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WebGIS tools to disseminate archaeological landscape memory

(Article begins on next page)

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*Elisabetta Colucci
**Antonia Spanò
***Filiberto Chiabrando

WebGIS tools to disseminate archaeological landscape memory

Abstract This research works is providing digital tools for knowledge, fruition, communication and promotion of built heritage, in a framework of landscape heritage valorisation.

The application could be placed in a framework of established methods within a field of study, increased in the recent years, aimed at promoting the integration of processing digital methods and information dissemination.

The central aim of this work is to obtain and manage spatial information that can be helpful to represent and promote the peculiar features of the Archaeological Mine Park of San Silvestro, using proper acquiring techniques derived from Geomatics, regional data retrieved from the spatial data infrastructures and archaeological data.

The use of innovative rapid mapping methods, the generation of orthophotos and DTMs-DEMs (Digital Terrain Model-Digital Elevation Model), the harmonization of different sources, scales and reference system data, the integration of datasets that synthesizes the studies and the excavation activities of the parks over the years, have provided a large spatially referenced archive that testifies the historical richness of the site. Those information, if communicated via WebGIS, can help to highlight the memory values of a territory.

In addition to the opportunity to integrate multi-content and multi-source spatial data into a single platform, the Web-GIS project uses applications and solutions in order to promote the preservation of the memory of the territory and the historical identity of the place. It is widely known that reaching the valorisation of a cultural heritage is possible only establishing and organizing stable structure, resources and networks.

*   Politecnico di Torino - DAD (Department of Architecture and Design) - Viale Mattioli 39 - 10125 - Torino - elisabetta.colucci@polito.it

**   Politecnico di Torino - DAD (Department of Architecture and Design) - Viale Mattioli 39 - 10125 - Torino - antonia.spano@polito.it

***   Politecnico di Torino - DAD (Department of Architecture and Design) - Viale Mattioli 39 - 10125 - Torino - filiberto.chiabrando@polito.it

1 | INTRODUCTION

The most important aim of the proposed application was to lay the foundations of a WebGIS for the *Archaeological Mine Park of San Silvestro.* In addition to the opportunity to integrate multi-content and multi-source spatial data into a single informative platform, the project uses applications and solutions to support the preservation of the historical memory of the territory. Therefore, it works in the well accepted framework of reaching the valorisation of a cultural heritage, establishing and organizing stable structures, resources and networks. We can consider this project as an emblematic case of how today the opportunity to share in the internet network the knowledge heritage about territories and assets is needed and highly required.

The innovative researches and applications about the Medieval Archaeology, took place in the Archaeological Park of San Silvestro over the years, and they underlined the archaeological evidences connected to the landscape resources in order to recreate the place history.

Although the traditional use of digital resources, these researches have led to the enhancement and the transformation of the territory, ensuring its fruition and sustainability.

The site highlights, indeed, the strength bond between housing and structures of raw materials transformation, that in the past were places of social and everyday life and extraction of mineral resources, and the landscape (Guideri, 2008). Since the mid 1980ies, the valorization of the whole area of the Park has been made possible by the archaeological excavation at the Rocca of the Park carried out by the University of Siena. Nowadays, the Rocca and the mines of this territory are an important example for knowing, from the archaeological point of view, the history of the mining work organization during the Middle Ages (Semplici, 2011).

The safeguard and preservation project of the site gave a significant contribute to the promotion of other archaeological areas; tourism has developed and a new system of cultural and natural heritage was born in order to enhance the memory preservation. Thanks to the research, which promoted the area, arousing the interest of various fields of study and stakeholders of the territory, it was possible to create and open the Archaeological Mine Park of San Silvestro; moreover, the public institutions volition and the private funding rise to the possibility to start the project that today is self-supported thanks to the profits of the visit. The Park visit allows visitors to learn the history of this territory and the main mining extraction techniques used by different civilizations over the centuries.

This contribution will also highlight a summary analysis about the territory regulations, landscape and territorial plans of the Tuscany Region, and their updating and integration have favoured the site protection. These planning regulations may also represent how innovation of geographical information systems can contribute to the knowledge and protection of both territory and landscape. In addition to the cultural promotion and the economic and social development purposes, an important role in this scenario derives from educational aims; these goals are pursued at several levels: from the Park laboratories offered to the visitors, to the specialized archaeological formation of the students who have applied standard excavation methodology over the years, both for stratigraphic analyses of horizontal and vertical plane and for the investigation about stratigraphic units of the walls (Bianchi, 1996).

These educational purposes on the Park project have allowed the Geomatic Team of Politecnico di Torino to perform activities of survey in the Park area using innovative 3D techniques in order to valorize the cultural and landscape heritage. Data acquired and the following cartographic products (Brocchini *et al*., 2017) have become part of the Web GIS project to ensure that, thanks to the data shared via web, the knowledge and the diffusion of its value can be pursued.

Finally, the present study aims to underline the necessity to insert the archaeological landscapes

representation in a GIS, in order to enrich the regional geographical data infrastructures.

Other themes, in addition to technical advantages related to the territory government, derive also from the will of involve communities into this scenario; these themes, like the Public Archaeology (Serlorenzi *et al.*, 2015), are the basis for future conservation.

2 | INNOVATIVE SYSTEMS FOR THE COMMUNICATION OF THE LANDSCAPE AND CULTURAL HERITAGE HISTORICAL MEMORY

2.1 Use of GIS platform in archaeological and landscape domain

It is equally established that the use of IT tools such as GISs in relation to the adoption of data storage systems relating to cultural and landscape heritage (CH, LH), as well as the innovations and transformations that have taken place in digital mapping, have not come about because of a simple consequence of technological development. It was the subject of a widespread reflection between the late 1990s and the 2000s, that the integrated uses of the aforementioned technologies have surely offered the opportunity to use new information, otherwise unavailable, and therefore the tools themselves have been the subject of research (Scollar 1999, Wheatley and Gillings 2002).

An interesting contribution from the same years (Djindjian, 1998-2001), besides providing fascinating statistical considerations on the geographic distribution of 150 GIS projects (also referring if research institutes or public administrations guided them, or which type of DBMS and software tools were used by the sample), provides a schematic classification of the needs which the GIS responds. It can still be considered current.

The several independent information systems that continue to appear in the many application proposals still today are four.

- Systems supporting rescue archaeology (aiming at site prediction to optimise efficiency and cost of field sampling);
- the so-named intra-site GIS supporting excavation field archaeology; involving the realisation of numerous drawings, graphics, maps, photographic recording, using 2D/3D reconstruction;
- systems supporting regional settlement studies, which concern relationships between landscape, CH and communities, that require spatial analysis and modelling;
- Cultural Resource Management (CRM), of which the institutional role is to survey, protect, and preserve the cultural heritage.

In the third millennium the methodological developments, even in terms of the affirmation of new fields of study is bounded to the requirements and to the implementation of standards, to which the next paragraph is related. It is possible, however, citing necessarily a few contributions among the many significant, to outline some dominant research enhancements on managing digital resources about CH and LH. Among the first ones there is the association between archaeological landscapes and risk (D'Andrea 2000, Weldrake 2010); other resources are available for example through website of project deepening and monitoring specific areas as Coastal Archaeological Resources Risk Assessment (*CARRA*). In general, the basic assumption is the drafting of archaeological maps based on topographic databases, reference systems and nominal scales complying with the standards of technical cartography today available ((D'Andria *et al.*, 2008). Another research sector presenting deep developments is the one dealing with the introduction of third and fourth dimension inside GIS platform with the aim to advanced 3D web-based repository of reality-based data. (Apollonio *et al.*, 2012); for the management of the entire 3D documentation process of the excavation with object oriented strategy (Katsianis *et al.*, 2008); for the use of stratigraphic analysis of elevations (Drap *et al.*, 2012); or combining the 3D component and the use of national and international spatial data infrastructures to

link excavation data and source of materials (Sammartano *et al.*, 2017).

The virtual archaeology is another emerging field that has subjected to an exceptional development; both for the high need to communicate the results of studies in the form of perceptively immediate and multimedia contents (*e.g.*, Piñas Azpitarte, 2012), or focusing the land perspective (Spanò *et al.,* 2016).

A last major horizon of enhancements is the refinements of archaeological information systems (AIS) in the domain of public archaeology (*e.g.* Serlorenzi *et al.,* 2015). We are in the sphere of CRMs and web projects funded with public resources are involved, which in Italy have the biggest reference in the SITAR project,[1] and which generally have to rely on the use of standards of each level, as well as having specific ontologies for sharing historical AIS landscape.

2.2 Open source and proprietary software

The choice of the right tools to perform an activity is one of the key matter in any technical project; nowadays, there are a lot of GIS software packages, both open-source and commercial, that allow data management, visualization and maintenance.

GIS softwares include a wide range of applications, which enable the use of a combination of digital maps and georeferenced data; in addition, a GIS should allow the creation, the discovery, the maintenance and the delivery of spatial data from a data repository, ideally via one or more web services.

While commercial packages usually offer products suitable for all of software categories, open-source software focus on a single one. (Jafari Salim, 2014)

The open-source GIS software (Free and Open Source Software for Geospatial Applications, FOSS4G) (Brovelli *et al.*, 2016; Steiniger, Hunter, 2012) can be classified into several categories in relation to the tools offered and the functions that are present, these are: data creation, data editing and data storage; data integration from different sources; data analysis and query. In (Steiniger, Weibel, 2009 e l'Associazione Italiana per l'Informazione Geografica Libera, GFOSS) were defined the following GIS software:

- Desktop GIS, "Mapping software that is installed and runs on a personal computer and allows users to display, query, update, and analyze data about geographic locations and the information linked to those locations" (ESRI 2012). Some examples are *Quantum GIS, GRASS GIS, gvSIG, uDig, Open Jump*;
- Spatial Data Base Management Systems (SDBMS), like *PostgreSQL, Spatial Lite* e *PostGIS*;
- WebMap Servers, that are used in order to share maps dataset via web. In particular the software, which supports the Open Geospatial Consortiums (OGC) WMS (Web Mapping Service) and WFS (Web Feature Service) standards, that will be described in the next subparagraph;
- Server GIS and Web-GIS client, software which provides access to functionality via web protocols (*Geoserver, Map Server, Geo Network, Geo Node*), in addition this server GIS can be related with some viewers for allowing users to use, modify and analyze data (Frontends, pmapper, Open Layers, Chamaleon, Map fish);
- Mobile GIS, GIS software which runs on a mobile platform (*gvSIG Mobile, Quantum GIS for Android*);
- Remote Sensing Software, which could be focused on the transformation of UAV or satellite data, like Lidar data;
- GIS Libraries, used with Desktop GIS or Server GIS.

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1 https://beniculturali.academia.edu/SITARProjectKnowledgeExperienceBase

As regards the commercial solutions, today the key players in the GIS software market are *Autodesk, Bentley, ESRI Inc., GE, Pitney Bowes* e *Intergraph.* For example, these are *Autocad Map 3D* (https://www.autodesk.it/products/autocad-map-3d/free-trial), *Bentley Map V8I* (https://www.bentley.com/it/products/product-line/asset-performance/bentley-map)*, GeoMedia Web Map* (https://www.hexagongeospatial.com/products/power-portfolio/geomedia-webmap), *ESRI ArcGIS* (http://www.esri.com/arcgis/about-arcgis).

Currently, the diffusion and use of the GIS sw is rapidly increasing, as the bottom-up approach based on user requests is profoundly different and often preferred by users with respect to the commercial logics of integration of large analytical functions present in the sw solutions, often articulated in different and sometimes complex packages, by the software houses.

2.3 Spatial Data Standards and Information Systems for CH

The adoption of a European SDI was carried out through the INSPIRE[2] project, the acronym for Infrastructure for Spatial Information in Europe, whose directive came into force in 2007.

In Italy and wherever the widespread adoption of shared standards has been developed, both for geographic data (ISO / TC211) and metadata (ISO19115), improved detection, localization, retrieval and semantic interoperability of data.

The SDI affirmation also at local level has allowed the Italian Regions to provide environmental and territorial data catalogues on which to base sector planning plans on the territory and to protect the environment and landscape and provide related services research and sharing.

The systems for cataloguing and disseminating data from the local administration such as those responsible for the protection of cultural heritage, employ geographic services and web platforms similar to those used for basic and thematic general mapping.

They often use the Web Map Service (WMS) and WFS (Web Feature Service) services to display the major regional map bases on which the regional cultural assets datasets can be navigated, classified according to the defined standard of the Central Institute for the Catalog and the Documentation (ICCD) of the Ministry of Cultural Heritage and Tourism (MiBACT).

The access to digital contents forms organized by cataloguing standards, using alphanumeric or geographic retrievals (WebGIS) for aims of research, dissemination and enhancement of regional heritage is undoubtedly an evolved and widely used method.

The directions undertaken by the Italian Ministry on these issues are, however, even more ambitious. In the past the Carta del Rischio[3] (the Risk Map), the GIS platform created by a long process of data collection and digitalization in the '90s to respond to the need of conservation and protection of Cultural Heritage, responded in its conversion to WebGIS (2002-2005) to the need for widespread and homogeneous knowledge of the consistency of Heritage distributed across the territory and, above all, of its state of integrity and risk. It also defines degrees of vulnerability in relation to territorial danger.

At the same time, since 2004, the ICCD has launched the SIGECweb project, the general Catalog Information System, which optimizes the functionality of the previous system, adopts the new standards and implements the new subjects set up for cataloguing, integrating the "geographic" side of ICT technologies and thus guaranteeing spatial reference of data. Data is retrievable and navigable, thanks to the relationship between data and objects, also allowing statistical queries on big data.

The interoperability, as planned from the project phases, allows connection with other projects of the

2   http://inspire.ec.europa.eu

3   http://www.cartadelrischio.it/

Ministry. The integration with the "Vincoli in rete" project is currently under development, carried out by the Istituto Superiore per la Conservazione ed il Restauro (ISCR), which in addition to being a bridge between SigecWeb project and the Carta del Rischio, also integrates SITAP, the Information System of the Direzione Generale Belle arti e Paesaggio. Confirming the interest and awareness of the need to use standards, systems and languages that transcend national borders, many studies are currently underway to direct systems towards internationally recognized standards, since the only available standard, CIDOC CRM, is for museums.

3 | ARCHAEOLOGICAL MINE PARK OF SAN SILVESTRO: TERRITORIAL AND HISTORICAL FRAMEWORK

As announced, the results of a study conducted on the Archaeological Mine Park of San Silvestro, in the province of Livorno (in the hills of Campiglia Marittima), few kilometres far from the coast (San Vincenzo), will be presented. The area of the Val di Cornia Parks, which is a system of archaeological and natural parks, with the addition of museums, is located in in the south-west of Tuscany (Figure 1).

Figure 1 Municipality of Campiglia Marittima, Suvereto, Sassetta, San Vincenzo and Piombino.
Dataset from Tuscany Region's GEOscopio Geoportal - dataset scale 1:10000 *(Colucci et al., 2017)*

The San Silvestro Park was born as an instrument of protection and valorisation of a cultural deposit (Francovich, 1994). The Rocca with the village has been discovered by the University of Siena archaeologists, and the area is deeply marked by the history of many populations that, from the Palaeolithic to the last century, settled in this area in search of minerals (for instance: copper, lead and silver). The area is part of the landscape and it represents a high cultural value, subjected to the requirements of ordinary maintenance and risk of deterioration. The park includes part of the mining zone characterized by the presence of deposits of copper, lead, silver, iron, zinc incorporated in metamorphic fragments of rock named skarn, made by the reaction between magmatic fluids and

limestone.[4] The presence of metals had a strong influence on the settlement: for hundreds of years, there was a stratification of extraction and processing of metals, ended in 1976. (Semplici 2011)

The first way to valorise the mining and built heritage is their accessibility, so six different visiting paths have been fulfilled. (*Via del Temperino, Via delle Ferruzze, Via dei Filoni Porfirici, Via dei Lanzi, Via dei Manienti and Via delle Fonti,* Figure 2).

Figure 2 Municipality of Campiglia Marittima, Suvereto, Sassetta, San Vincenzo and Piombino.

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4   Metamorphic contact rock, rich of iron oxides and sulphides, formed thanks to a mesomatic reaction of interchange between an ultrabasic magma and a silicified and rich of metals limestone (From dictionary item "Skarn", found in "encyclopedia Treccani).

3.1 The birth of the Park and regulations that has favoured it

The park was launched in 1996, after the archaeological excavation in the mediaeval mining village of Rocca San Silvestro by Università di Siena, under the supervision of R. Francovich.

Successively the *Val di Cornia Park's System* was created, formed by: *Archaeological museum of Populonia territory, museum of Castle and Piombino City, museums of the Campiglia Rocca, Archaeological Mine Park of San Silvestro, Archaeological Park of Baratti and Populonia, Coastal park of Rimigliano, Coastal Park of the Sperpaia, Forest Park of Poggio Neri* (Figure 3).
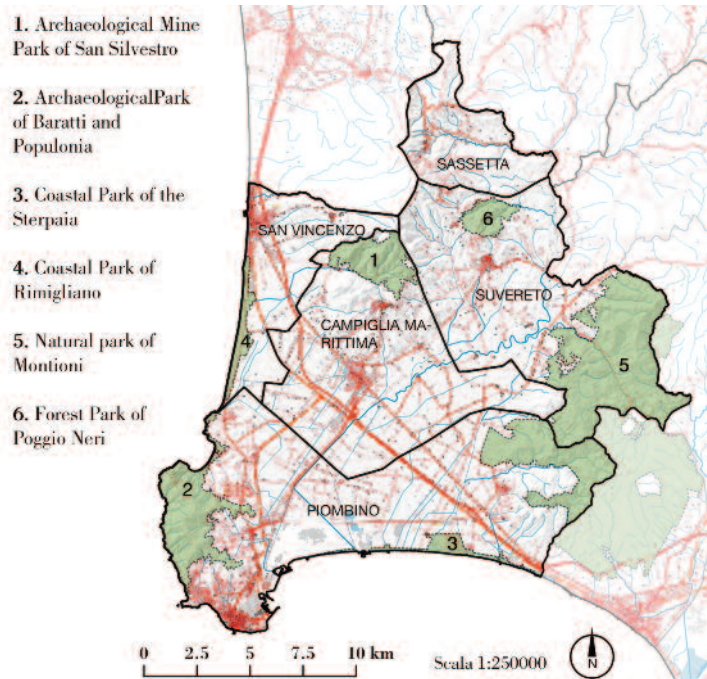

Figure 3 *Val di Cornia Park's System.* Dataset from *GEOscopio.* - dataset scale 1:10000 *(Colucci 2017)*

The birth of the park system is also linked to the foresight of the regulations in Italy and in the Tuscany Region, which over the years have evolved, increasing the protection of the landscape

It is very important in fact to adopt research strategies for the smart and sustainable preservation of the cultural heritage, using methodologies and techniques to study and promote the sites and implementing techniques for the preservation and communication of the memory, in order to integrate protection and a sustainable development.

From the 21st Century, in Italy, the landscape perception and the sensibility about its safeguard and development have increased more and more. The landscape, thanks to the *Codice dei Beni Culturali e del Paesaggio*[5] and to the *European Landscape convention* (signed in Florence in 2000 and ratified by Italy from 2006), became object of the public policies and it has been proposed as a central theme in the *Piani Paesaggistici Regionali* (PPR). Previously, the contents of PPR were introduced by the law 1497/39 and then renewed by the "Galasso" law.[6]

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5 D.lgs 42/2004

6 Legge 431/1985.

After the *European Landscape convention* and the *Codice dei Beni Culturali e del Paesaggio*, the landscape plannings were extended to the communities using the promotion of the different ways of life adopted by the population in relation to the environmental situations and in the whole regional territory. As other Italian regions, the Tuscany Region chose to adopt a territorial plan with specific consideration of the landscape values; according to the *Codice dei Beni Culturali*. Further, the landscape plan is integrated to the present *Piano di Indirizzo territoriale* (PIT) which gains the value of landscape plan (the fusion of PIT and *Piano paesistico* has generated the *Piano di Indirizzo Territoriale con Valenza di Piano Paesaggistico*).

The goal has been to provide the public administration with unitary planning tools for the territory and the landscape: so, the PIT proves to be a planning regional tool that carries both the territorial and landscape domains.

"Territorial quality and landscape quality are not only strongly linked aspects, but according to a widely diffused interpretation the first represents the structural dimension, the second the perceptive aspect of the territory".[7] The landscape, in Tuscany, is a fundamental heritage which includes the memory and the work traditions of the past generations; it is a shared heritage that has to be safeguarded and valorised because it is a precious element of touristic attraction.

In this regard, the safeguard of CH analyses the concepts of protection, valorisation and vulnerability. Furthermore, another important role derives from the study of the meaning of cultural, archaeological heritage and landscapes and sustainability of the landscape.

Figure 4 Normative references at international, national and regional levels investigated (Colucci 2017)

3.2 Historical notions

The mining and marbling activity has always been a peculiarity of the campigliese territory, but there is a contradiction. On one hand the traditional mining activities left significant traces offering to investigate the metallurgical and mining techniques of European history, on the other, contemporary activities create incredible damages that offend the exceptionally rich territory from the archaeological and natural point of view. (Francovich, Farinelli, 1992).

The Etrurian were the first to inhabit the campigliesi mountains between the VII and the V centuries B.C. and they dug mines manually. Many years after, in 1005, the aristocratic family *Conti della Gherardesca* arrived in San Silvestro, attracted by the presence of saleable metals and exportable in cities; they built a village, named *Rocca a Palmentum* (today Rocca di San Silvestro). From 1108 to

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7   PIT, Territorial Plan with Landscape Plan value. General Report of Landscape Plan

1330, the propriety of the mining territories passed to the *Conti della Rocca,* who reinforced the Rocca and erected buildings, but the mines were negatively influenced by the difficulties in extraction and processing techniques and by the presence of an excess of different minerals in the subsoil. (Semplici, 2011).

In the first ten years of the 16th century the territory was under the control of the *Medici* family; *Cosimo I De Medici* recruited in his mines specialized miners from the German, named "Lanzi" by local population, and in 1568 the building for German miners *Villa Lanzi* was built.

During the 18th century the territory could not ignore the industrial revolution, so a fervent extraction activity began again in the campigliesi deposits, but this time the techniques changed considerably, thanks to the use of explosive. In the 20th century, the English society *Etruscan Copper Estates Mines* wanted to complete the Etrurian work begun two thousand years before and in a brief arc of time, from 1900 to 1908, it however left evidences on the territory. Despite this, the mines disappeared one more time for forty years and they opened again only after the Second World War.

The extraction activity continued in the second half of the 20th century, but the mine closed definitively on October 1976, because of the excessive costs.
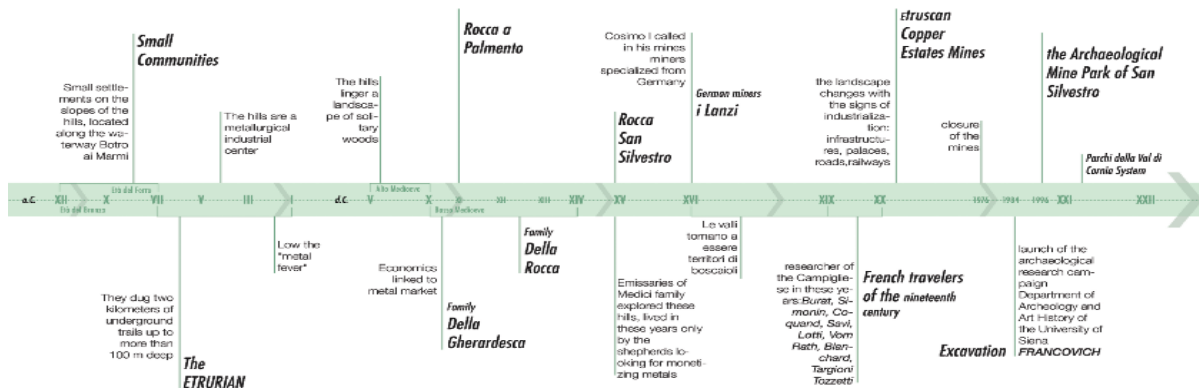

Figure 5 Figure 5 Two thousand years of history *(Colucci 2017)*

4 | THE WEBGIS PROJECT

4.1 The spatial data and related harmonisation

The achieved WebGIS uses different data sources. The main base maps of the Web GIS have been generated using the regional datasets available from the regional SDI i.e. the *Geoportale della Regione Toscana* – GEOscopio. Also, the SDI use a WebGIS to visualize and share geographic data of the Tuscany Region, so with the purpose to provide a geographic framework for the San Silvestro Park, the following datasets have been downloaded from this source:

- *Integrazione del PIT con valenza di Piano Paesaggistico (Integration of PIT plan with landscape plan value),*
- *PIT_invariant_50k,*
- *ISTAT surveys for demographics and industry sector,*
- *Topographical Database 10k_049_Livorno_2010; and 5k and 2k topographical databases.*

The second group of datasets was the archaeological data: the spatial archaeological information were provided by the Parchi della Val di Cornia and they include paths and mineral ancient sites of the park.

Finally, as third group of data, the large scale spatial information were acquired during the Team DIRECT fieldwork[8] aimed to data collection. The results of the processing workflow, DSM and orthophotos products at the 1:1000 scale, have been inserted into the generated Database.

In the first part of the aerial survey, a fixed wing drone (eBee by SenseFly) has been used, due to the large area coverage offered. A total of two high altitude flights (100-150 m) were performed and an ortophoto and a DSM were generated, in order to provide an overview of the neighbourhood of the site. The post-processing of the data was realized using the software *Pix4D Mapper.*

Merging and sharing of geographical information via web (both in a local and in a global field) allows to reach relevant aims:

- improve the effectiveness and efficiency of interactive works both in the public administration and in the field of the ordinary relations among organizations and institutions (Campiglia Marittima municipality and other municipalities of *Sistema dei Parchi della Val di Cornia*);
- provide to everyone a tool that allow not only the data visualization, but also their manipulating;
- reach a great number of users who do not own a specific knowledge, in order to promote the discovery of the park ensuring its safeguard and preservation;
- storage data from different historical period.

The GEOscopio dataset are featured by a different coordinate system compared to that shared today as a standard. For this reason, it was necessary to harmonize the different databases, which were transformed according to the INSPIRE Directive.

In Italy, a traditional datum used for geographical information is the Roma40 coordinate system, no longer used in the European framework. Roma40 is based on the Hayford ellipsoid oriented in Monte Mario (Roma) used with Gauss-Boaga projection, a suitably modified conformal Gauss representation with false origins for the two zones: 1500 km for the west zone and 2520 km for the east zone. The geodetic Italian System is now the ETRF2000 (European Terrestrial Reference Frame) according to the 2008 version of the reference System ETRS89 (European Terrestrial Reference System), realized by IGM (Istituto Geografico Militare). It is based on the coordinates provided by GNSS (Global Navigation Satellite System) permanent stations network with the representation projection Universal Transverse Mercator (UTM) using the zone 32 for the study area. The coordinate system selected for the database of this research was converted with ConveRgo[9] Software in the ETRF2000 version. In accordance with the INSPIRE directive, the Reference System used for the GIS project was WGS84/UTM Zone 32N (code EPSG:32632).

Several thematic maps shown in the previous paragraphs were performed thanks to the use of GIS tools. After the harmonization of the different datasets, several analyses and thematic maps generation were performed: 3D analyses using the DSM and overlapped by the orthophoto derived from UAV photogrammetry (Figure 6), chronological distribution of the mining sites (Figure 7). The geomorphological conformation of the area around the site has been even represented, as well as the land use transformation within the park boundaries (*e.g.* Figure 10 shows the land use transformation, from 2007 to 2013 in the zoomed area).

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8   19th -23th september 2016

9   www.centrointerregionale-gis.it/CONVERGO/documenti.asp

Figure 6 Visualization of the UAV survey ortophoto compared with the six paths of the Park (Colucci *et al.*, 2017)
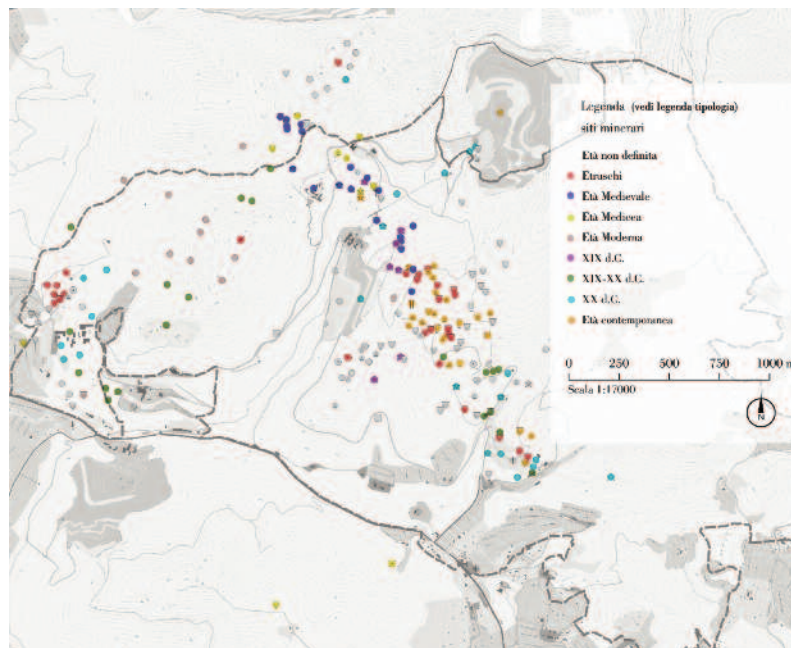

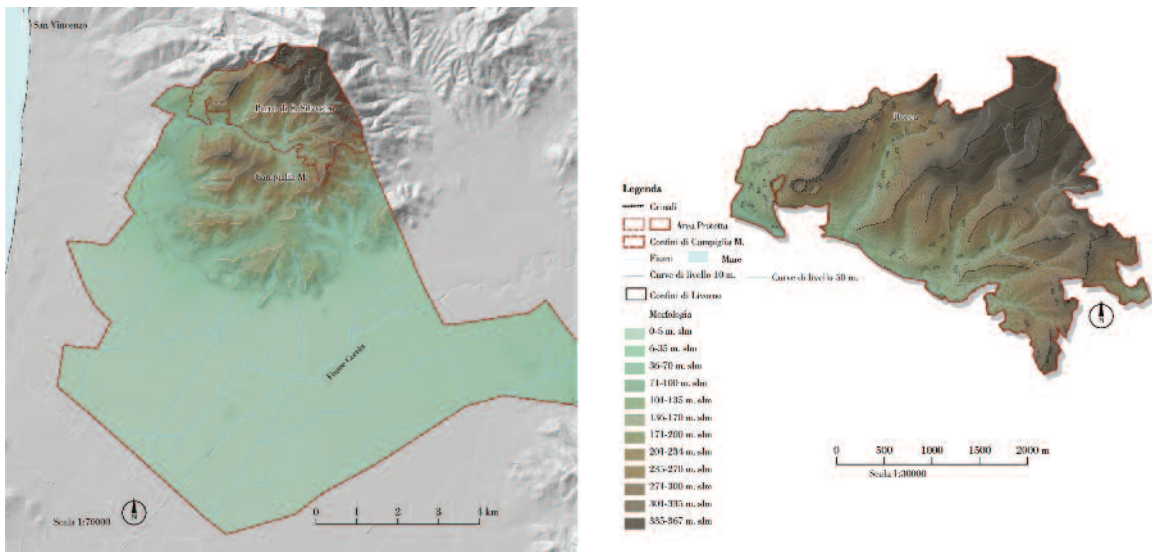**Figure 7** Chronological distribution of mineral sites of the Park

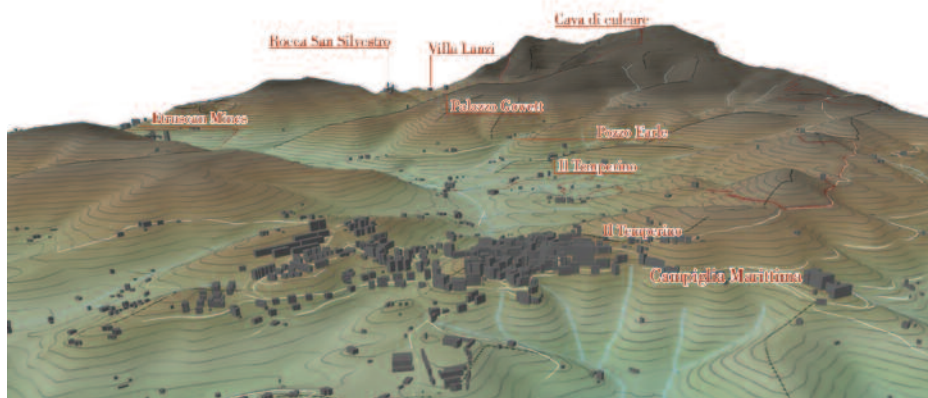**Figure 8** Orographic conformation of the territory

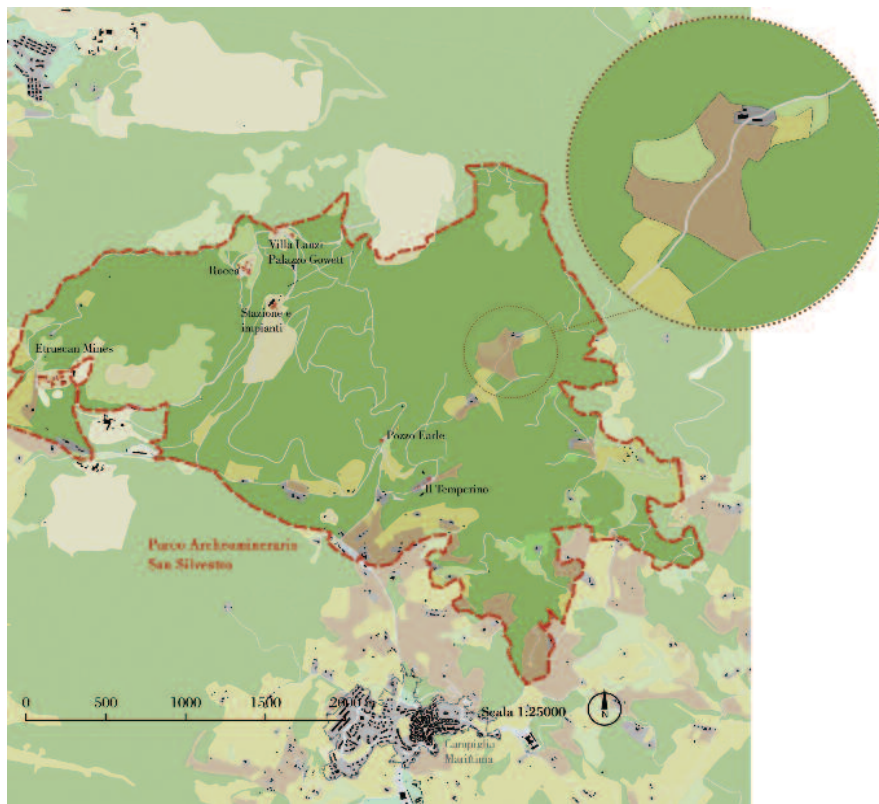**Figure 9** 3D model of the site surroundings

Figure 10 Land use transformation in San Silvestro Park

4.2 The WEBGIS application project

This project is therefore devoted to the realization of a web sharable maps archive that shows the growth of the Park.

In brief, the activities presented in this paper aims to show and disseminate the territorial heritage evaluation process provided firstly by regional plans, and then an archaeological and historical support of the campigliese landscape have been induced after the birth of the Val di Cornia Parks System.

The final purpose, indeed, is the definition of a WebGIS model that harmonize large-scale data acquired on the field during the Team Direct stage with the regional datasets available from the GEOscopio, relating and comparing them to features of the Archaeological Mine Park of San Silvestro. The WebGIS project is usable by a wide and differentiated community as a tool for working, managing and organizing data of the Park and to communicate them to users, who will be able to know upgrades of studies taking place in the area, for example by selecting separate and targeted views.

4.3 Procedure and software used for the Web-GIS generation

The client-server structure of the WebGIS of the park use an Open-Source platform which lets the client to access to the geographic information in the web.

The software PostgreSQL 9.6[10] was used as graphic interface PgAdmin4 installed on a device macOS Sierra. PostgreSQL is a powerful, fast and standard suitable software for the database management, it could can be used to create simple web or massive database applications. It is a ORDBMS (Object Relational Database Management System), *i.e.* a relational database based on objects.

PgAdmin is a free C++ application and it allows to create and manage the database in a simply way and without the use of prompt in Psql. The achieved operations were the following:

• access to server PostgreSQL 9.6,
• creation of a new named database
• insertion of a new scheme,
• creation of tabs.

In order to create the database, the most relevant entities to describe the development and the transformations of the place were selected; successively, the features (attributes) of each object have been defined, this operation was made considering the cartographic classes of the regional SDI, taking also into account also the extension of new data from the Team DIRECT survey acquisitions. Later on, the relationships between the objects were defined and a conceptual model was designed.

For each tab, it was necessary to define columns (the attributes) after the column id (not null) and geometric features (lines, polygons, points), defined and implemented using postGIS, which is a Quantum GIS plug-in. PostGIS is the spatial extension for PostgreSQL and it adds spatial data to other typical in the database, becoming a "geodatabase" able to manage both alphanumeric data and vector elements. PostGIS is not realized with an own graphic viewer, but it is possible to utilize the OpenSource software QGis.

To import and populate tabs, it is necessary to connect to the server PostgreSQL and afterwards to the database created.

The design of a WebGIS considers the users' needs and offer them the ability to use an internet browser to access data. A WebGIS tool is not requested to be complex, but to represent in a simple way the important information. A friendly use is the base for the success of a GIS published on web. In order to publish the WebGIS and sharing the data, Geoserver[11] was employed, which is an OpenSource server of geospatial data that allows to provide maps and data from a great variety of formats to client standard. The visualization of GEOparco, which is the proposed name of the WebGIS project, is possible using OpenLayers[12] (Figure 12) that is a JavaScript library to view interactive maps in the web browsers (WebGIS).

In the LayerPreview section, it is possible to view the geometric entities, while the entities attribute tables can be displayed by clicking on different geometries.

[10] http:// www.postgresql.org

[11] http://geoserver.org/display/GEOS/Welcome

[12] https://openlayers.org

Fonte	PARCO ARCHEOMINERARIO DI SAN SILVESTRO | File Qgis		DATABASE POSTGRESQL per PostGis | Tipo spaziale Qgis	
Geoportale Gruppi di Download_Sh apefile dal GEOscopio, Cartoteca e scarico Open Data geografici	Integrazione del PIT con valenza di Piano Paesaggistico PIT_invarianti_50k Censimenti ISTAT Popolazione e industria Database topografico 10k_049_Livorno_2010			
Shape_file utilizzati riclassficando gli shapefile del Geoportale della regione Toscana	comuni			
	province			
	Area Protetta Parco Archeominerario di San Silvestro		Cava di calcare confine Campiglia	Polygon
	Confine di Campiglia Marittima		Confine parco	Polygon
	sentieri	strade_01	sentieri	MultiLineString
	strade		strade ac viecoli	MultiPolygon
	viabilità mista secondaria		viabilità mista secondaria vms	MultiPolygon
	aree att. attr. Sportive	immobili e antropizzaz ioni_02	aree attrezzate	MultiPolygon
	edificato		edificato	MultiPolygon
	elementi divisori		elementi divisori	MultiLineString
	opere di sostegno		opere di sostegno	MultiPolygon
	pensiline e tettoie			
	ponti		ponte	MultiPolygon
	fiumi	acque_04	fiumi	MultiLineString
	mare			
	breakline	orografia_0 5		
	cave		cave	MultiPolygon
	coste			
	curve di livello		curve di livello	MultiLineString
	alberi isolati	vegetazion e_06	alberi isolati	MultiPoint
	aree verdi		aree verdi	MultiPolygon
	bosco		bosco	MultiPolygon
	coltura agricola		coltura agricola	MultiPolygon
	filari di alberi		filari di alberi	MultiLineString
	pascolo o incolto		pascolo o incolto	MultiPolygon
	temporaneam. Privo di vegetazione		temporaneamente privo di vegetazione	MultiPolygon
	località significative	toponomas tica_08	località significative	MultiPoint
	aree di cava	aree di pertinenza _10	aree di cava	MultiPolygon
	unità insediative			
	linee del suolo	linee_xx		
	tutto il suolo			
Nuovi shapefile	Via dei manienti		sentieri del parco	MultiLineString
	Via dei Lanzi			
	Via dei filoni Porfirici			
	Via delle Ferruzze			
	Via del temperino			
	Via delle Fonti			
	Siti minerari		siti minerari	MultiPoint

Figure 11 A portion of the WebGIS conceptual model: database entities

Figure 12 Entity and features visualization in OpenLayers

Many functionalities are available; among others it is possible to extract and save in the users' desktop the park layer group as images (using *.tif* extension) or download the *.kml* file and open the generated link in Google Earth (Figure 13). Moreover, Geoserver enables creating the WMS file that can be uploaded in QGis and used as a base for the GIS project.

Figure 13 Visualization of the San Silvestro Park DB in Google Earth
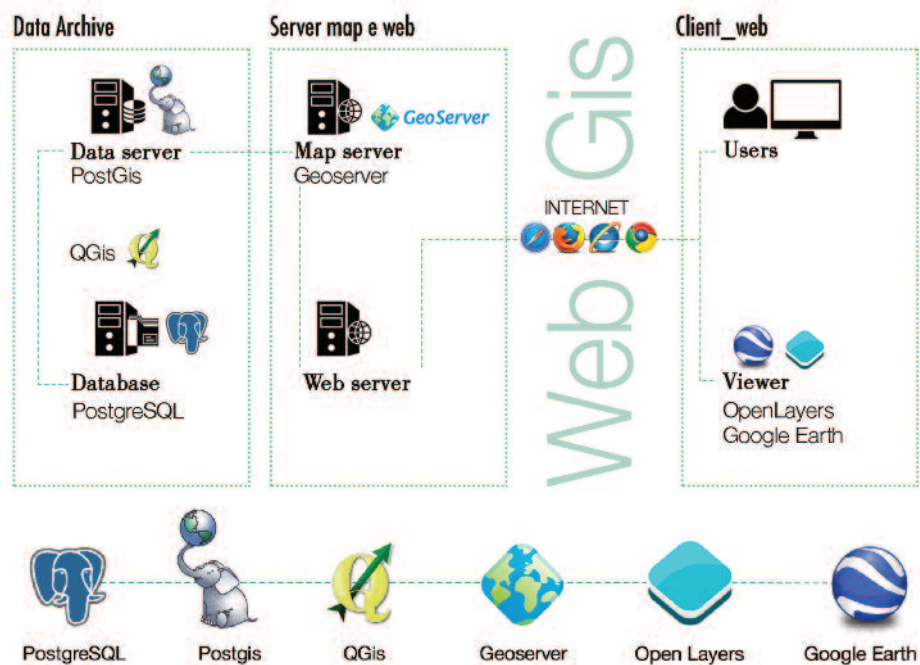
Figure 14 Relationship among the software for the creation of WebGIS platform

The Archaeological Mine Park of San Silvestro WebGIS may be published in the next future, so the Figure 15 reports the interface with the proposed logo.
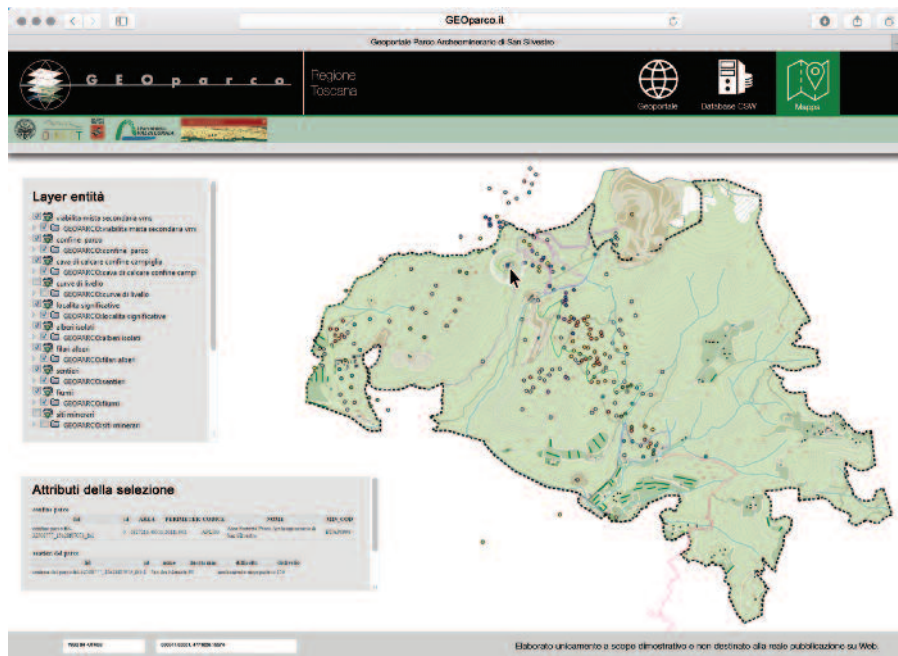

Figure 15 Preview of the planned GEOparco web-site

4.5 Discussion

The application's operational phase was characterized by the creation, storage, and web visualization of the object relational database (ORDB). Surely a critical point that afflicts this application, like many others, is the lack of availability of data structured according to the standards, both on the geografic side and on that of cultural heritage.

As recalled, the first possible harmonization was that related to the cartographic reference systems that allowed the integration of the different datasets: the ones distributed by the Tuscany Region, the datasets provided by the park in the form of geo-referenced study material and those of new creation derived from 3D surveys of the park areas using drone technology.

On the side of the geographical data provided by the regional infrastructures, the Italian panorama offers rather varied solutions and updates with respect to the specifications of the current standards Despite this gap, for example for the Tuscany region the classification of the basic topographic database does not meet the Inspire standard, particular attention was given to the design of the archive in which the classes of the objects catalogue used by Tuscany Region were reported (an example of which can be seen in Figure 16).

Regarding the standards and infrastructures of geographic data pertaining the cultural heritage, considerable attention has been paid to the use of consolidated GIS tools, for example the use of the Web Map Service of the OGC, which is certainly prefigured for updates in progress that will allow open access to the archives of assets safeguarded by the national agency MIBACT.
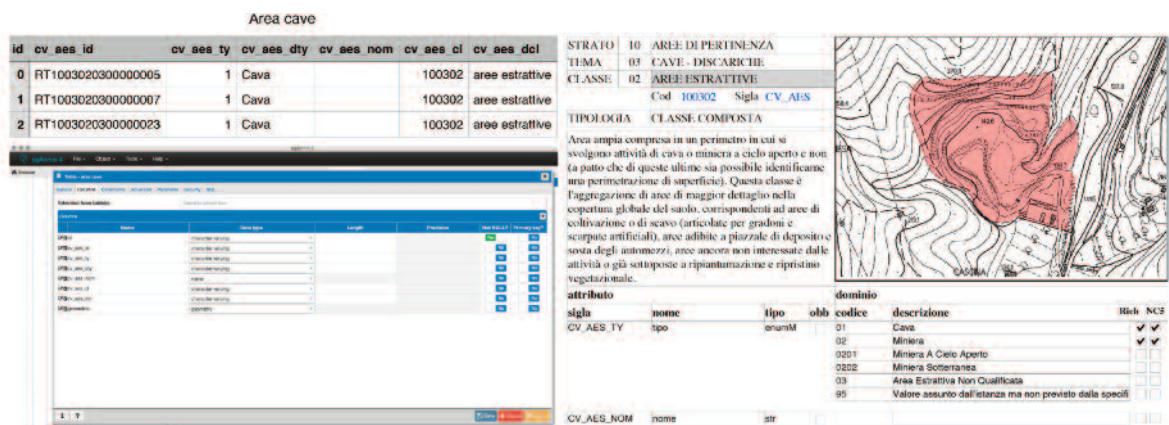

Figure 16 Attributes Table of "Cave area" class. (above): the attribute table exported from PostGreSQL (below) table columns properties, (right) the catalog of the classes of the Tuscany Region DB

5 | CONCLUSIONS AND PERSPECTIVES

At present, the project of the database web publication, that we named at the moment GEOparco, can support the internal management of the park and the relationship with the other components of territorial valorization made by the park system.

The potential of this WebGIS model lies in the opportunity to update the DB with new data, and in the access to an open system that allows to easily share data with non-specialized users. The park authority will be able to integrate the database into a single IT support, as well as link information archives located in different physical locations, establishing dynamic network connections that constitute the physical space in which the system is developed. A main feature is the interoperability of the DB with future datasets, *i.e.* "the possibility for spatial data to be combined so that the result is consistent and that the added value of the datasets and related services is enhanced" (INSPIRE Directive, 2007).

Moreover, the prospect of access to data on the web, for example, if coordinated to the website that promotes the cultural and tourist resources of the park system (http://www.parchivaldicornia.it/it/il-parco-archeominerario-di-san-silvestro.html) would have the advantage of providing an immediate and easy to use tool, for dissemination purposes to complement the educational and tourist purposes of the website.

Visitors would be given the opportunity to know, for example, the length, the difference in height, the travel time of a certain path within the park, or the historical periodization, the type and group of mineral sites in the boundaries of the park; this obviously would allow them to plan a more informed visit.

A strong point in the creation of an integrated database such as the one proposed is the applicability to other territorial, landscape and built heritage, which will facilitate in the future, also in virtue of the OGC standards already mentioned, the integration in management and protection systems of Mibact, referred to the beginning of the paper. The full functionality of local and national systems for the continuous monitoring of the landscape and of cultural heritage allow their full protection, conservation, and become engines of environmental, social and economic sustainability.

Finally, we would like to suggest that the visibility carried out through WebGIS projects of landscape values can facilitate the exchange with new institutions. The recent International Program of Geosciences and Geoparks (International Geosciences and Geoparks Program, IGGP), launched in 2015 by UNESCO, has established Geoparks as territories that possess a specific geological heritage, whose sustainable development strategy provides for a management according to the concepts of protection, education and promotion. They have been defined as a new category of sites protected by UNESCO and now, in Italy, there are ten geological parks recognized at European level for geological, archaeological, naturalistic, historical and / or cultural interest. For these sites and others, such as the Parco Archeominerario di San Silvestro, an active role in the territorial economic development is foreseen and a significant impact on the dissemination of positive principles concerning the relationship between men and the environment are pursued. Since it is shown that information systems can support these purposes it is good to promote their use.

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