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SITAR - SISTEMA INFORMATIVO TERRITORIALE ARCHEOLOGICO DI ROMA. A NEW TECHNOLOGICAL SUPPORT IN THE PROCESS OF URBAN PLANNING

Serlorenzi Mirella [S.M.][1], Jovine Ilaria [J.I.][2], Parolini Cecilia [P.C.][3]

[1]Soprintendenza Speciale per i Beni Archeologici di Roma, ROME, ITALY, mirella.serlorenzi@beniculturali.it; [2]Soprintendenza Speciale per i Beni Archeologici di Roma, ROME, ITALY, ilaria.jovine@beniculturali.it; [3]Servizio SITAR Soprintendenza Speciale per i Beni Archeologici di Roma, ROME, ITALY, cecilia.parolini@gmail.com

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ABSTRACT

In 2008, the Soprintendenza Speciale per i Beni Archeologici di Roma launched the SITAR (territorial archaeological information system of Rome) project for recording archaeological data. SITAR meets the primary needs of the Soprintendenza: protection, exploitation and preservation of the exceptionally rich archaeological heritage of Rome. The system is a unique tool for the organization of the data available for the entire urban area of Rome, and it provides invaluable support in the process of urban planning.

The system brings together very different kind of data sets, ranging from large monumental contexts to single archaeological features found in rescue excavations; it also records all of the scientific data deriving from the entirety of the investigations (both salvage ones and planned ones) carried out in the territory of the Soprintendenza.

In the future, the system will function as the information center and general repository for all results of the various research projects carried out by the different offices involved in the safeguard of the archaeological and historical heritage of Rome. Because of its modular logical architecture, the system is highly adaptable and will allow for interaction and exchange with new and up-to-date systems that will become available to the offices working in the territory. This, in turn, will lead to the mutual utilization of the archaeological data and the integrated management of the recorded archaeological resources.

The mission of the *Soprintendenza Speciale per i Beni archeologici di Roma* (hereinafter SSBAR) is to safeguard, preserve and exploit the archaeological heritage of Rome. These tasks represent the essence of archaeology, which takes into consideration the social aspect of history[1], as D. Manacorda eloquently put in a recent definition: *"I resti archeologici non trasmettono in linea generale un messaggio diretto; la loro interpretazione richiede un complesso percorso di indagine scandito dalle tappe della individuazione, della raccolta, della descrizione e dell'organizzazione dei dati, che possono garantire il raggiungimento di un'interpretazione storicamente validata"* [1].

Our project began in 2007, when the SSBAR decided to equip itself with SDI (Spatial Data Infrastructure)[2] [2], and to translate into a technical language a very complex theory which considers archaeology as a science, and therefore closely linked with a number of other disciplines. One of the difficulties of this work in Rome derives by the changes of an historic city constantly evolving, and by the issue of deciding what to preserve of the ancient layout of the city within contemporary architecture. Rome witnessed dramatic changes and transformations in the course of her history, either in the city center and in the suburbs; all of them leaving visible marks in the development of public and private spaces. This is still happening today with hundreds of daily rescue investigations deriving from the construction works.

It was necessary to create a dynamic tool that would allow to map the territory of Rome, including the monumental center within the Aurelian walls, as well as the suburban, productive and agricultural areas.

[1] For further reading: A. RICCI, *Attorno alla nuda pietra : archeologia e città tra identità e progetto*, Roma 2006; M. AUGÉ, *Rovine e Macerie. Il senso del tempo*, Torino 2004.

[2] http://en.wikipedia.org/wiki/Spatial_data_infrastructure.

The choice mandatorily fell on a SDI because of its ability to be constantly implemented and improved, and which allows the interaction of data, once they are uploaded on a network, with new and up-to-date systems that will become available to the offices working on the territory, and regulating town development.
Ultimately the goal of the SITAR is to be part of the urban and suburban development and, when possible, of the requalification of degraded areas even with the integration of the ancient layout into the social modern one[3]. It is then necessary to analyze the distribution and transformation of the ancient city in order to monitor the expansion of the modern urban centre. Furthermore, the SITAR will guide the future development of Rome integrating the pre-existing levels. It is necessary to cooperate in the planning of the territory: SITAR can represent the junction with people in charge of the administration. To obtain this result the detail of the represented objects is fundamental, since the accurate description in the maps of the archaeological features outlines the operational basis to set the next and more important stages of data processing and interpretation.
The SITAR will function as the information center and general repository for all results of the different research projects carried out by the various offices involved in the defense of the archaeological and historical heritage of Rome. It is a multi-tasking tool to arrange the available scientific and administrative data. Thanks to its modular logical architecture, the system is highly adaptable and will allow data exchange; this will lead to the mutual use of the archaeological data and the integrated management of the recorded archaeological resources.
The overall goal of the SITAR project is to publish the recorded and interpreted data, using the standards and technologies OGC compliant, as the WFS and WMS standards, in order to share the descriptive and cartographic databases with the other offices dealing with town planning. This will also foster a real interaction with others public SDI and encourage the research, study and use of new analytic methods to increase the knowledge and the exploitation of the urban archaeological heritage.
SITAR brings together many types of data sets, from large monumental contexts down to single archaeological features discovered in rescue excavations carried out in the territory of Rome. It is a geospatial database that publishes information, properly digitized and georeferenced, through a SDI that can be easily accessed and disseminated. Operationally, from the collection, computerization and organization of documentation, we proceed to the implementation of the system by filing a summary of information, identifying data useful to describe and to spatially represent the identified evidence. This is to have uniform archaeological data that might be valuable for public use. It is possible to develop a dynamic cadastre of scientific and administrative information, that responds to the needs of cross-connections between different operational areas of the SSBAR.
Our Project is based on sharing information and this makes SITAR a promoter of knowledge, fruition and safeguard of the common heritage.

[S.M.]

SITAR LOGICAL STRUCTURE

The structure of the SITAR is built on four logical levels necessary to hold all the information supplied by SSBAR. These four steps, required also to cope with all the needs of the different operative areas of the Institution, are (Fig.1-2):

[3] The project developed from two *Commissioni Paritetiche Ministeriali* to establish minimum requirements and to create a SDI of Italian towns, their territories and their archaeological heritage (1st *Commissione Paritetica Ministeriale* set up by D.M. January 24th, 2007; 2nd *Commissione Paritetica Ministeriale* set up by D.M. December 22nd, 2009). The Project SITAR follows also the guidelines of INSPIRE, Infrastructure for Spatial Information in the European Community, set by the European Parliament and European Council (Dir. 2007/2/CEE of March 14th, 2007), and the national standards issued by Italian Ministry of Cultural Heritage to codify public GIS projects and new approaches to analysis of archaeological heritage (for example, the recent guidelines for the Archaeological evaluation or for the study and control of Seismic Risk on archaeological buildings). Finally it participates to the current permanent working group created by *Direzione Generale per le Antichità* and by Academic Institutions (November 30th 2011) to create a SDI of Cultural Heritage.

1. OI – *Origini dell'Informazione* (Information Origins): univocal indicators of all scientific and administrative contexts, within which new archaeological and topographic evidence is generated everyday;
2. PA – *Partizioni Archeologiche* (Archaeological Partitions): archaeological or geological material evidence, as well as the partial reconstructive hypothesis; each PA takes its origin from a single OI and it represents a specific portion of its scientific value, even if PA are sometimes fragmentary and apparently do not have connections with other known PA; this is valid also for the PA that will be found in future investigations. PA are always identified by consistent chronological and functional principles.

Logical class and files name	Type of informations	Informative value and *cognitive/interpreted* process
OI Origine Informazione (Information Origin)	Administrative Information	Data origins (metadata of scientific data)
PA Partizione Archeologica (Archaeological Partition)	Description of scientific data	Analysis of scientific data
DT Dispositivi di Tutela (Safeguard Tools)	First contextualization of scientific data aggregated (UA)	Safeguard of Cultural Heritage
UA Unità Archeologica (Archaeological Unit)	Interpretation of scientific data	Synthesis of scientific data

Fig. 1 - SITAR logical structure

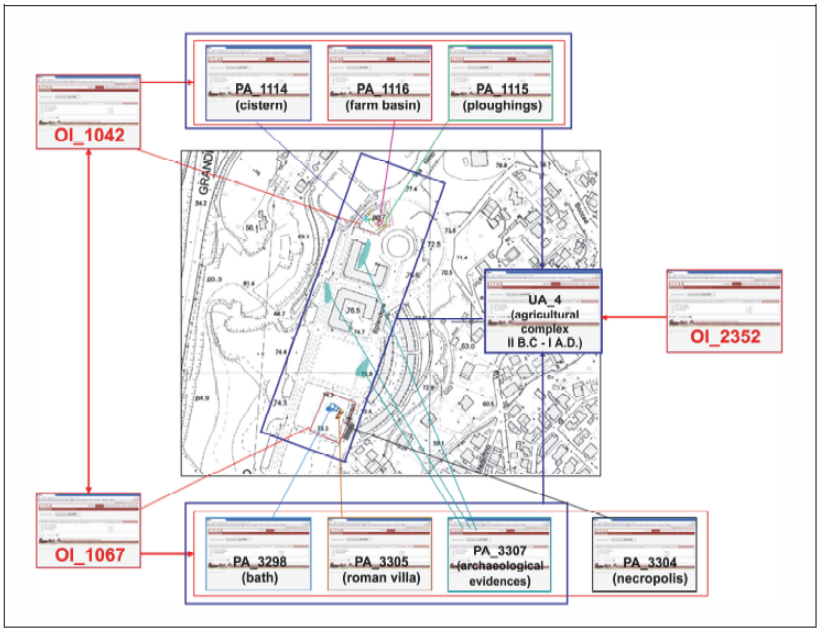

Fig. 2 - From *Archaeological Partitions* to *Archaeological Unit*

3. UA – *Unità Archeologiche* (Archaeological Units): logical aggregates deriving from the interpretative correlation of several PA. The latter, once they have been analyzed in a specific context according to the consistent chronological and functional principles, lead

to the univocal identification of topographic contexts, i.e. the ancient urban layouts of Rome and the surrounding territory;

4. DT – *Dispositivi di Tutela* (Safeguard Tools): law-constraints which punctually preserve important monuments but not their contexts; they are, as well, archaeological, monumental and landscape safeguard measures (Fig.3), representing the intermediate level between an immediate and punctual protection of ancient heritage and a wider planning for the exploitation of urban and extra-urban territory. This is the task of several Institutions working together, like the Ministry of Cultural Heritage, local authorities, Associations, citizens[4].

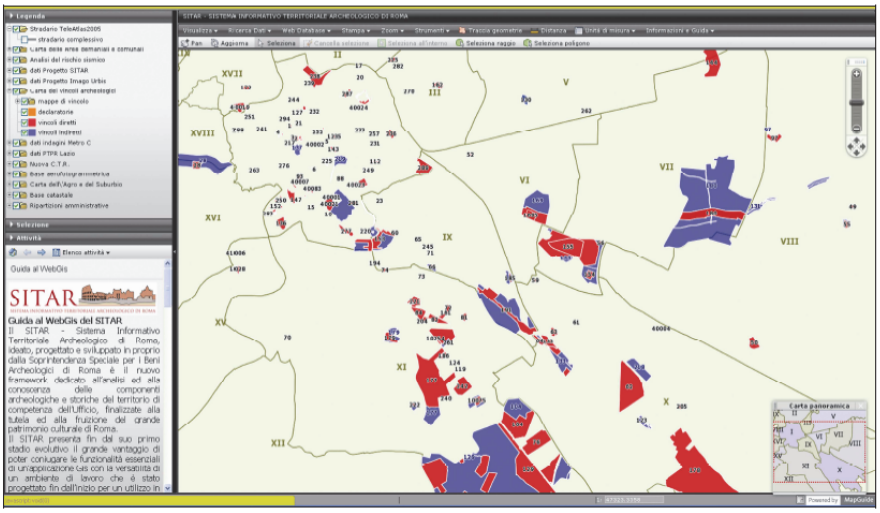

Fig. 3 - The *Safeguard Tools* on SITAR WebGIS

The four above mentioned primary levels correspond to four sections of the same database. The sections are provided with a spatial dimension, embodied by a cartographic map.

More specifically, thanks to the OI level, it is possible to record the essential and basic information related to every safeguard, research or study action carried out in the territory under the control of the SSBAR. This level allows a quick management of single administrative files: it could even lead to the discovery of new scientific elements, or PA, as they are called in the SITAR system. Potentially the OI level can work as the connection with other SSBAR administrative and scientific archives, that right now are dispersed in different location and databases.

The PA level is useful to survey the archaeological and historical evidence in the territory of Rome. First of all, as a geometric cadastre, it can work as a tool to quickly record the known data already included in the SSBAR archives, even when the data have been entered with enormous differences in definitions and formats. The large scale data-enter of the fundamental descriptive and spatial data related to each ancient macro-context, guarantees an implementation of the monothematic cartographic layer; starting form this it will be possible to make the suitable adjustments to the digitalized data. This will lead to construction of a first preliminary diachronical map of the historical layouts of ancient Rome.

Of course, information deriving from PA cannot supply a complete knowledge of the history of Rome: PA themselves are the starting-point of any future archeological reconstruction and topographic analysis.

[4] There were law-constraints established in the so called STATUTI for the preservation of ancient monuments a long time before the Italian unification of 1861. But it is in 1939 that the first national legislation about heritage landmarks was promulgated. It was an extraordinary law both for the historical context in which it was promulgated and for the modernity and actuality of the principles it established. In 2004, after a number of elaboration of the original legislation, a new law was passed (D.lgs. 42/2004); the art. 12-13-45-46 of this new law regulate the safeguard procedures for the cultural heritage.

The higher conceptual level of the system is the UA; UA are identified and described after a long analytical process of the archaeological and spatial data put in the lower level archives. This conceptual level of the system can dialogue with external territorial databases, due to its degree of aggregation, abstraction and representation. PA can link SITAR to the Public and Private operative offices in charge of the urban planning. Finally, UA are the lexical and spatial description (bi- or tridimensional description) of ancient monuments or of archaeological areas, which are represented with their characteristics, actual physical dimensions, and even in the light of the anthropological meanings standing behind their construction, their use, their abandonment, their rediscovery and their exploitation; or in a word: their life.

[J.I.]

SECURITY POLICIES

Once the SITAR will be web-based, it will be a fundamental information tool and, to avoid an uncontrolled data drain, it will use a Role-Based Access Control System (RBAC). This is a very simple system that can give each user a specific role associated to different operative levels. Each profile is linked to different options, based on the degree of action the user will be allotted.
There is an important distinction between *authenticated users* and *not-authenticated users*: the first, divided in *internal users* and *external users*, must submit credentials to obtain an operative role within the system; internal users are the SSBAR managers, officers and collaborators, whereas the external ones have only limited authority, belonging to credited Institutions, like Universities, Research Institutions or specific administrations.
Finally, *not-authenticated users* are the ones using SITAR front-end instruments on web; these will have access to public open-data, and will be able to visualize only data sets made available by the SSBAR. *Not-authenticated users* cannot modify any data.
At this stage, RBAC System encompasses seven main roles, organized in an apical structure, from *Administrator* down to *Invited*. It is noteworthy that SSBAR officers will sometimes have two access permits. They will have full authority to modify, insert, delete the data gathered in the area they are in charge of; on the other hand, they won't be able to operate on data from other areas, that will be read-only.
To sum up, this Role-Based Access Control System neutralizes the risk of an uncontrolled data drain and it is based on three steps: the system assigns a role, then authorizes it on the basis of the credentials and, finally, allows the action on the data.
The SITAR system available on web and structured on its logical classes from OI to UA, meets the need to have a more transparent and efficient public administration; furthermore it protects confidential and/or unpublished scientific data that may be included into the files.

[J.I.]

WEB SERVICES AND WRITING STANDARDS OF EXCAVATION DOCUMENTATION

The network is the infrastructural basis of SITAR both for the internal workflow traffic and data produced (once they have been properly modified and analyzed), and for the link with other SDI outside the SSBAR. Above all, the Web allows having an open approach, essential to make the SSBAR a provider of data, web applications and web services for Rome archaeology, for varied and multiple users. The use of the Web was an obvious choice, as a tool for publication and circulation of applications to manage the internal relation of informative system components. In this way it is possible to make public a methodological path and to make available to users the administrative and scientific information; the users can then utilize the SITAR data for any future specific processing, according to one's use rights and personal access profile [3]. One can quickly and easily access a number of applications which will help to dialogue with the archaeological culture of ROME, i.e.: accessing web services of SITAR portal directly from the

contexts of investigation just through an internet connection: all of this will facilitate the procedure of safeguard of the territory. Procedures will consequently be more assertive and immediate due to the technological support.
WebDB and WebGIS are the operational interfaces (Fig.4) of SITAR database with which any user can interact, contributing at the same time to the implementation of the system through specific web-services on the basis of the increasing solidity of digital archives. WebDB is a management software of alphanumeric descriptive data, whereas WebGIS is the web platform for the representation and publication of geo-spatial data[5].

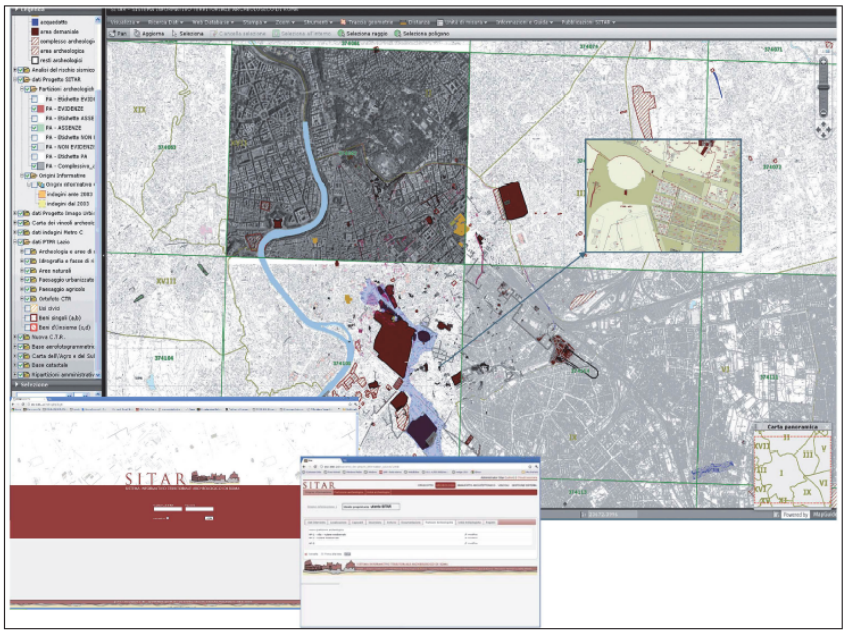

Fig. 4 - WebGIS and WebDB interfaces

The next goal will be to merge the essential functions of WebGIS and WebDB into a single user interface, still using web and open-source technologies to facilitate the access of SITAR database to a wider audience [5]. Furthermore, these tools allow an immediate and constant implementation of the primary information levels of SITAR according to standards that gradually become shared; this process consequently leads to the understanding of ancient monuments. The latter are recorded in details with their original size and the current state of preserva Indeed the highest level of SITAR's performance can be reached only with a high degree of standardization in the procedures of archaeological recording. Standardization is one of the key elements to structure and carry on a service able to manage a SDI. tion.
On the one hand, this means to uniform a huge number of preexisting data filed in the archives during the past decades of the SSBAR safeguard activities.
The information often derives from heterogeneous documents, different for typology and informative complexity and it is necessary to convert them into the unique operative logic of SITAR database [6].

[5] Open approach philosophy translates also to use of software open source, at the basis of this interfaces: WebDB is based on software *Post-GreSQL* with spatial extension *PostGIS*; the WebGIS is planned with *Autodesk Map-Guide Server Enterprise* (http://wikihelp.autodesk.com/Infr._Map_Server/ita/2012) and aligned with standards of *Open Geospatial Consortium*, thanks some tools for maps and web-layouts editing. The System for administrative management of database was processed through the open-source framework Symfony 1.4.9 (http://www.symfony-project.org/; http://www.postgresql.org/).The digital archive, dedicated to all types of documents, is managed by *web file system* developed with *framework Drupal* by CED of SSBAR, with intention to deal them like as a *web application* for consultation of files attached to various contextual information objects. In this project phase the *data-entry* occurs through the *desktop editing* of geo-spatial information, using commercial software such as Autodesk Map 3D and Raster Design 2009\2011, Geograph and others *software open-source,* which temporarily replace more complex analysis tools still in the experimental phase. http://wikihelp.autodesk.com/enu [4].

On the other hand, it is necessary to code and keep up-to-date some basic standards in order to make new archaeological and administrative data easier to read. This is the only possibility to guarantee a good level of uniformity and quality for the information daily entered into the SITAR.
A reference document has been provided in order to standardize the various descriptive, cartographic and iconographic documents produced by SSBAR consultants; in an experimental phase, consultants have been asked to use the standards in order to help in the improvement and development of the System as well as in the broader archaeological methodology.
SITAR provides guide-lines to correctly edit documents [7], as showed in the following list:
- administrative documents: digital copy in .pdf format;
- scientific documents: digital copy in .pdf format;
- photographic documents: digital copy in .tiff or .jpg format.
Standards have been provided also for cartographic and topographic documents; they are:
- in vectorial maps (.dwg) different CAD Layers must be included in order to show: topographical benchmarks for georeferencing of topographic drawings; limits of the investigation area; absolute elevations.
- in cartographic documents must include a map of the PA showing also the stratigraphic units.
- if there are raster images (in .jpg, .tif, .bmp format) in CAD files, their frames must be set in specific layers.

[P.C.]

SITAR AND TRAINING

Because of the very nature of SITAR and its institutional mission, the procedures involving the implementation and interpretation of data, gathered in current researches, have been entrusted to the SSBAR technical and scientific staff: officers and their assistants; this guarantees a high standardization level for criteria used in the production and acquisition of the excavation record. At the same time, it guaranties the correct filing of administrative data as well as the accurate interpretation of the scientific information.
A primary role has been given to the SSBAR staff: since the early stages those who had the necessary skills have been involved in the Project. Specific training courses had been launched to illustrate the structure and the functions of the system, the data-entry procedures and elaboration of the archaeological data.
The training of the staff has been arranged into two different steps: the first one provided a number of meetings open to the SSBAR staff, in order to illustrate the aims of the Project, its mission, its potentials and the operative procedures.
In the second step, SITAR Staff organized one to one meetings for officers and assistants, to answer specific questions related to the office daily routine [8].
The ability to adapt the training to the specific questions of the participants resulted into a constructive approach and had an extremely positive feedback.
The constant interaction between internal staff and external participants, in addition to continuous exchange of questions, answers, doubts and suggestions was extremely useful to test and improve the technical aspects of the System.
The main purpose of the training of SSBAR Staff definitely is the dissemination of the operative abilities required to improve and use the SITAR; moreover, it allowed the validation and the spreading of public data, and the protection of confidential files.
Nevertheless, because of the small number of SSBAR Staff involved in the Project, it is necessary to have several collaborations with different professionals external to the SSBAR, supporting the successfully managing of the SITAR. For this reason it has been crucial to plan the training for the external professionals working as free lance archaeologists or within archaeological firms, and for students of Italian and foreign Universities.
The training for the professionals already having archaeological or computer knowledge needed to develop SITAR, is based on a series of individual meetings to demonstrate the structure and

operative steps of the System, and to explicate standards for the correct writing of scientific documents for the SSBAR.
The still ongoing training addressed to students has a double purpose: on the one hand, it is an important corollary to their archaeological studies that must include a solid knowledge of SDI; on the other hand, it can provide the skills necessary to properly operate in the SITAR, in addition to the tools to face excavation protection and exploitation issues of the archaeological heritage.
The constant exchange between SSBAR and Universities is one of the most important and fruitful effects of SITAR's training, guarantying mutual and numerous scientific and institutional advantages.
During the *stage*, students have a preliminary approach based on lectures and practical exercises; following this, the students are directly involved in the main activities of SITAR, i.e. recovery, selection and acquisition of archives record, researches on published materials, data-entry, georeferencing, vectorialization, processing of thematic maps, SDI testing.

[J.I.]

FUTURE DEVELOPMENTS

SITAR is beginning to experience modeling 3D data to create the "first archaeological 3D cadastre" of the city of Rome in order to facilitate a more detailed analysis of the ancient archaeological preserved architecture[6]. In the medium-term SITAR hopes to conclude a first consideration on the conceptual model of 3D as well as on the most appropriate data model for the description, the filing and the spatial information management, including all valuable procedural aspects generally used (GML, CityGML[7], KML, SVG, etc.). In cooperation with other Public Institutions and with the desirable technological support of one or more software-houses the primary aim of the project undoubtedly is the definition and creation of an environment that is 3D-Operational, at least for the modeling and the specific analysis of the basic data; this will lead to a better and more realistic visualization of the data.
So far SITAR conducted some experiments starting from data made available by the daily work of implementation; this is according to two different working procedures (Fig.5):
- modeling 3-dimensional data from archaeological and geophysical investigations. Using the available altimetric points, digital elevation model of soil have been produced for some ancient chronological phases identified in a sample area;
- reconstruction and rendering of 3-dimensional models of ancient structures. During the collaboration between the SSBAR and the Indianapolis Museum of Art (IMA) 3-dimensional reconstructions of three funerary buildings have been developed; the volumes of the preserved remains have been integrated with the restored ones through the decomposition of the information objects into the SITAR logical levels.
Thanks to these experiences, it was possible to reflect on how to model and recreate human and geological stratification for the reconstruction of the ancient settlement systems as well as the volumes of the elevation of the single buildings, in respect of the correlation relationship between PA and UA. Although the results are still provisional, this was an opportunity to begin a significant discussion on the need of data standardization for the spatial rendering of 3-dimensional geometries and for the definition of topological relationships [9].
The analysis of 3D data fits perfectly into the wider project of data processing: this is essential if SITAR wants to be part of the planning of urban areas.

[6] This course has still a few trials they can focus on concrete issues of modeling and of dynamic management of 3D data. We are starting from a first mapping of trans-national experiences that suggest real innovation and a focus on real needs of their management system.
[7] CityGML http://www.citygml.org, http://www.citygmlwiki.org, http://www.opengeospatial.org/standards/citygml.

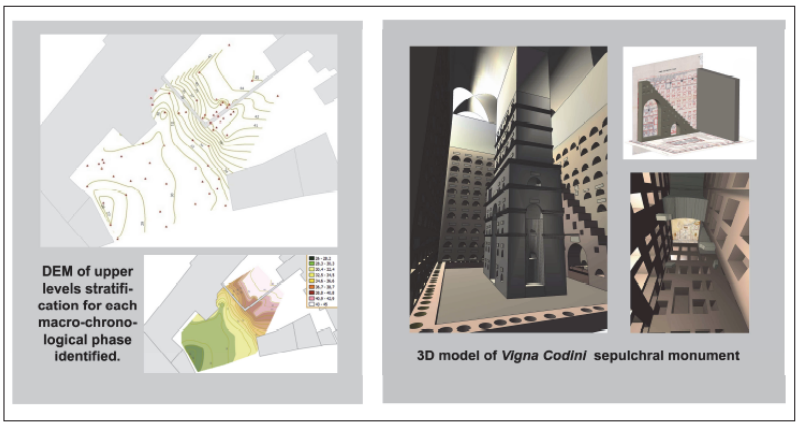

Fig. 5 - 3D modeling data experience

As a matter of fact, the processing of the archaeological data within the SITAR implies to have a broader view from the merging of the individual evidence of regional layout; each evidence should be included within this territorial system, taking into consideration the relationships between the evidence and its original context. As archaeologists and as administrators we have to interpret the data and to transform any material evidence, even the most basic one, into a historical document.

Clearly enough we must avoid to necessarily hypostasize the function of any structural remain, especially when it has been found "orphaned" of its context into a cable trench or small sounding. However, it is compulsory to assign a potential value to the discovery, including it within the context of the other known data. In this perspective, the goal of SITAR is to transform these material elements into variables, to whom are assigned specific values in a statistical-mathematical calculation. The result of this calculation will identify areas that will create a map of the archaeological potential. This is a level of information that is currently being conceptually developed, because the beginning of the experimentation calls for a long period of data-entry, that in a city like Rome is inevitably substantial due to the amount of information to be processed. This set of tools will allow those who are in charge to join forces with the Institutions responsible for the urban planning, to guide the development of a contemporary city that will encompass within itself the preexisting ones.

[P.C.]

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