediately found great potentialities in the GIS, strongly increasing its development and its interdisciplinary experimentations. In fact an enormous quantity of archaeological data has spatial connotation. In the spatial archaeological description an large number of attributes can be considered: form, quantity, distributions, geometries, locations, dimensions, morphological relationships, etc. The advanced visualization tools allow to contain and to represent all the available data, following the different phases of the research. Elaborating the data for the interpretation, we can reconstruct, by levels or by thematic, the phases of the archaeological research, from the ground to the analysis of the documentation (historical or recent acquisition). In practice the filling of the information, in an spatial system, it considerably widens the perspectives of investigation and data check.
We defined a "vertical" GIS as a spatial information system specifically devoted to the study of the built environment and a "horizontal" GIS as a system primarily directed to the analysis and representation of the landscape and generally of the territory. The geometric spatial analysis of the built has to face together with the problem of the representation of the documents and also with the maintenance, the constant monitoring and the degradation of the objects. But this is often entirely remarkable or absent in the archaeological GIS projects.
The GIS at territorial scale is mostly finalized to the macro-contexts to disseminate the information, while the GIS of the "built" is much more directed to the study of "micro" contexts (monumental, architectural in prevalence), for a monographic analysis of the architectural manufactured elements. A cultural spatial information system can give back the connectivity of the information that belongs to the architectural context. The dialog of the data related to the surfaces, to the geometries, to the volumes with the historical and analytical documentation of the monument intend to represent the cognitive and cultural dimension of the context, foreseeing the knowledge and the maintenance of it. In conclusion the "vertical" GIS elaborates again and recovers information that are typically skipped by the surveying and by the canonical drawing.
In the last years the GIS manages 3D data giving the possibility to visualize the reality but also to study it, for example by sections and profiles. This allows not only to understand the reality but also to open the way to a different types of analysis.
Unfortunately in architecture and in archaeology the digital documentation of the manufactured articles and the monuments are still distant from a sufficient level of standardization. This means that the different kinds of survey, the graphic representations and the associated database do not follow some criterions of homogeneity.
Within Europe, a wide range of recording methods are employed in the compilation of inventories, often within a national framework. These compilations, in particular those relating to the recording and the protection of the archaeological heritage use some form of public access of the information to facilitate the research utilising archaeological core data where this has an international dimension.

3. THE HERITAGE INFORMATION STANDARD: NATIONAL AND INTERNATIONAL DEVELOPMENTS

Information standards play an important role in the effective documentation practices needed to help to protect cultural property. In the world becomes very urgent for the museums, archival communities, libraries, archaeology, architecture and cultural heritage site the necessity of a standard documentation.
We tell in brief the present state of standards in such cultural heritage fields.
The international development of this purpose is based on the introductory part of a brochure produced by the Getty Information Institute and CIDOC, about the *Developments in International Museum and Cultural Heritage Information Standards*, published in 1993 and updated in 1995.
Standards offer a base model for creating practical systems and guidelines, give the rules for structuring information, so that the data into a system can be reliably read, sorted, indexed, retrieved and communicated between other systems.
Data standards ensure that a database is internally consistent

and also that the data is formatted and stored for an easy "export" to other systems.
The most important reason for using standards is the protection of the long-term value of data. Standards are an essential base for sharing information to create valuable resources that can be easily used and disseminate outside. Standards can have different form, from strict one to more flexible guidelines that take into account both the needs of individual institutions and the government constraints.
The international and national information standards related to museums and cultural heritage organizations is grouped into four principal components:

1) The functional components that are the requirements for cataloguing and collecting management, membership, administration, finance and publishing.
2) The data structure, content, and values that constitute the different fields used to record information and their relationships, the rules and conventions governing how data are entered into the fields, the vocabulary used in the various fields and the specifications for individual character sets.
3) The procedural standards that define the scope of the documentation procedures needed to manage operations.
4) The interchange standards that define the technical framework for exchanging information, whether between systems in a single institution or among systems in multiple institutions, all developed by the International Organization for Standardization (ISO).

The national and international information standards have been identified and approved with the full support of the community that will use them to be effective and useful. They are also responsible for publishing and maintaining them, such as the British Standards Institute (BSI), the Association Française de Normalisation (AFNOR), the Deutsches Institut für Normung (DIN), the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO). Also the ICOMOS (International Council Of Monuments and Sites), the principal adviser of the UNESCO in subject of maintenance and protection of monuments and sites, in the “International Paper for the Management of the Archaeological Patrimony”, in 1990, recommended the cataloguing.
The cards of cataloguing must allow to decide the priorities and the type of the maintenance and the restoration, the cultural services and also they must limit the thefts and the clandestine commerce providing the possibility to vindicate the ownership of the objects.
This requires the necessity to insert for every category of objects different types of information which allow a correct and exhaustive description of it. The various sections where the data standard is divided represent the minimum categories of information required to make a reasonable assessment of a monument or site, whether for planning, management, academic or other purposes.
According to a computer methodology, cultural heritage can be considered as an entity (physics or abstract) described by attributes. Particularly, the informative content of the attributes, becomes very important for the automatic management of the described object, or for the user that is interested to visualize and eventually to modify it.
Object ID ™ is an international standard for describing cultural objects. The Object ID ™ project, initiated by the J. Paul Getty Trust in 1993, was promoted in 1997 by major law enforcement agencies, museum, cultural heritage, art trade and art appraisal organisations and insurance companies.
The illicit trade in cultural objects is widely recognized as one of the most prevalent categories of international crime. UNESCO sustains this system of cataloguing since it allows to compile a rapid inventory of the threatened cultural goods and to find again the traces of those that have been stolen or lost. Also the police has long recognised the importance of good documentation to protect art and antiques against the thieves and to return the recovered objects to their rightful owners.
The contents of the standard were identified by a combination of background research, interviews, and, most importantly, by major international questionnaire surveys. In total, over 1000 responses were received from organisations in 84 countries. The result is the Object ID checklist.
Regarding the national example of standard documentation for cultural heritage we analyzed and applied the standard information card named MA-CA (Archaeological Monument-Archaeological Complex) provided by the Central Institute for the Cataloguing and the Documentation (ICCD) of the MIBAC (Italian Official Ministry of the Cultural Heritage).
The management of the information related to the Italian Cultural Heritage certainly is not a simple assignment, considering the enormous massive structure of materials to hold under control. The Central institute for the Catalogue and the Documentation (ICCD) is one of the Central Institutes of the Office for the Cultural Heritage Activities. It has the assignment to supervise and to unify the whole cognitive procedure for the creation of a general database of the Italian Cultural Heritage, as well as to define the formalities of the fruition of all acquired data.
We illustrate here in detail the implementation of this standard in the Ancyra HIS.

4. THE MULTIMEDIA ANCYRA HIS

4.1 The Ancyra Project overview

We present the structuring into the database of many documents about the Temple of August in Ankara, developed for the Ancyra Project (from the Roman name of Ankara), an initiative promoted in 1977 in collaboration with the Department of Classics in the Faculty of Humanities at the University of Trieste (Italy). The Ancyra Project has produced a notable quantity of material in different form: textual, graphical and as well as in multimedia form.
Our contribution at this Project was to develop a Heritage Information System (HIS) about the Temple, using commercial GIS software. Every catalogued document is there geographically related to the database and it is possible to visualize the 2D and 3D representations of the architectural structures of the Temple using also Hypertexts. The database is connected to the GIS by some tools implemented in Visual Basic code on purpose developed.
The Temple in Ankara was consecrated to the Emperor Caesar Augustus and to Rome Goddess. On the walls of the temple in Ankara was carved a copy of the text of his last will, both in Latin and Greek. This is the most important historical inscription of the ancient world, the so-called *Res Gestae Divi Augusti*.
The photogrammetric survey of the inscriptions and of the Temple have been already accomplished. 3D model have been set up, for Virtual Reality, both passive and active. A Digital Surface Model (DSM) of the entrance door of the temple has been derived (Botteri et al., 2002).
A dedicated GIS has been prepared; collecting and organizing these different sets of data and the experience via Internet was set up. We are making an attempt to save at least the memory of Augustus in Ankara. In fact the building is dramatically

deteriorated because of the pollution, the seismic disaster, the climatic factors and as well as man-made damage.
We carried out the photogrammetric survey of all the engraved walls, covering an area of approximately 40 square meters. A photographic documentation of the monument complex has been also produced with regard especially for the architectural features of the building (Figure 1).
The rectified photomosaic of the walls has been added as texture to the plotted walls for a complete knowledge of the monument regarding the deterioration map in view of the restoration of the inscriptions (Botteri et al., 2003).

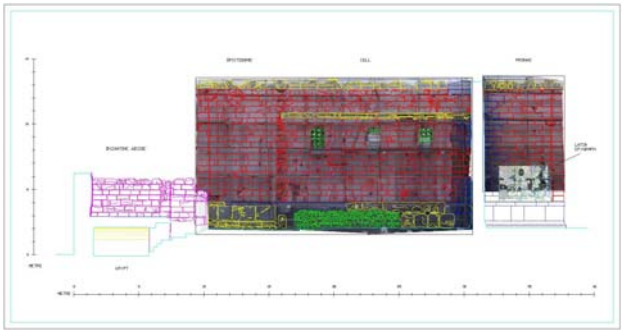

Figure 1 The plotting of the walls with the texture of the orthoimages

The animated visualisation of the temple gives a better understanding for researchers and for the possible restoration project. The WRML interactive virtual tour displays a related GIS for the complete knowledge of the monument.
In August 2004 we acquired new topographical measurements that completed the survey of the Temple, previously in part covered by the presence of the scaffolding, adding the survey of the archaeological finds, of the Mosque, built behind the Temple, and also of the Grave of the Saint.

4.2 Interoperability and database management

The data collected for the HIS were structured in conformity with the standard MA-CA card, afterwards we considered the Object-id Card and the possibility to exchange the information one each other.
These are national and international standard for describing cultural objects with the purpose to make interoperable the information. The MA-CA card is organized in paragraphs (homogeneous voices), in fields further subdivided in simple and structured subfields. This type of structure gives the maximum degree of desegregation of the data information as it is suggested by the rules introduced by the use of computer system. In the paragraph a voice is considered repetitive if it links more than a value at the level of simple or structured field and also at the level of paragraph or subfields. It is suitable to consider mandatory the fields for which it is necessary and always possible to give information. For the database implementation by the MA-CA card we used the DBMS Microsoft ACCESS. The term DBMS (Date Base Management System) intends a general system for the database management used for structuring, building, modifying and consulting the data. A database is in fact an organized collection of information for an easy management of the data. The database realized by ACCESS can contain four different types of objects: tables, masks, queries and reports. The information stored in the tables presents in every column the field or the single category of information and in every line the record or the single voice of the database.

We performed a mask, as a graphical user interface on video, to insert and to update the information (Figure 2).

Figure 2 The Mask to insert the information in the MA-CA card

The most important performance of a GIS is the possibility to make the queries, which gives any information about the data by means of SQL language. The result of the queries is defined *dynaset*, that combines *subsets* and *dynamic* which are the characteristics of a table. The dynamicity intends that any change in the original table automatically is updated in the query result (and vice versa). There are different types of queries, producing different results, for example we used the Selection Query that allows to specify different criteria for the selection of the records.
The database of the Temple of August and Rome is based on a principal table named CATALOGUING characterized by an univocal field ID_SCHEDA, the primary key that allows the univocal definition of the field value. The compilation of the MA-CA card puts inside all other fields. In the table there is also the field IDOBJ that recall the Object-id method. This field is able to connect both typologies of cards: the Object-id card and the MA-CA card, that can be placed completely in the first one. The other tables of the repetitive paragraphs and the structured fields are connected by the univocal field ID_SCHEDA, by means of the relationships “one to many”: to a single object can correspond repetitive cards.
We realized a relational model structured in 85 tables connected directly or indirectly to the principal one (Figure 3).

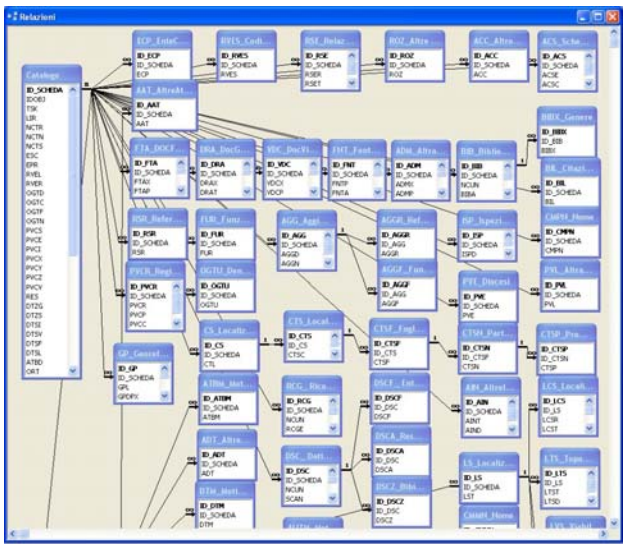

Figure 3 The relationships among the tables in the database

Considering the common fields encoded equally in the card MA-CA and in the other typologies of cards (for example the RA for the archaeological finds), based on the standard ICCD, it is possible to conform inside the table CATALOGUING every type of cards by means of the tool of Selection Query or using dedicated Masks. The important parameter to distinguish the cards is the field TSK which contains the distinctive code of every typology of card. If you want to extract from the database the data related to the MA-CA card you have to perform a Query selecting all the records with the field TSK=MACA.
The Mask for the data input is organized in many cards which correspond to a specific paragraph of the MA-CA card. Every card is represented by simple sub masks or complex macros which open new areas of work (Figure 4).

Figure 4 The Mask performs the photographic documentation

4.3 Hyperlink, search and visualization

The Heritage Information System (HIS) is very important because it links the geographical elements with the documents giving the spatial continuity of the data. Moreover it allows the copies of the data, the analysis, the update and the organization of the information, the use of predictive models and dynamic simulations.
The IHS realized by the software ArcGIS can be distinguished in two correlated components: one determines the geographic position of the Temple and another describes the building in every part by maps and three-dimensional models. It allows both to visualize the architectural structures and to investigate the available documentation in a "vertical" information system (Figure 5). Every representation can be visualized by multimedia Hypertext.

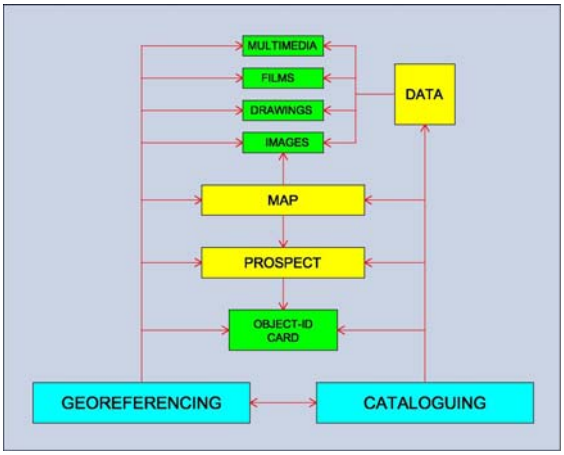

Figure 5 Conceptual schema of the data structure

The Ancyra HIS is an organized database at different scale, consequently the download and the visualization of the data on the map depends on the zoom degree. The layers connect raster images at different resolution to vector data related to the buildings and to other virtual documents as rendering and films. In the same time the plotting of each fronts of the Temple are organized with the similar structure (Figure 6).

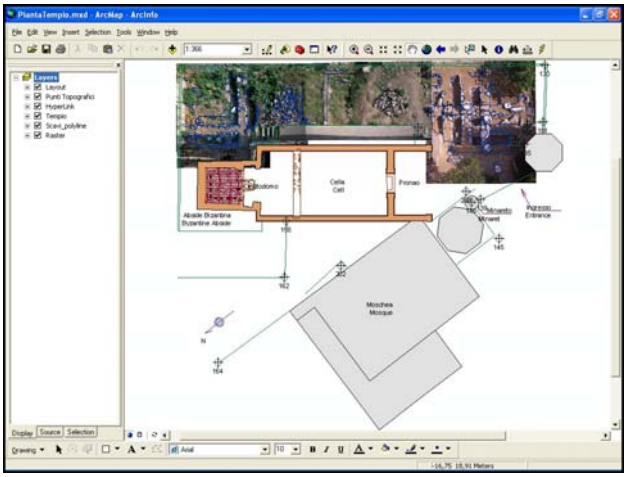
Figure 6 Raster and vector data organized in the HIS

In the Heritage Information System the purpose to connect all the available information to the geometric elements has realized two types of Hyperlinks: one related to the sensitive areas on the maps and on the plotting and another directly referred to the points that individualize the archaeological finds. The first type of Hyperlink is a standard function of the GIS that connects any external file in a properly application. On the layer *Temple* there are some sensitive areas which realize the link to the other data by means of the function *Hyperlink* of ArcGis. Also in correspondence of the epigraphs *Res Gestae Divi Augusti* we have realized some links to the MA-CA card. The other typology of link on the contrary realizes the connection between the point element and the information collected in the database inside the MA-CA card.
To solve this task we implemented in ArcGIS a new tool in Visual Basic code which performs the connection with the database realized in Access. The toolbar presents some command menu to open directly the MA-CA card, the image documentation, the drawings, the virtual representation by multimedia tools. The link starts selecting the layer *Cataloguing* and then selecting the point that individualizes the Temple in the window map (Figure 7).

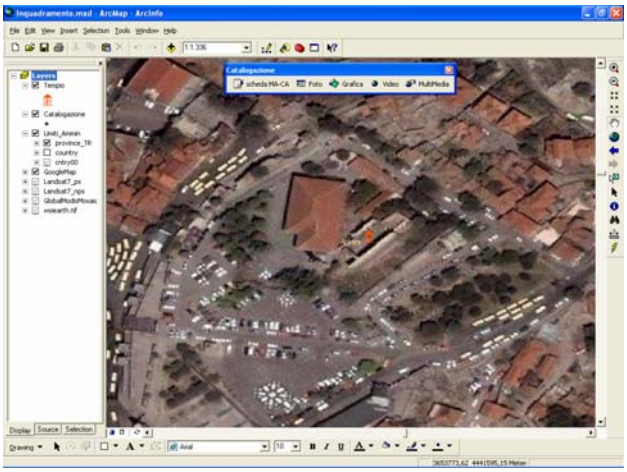
Figure 7 The sensitive map actives the Hyperlink functions

4.4 The data dissemination by Google Earth

To make visible the Project to the wide public of the Web we realized a three-dimensional model suitable for Google Earth. This web tool has revolutionized the environment of the GIS combining online the three-dimensional visualization with the characteristics of a GIS.
It allows to explore the Earth providing maps and images at different resolution, updated and available freely, till yesterday unimaginable. Besides to the geographic visualization there is the most used Google search engine, that gives a lot of information geographically located, in practice a free multimedia GIS. While this sector was once only for few experts, now for the simplicity of use, it has become available for all consumers with a fast Internet connection, independently from the knowledge of the cartography (reference system, projections, datum) or of programming languages to personalize the environment of work.
To export the three-dimensional model on Google Earth it was necessary to operate a preliminary simplification of the geometry of the buildings making use of the solid boxes. By Google Sketch Up we exported the archaeological complex in Google Earth taking care that the simplification did not sensitively modify the visualization of the buildings.
The file KMZ containing all the Project can be opened every time with Google Earth (Figure 8). The recognition of the coordinates happens in the Kml format (Keyhole Markup Language).

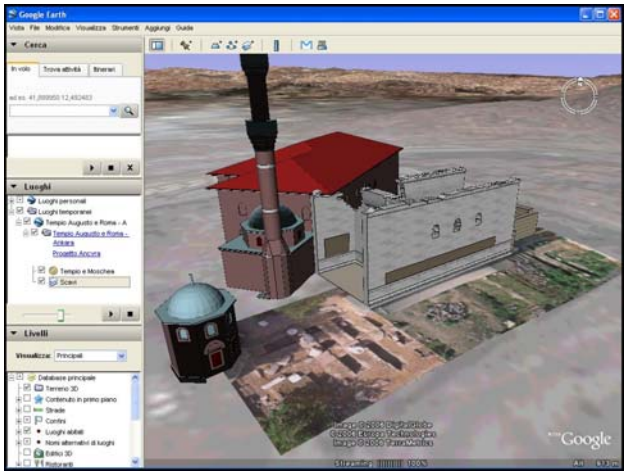

Figure 8 The Ancyra Project shared in Google Earth

To share the Project with other consumers of Google Earth we used as Web server the 3D Warehouse (http://sketchup.google.com/3dwarehouse/). In the home page of the Project we find a preview of the 3D model, a map at small scale to individualize its geographical position, a synthetic description, the keywords used for the web search and an index of complexity of the 3D reconstruction that underlines the quality of the project effort (Figure 9).

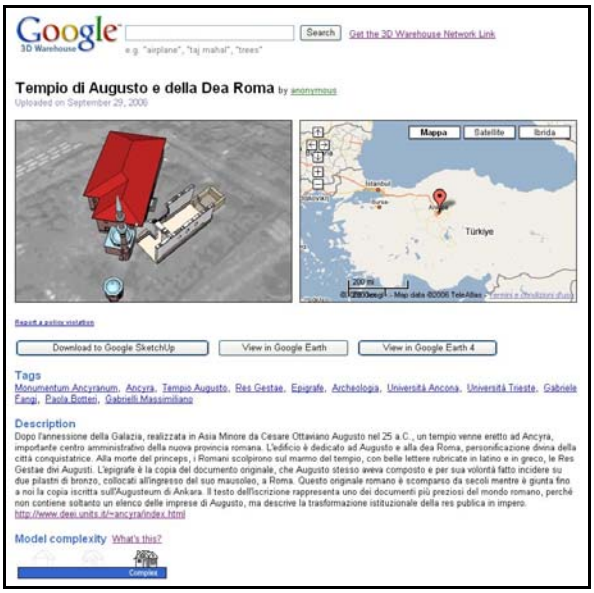

Figure 9 The description of the published Ancyra Project

5. CONCLUSIONS

The documentation of archaeological sites and monuments plays an essential role in promoting the understanding, conservation and preservation of the archaeological heritage.
The cataloguing in standard format of every available data allows to decide the priorities and the type of actions for the maintenance and the restoration of the objects. We have given an example of a dedicated GIS prepared collecting and organizing different sets of data in an standardized structure. Moreover we have realized some multimedia links, by a new suitable implemented tool in ArcGIS, to give the possibility of the best knowledge of the Ancyra Project. Finally the experience via Internet was set up sharing the Project on Google Earth. We are making an attempt to save at least the memory of Augustus in Ankara.
Considering these motivations we remark that the cultural archaeological GIS can be easy integrated, often with good results, with other environment of management and spatial analysis, as territorial planning, disaster management, environmental monitoring, risk map.

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