
WEBGIS 3D AND INTERACTIVE LOCATOR MODULE FOR MANAGEMENT AND PROMOTION OF NATURAL AREAS

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ABSTRACT

In the very last years the importance of geographical information has arisen both in the traditional market of cartography and several application sectors (e.g. Natural Parks). Today the new consumers of geospatial information make use of these tools to manage, conserve and promote a particular area of interest. This paper describes how to use a WebGIS application to support natural parks management and monitoring and to disseminate information in order to promote the tourist aspect of areas under observation. This friendly, innovative and reliable solution is called Cart@net and it is developed by Planetek Italia for the management, consultation, publication and share of cartographic databases.

Key Words: park management, promotion, WebGIS, interactive locator

1. INTRODUCTION

Natural resources management is undoubtedly an extremely complicated and difficult task. Ecosystems are complex and vary tremendously over time and space. Natural protected areas authorities must be capable of determining whether the changes they observe are the result of natural variability or the effects of anthropogenic activities. The Earth Observation and the derived products can greatly improve the land and sea management providing high resolution data in support to the territory safeguard and environmental monitoring.

Among the applications based on the Earth Observation funded by ESA EOMD program, PARC service and Archipelago System offer a powerful solutions for the natural resources conservation using hyperspectral and very high resolution data with the new web mapping technology.

In the context of natural areas management, P.A.R.C. (Park Advanced Remote Cognition) and Archipelago systems are aimed to help human decision makers in calculating the most logical decision in terms of management and to help the promotion of the territory itself through the Internet.

PARC Service project (<http://www.parcservice.org/>) aims to implement a system based on Earth Observation products with a WebGIS component, designed to support natural parks management for data collection, integration and dissemination issues. The users of this newly designed system is the authority of “Parco Nazionale delle Cinque Terre” who has been putting a significant

emphasis over conservation practices over this unique site facilitated its inclusion in the UNESCO world heritage list. This experience was extended to a natural area in the Aegean Sea Greece, for which an archipelago is a potential candidate to become a natural marine park.

The *Archipelago System* (<http://cartanetarkoi.webgis.planetek.gr/>) represents an extension of functionalities which have been tailored for marine application services. The application is centred around the monitoring of posidonia seagrass to become part of a 3D WebGIS for above and below sea level use. The system ingests data of different sources and type, namely: mapping through Earth Observation in clear and shallow waters, geophysical data plus general information such as JPEG files. The user target is Archipelagos Aigaiou, an NGO organization that is managing conservation of an archipelago located in Aegean Sea.

Specifically, both systems are able to facilitate the following procedures:

- Earth Observation data collection for situation monitoring and analysis
- Publication of the cartographic information on Intranet (for the natural area staff) or Internet (for general users)
- Cartographic 2D and 3D consultation exploiting integration with Google Earth environment
- Direct interaction between users and PARC or Archipelago system by inserting and updating tourist information about the area.

The projects emphasize WebGIS instrument not only to realize management and monitoring activities, but also to disseminate information in order to promote the tourist aspect of areas under observation.

2. P.A.R.C. (Park Advanced Remote Cognition) service

PARC service has been developed with the aim to assist the park authority during the current planning of safeguard policy and land management activities. At the same time the promotion of the park territory can take advantage from the innovative Earth Observation technology applied to PARC service.

The innovative aspect of PARC project is the integration of a WebGIS interface for the satellite products visualization with Google Earth application, currently the most used cartographic tool at global scale available in internet.

The park is a complex system of great naturalistic value, where the close interaction between natural and human aspects represents the most important value to be protected by the park policy. Actually, the natural heritage of the park consists of chestnut and holm forest which, together with the large extent of grapevine cultures, need to be constantly preserved and monitored against natural hazards.

Thanks to the WebGIS functionality all the geographical information provided by the Earth Observation-based services (e.g. status of vegetation, land-cover, etc.) can be published on the web so that Cinque Terre Park can promote their state natural integrity to public. The WebGIS functionalities make able the park staff to integrate, explore and publish any kind of data having geographical references.

The WebGIS portal includes a set of cartographic data derived from the Earth Observation (EO) data processing. EO technology can undoubtedly be considered as one of the great successes of the use of advanced information technology for the improvement of mankind.

This technology has proven to be essential and mature in developing EO-based products & services for public policies issues, such as: land-use assessment, landscape planning, and environmental management. In recent years, a large number of EO services have demonstrated their utility in providing data for natural resource management, especially in the context of Natural Park at national, regional and local scale.

EO services provided by PARC supporting the management of Cinque Terre Natural Park (including marine components) can be grouped in the following service categories:

- EO Imagery geo-rectification of very high resolution satellite imagery (i.e. IKONOS)
- Land-cover map service derived by very high resolution data (i.e. IKONOS)
- Vegetation index and land features extraction from hyperspectral CHRIS PROBA satellite data.

All the EO derived products are integrated into a WebGIS platform which presents some innovative functionalities in supporting the park management task to promote the park status to the public.

The first facility allows the dynamic consultation of Cinque Terre Park cartography by

Google Earth application. Google Earth is a free-of-charge, downloadable virtual globe program. It maps the entire Earth by pasting images obtained from satellite imagery, aerial photography and GIS over a 3D globe.

Every user of the PARC WebGIS application, while navigating the 2D maps of the park, could press the Google Earth icon to start a 3D consultation of the maps.

A further tourist and management tool provided by PARC service to Cinque Terre Park is the so called, Interactive Locator Module (ILM). It is a web-based tool useful to create a cartographic central database. Moreover the administration panel of the tool gives to the Cinque Terre park staff the possibility to track the geographic information that needs to be verified. During the cartographic consultation, the ILM tool offers to each user the possibility to indicate the occurrence of sites which can have a particular interest to the community. This tool can be useful, for example, to put placemarks of the most attractive places in the park, food and lodging structures, flora and fauna remarks, in way to realize a geographical layer using the inputs of the community (see Figure 1).

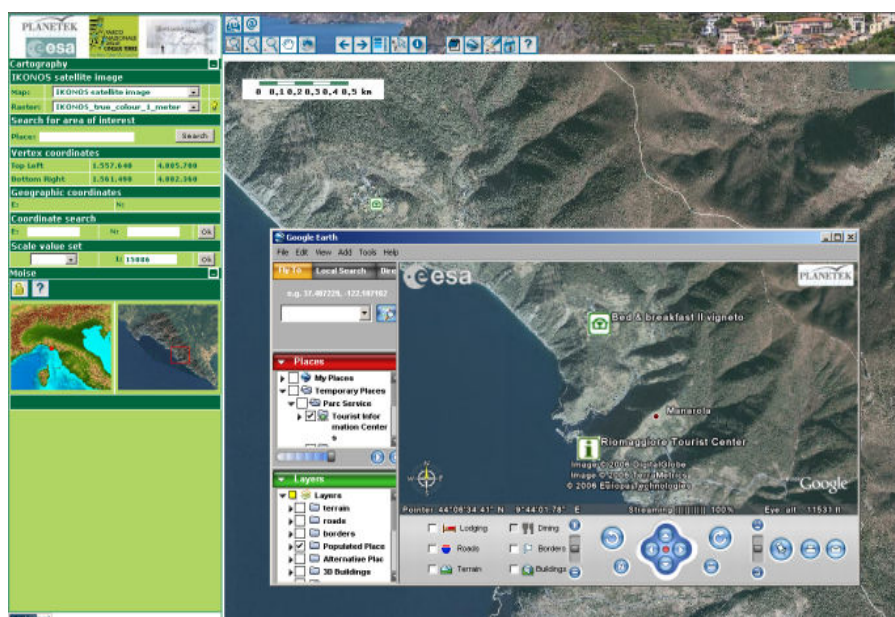


Figure 1: Visualization of the placemarks in the WebGIS portal and in Google Earth environment

The system includes also MOISE application, provided by Explorer Global (CA). MOISE is meant to produce an impact analysis report which should quantify the damages related to a hypothetical natural event such as, for instance, a forest fire, setting arbitrary parameters as input data related to demographic, topographic and economical aspects of the territory. Such software is currently under improvement to enhance the accuracy of the results.

Material and methods

The Service chain was based on Earth Observation data acquired from hyperspectral CHRIS PROBA and very high resolution IKONOS satellite. CHRIS PROBA data have been processed in order to derive the following experimental products: vegetation index map and multiangle and multiband composition in supporting to the land cover analysis.

The IKONOS image acquired on February 2005 over Cinque Terre National Park, was georectified in order to obtain a geometrically corrected pansharpened true color image. With the available corrected IKONOS data, a land use map of Cinque Terre Park was produced.

In order to better fulfill the User requirements, the legend of the land cover and the number of classes have been defined in agreement with the final User, taking into account also the specific characterization of the territory.

First of all a supervised classification on the multi-spectral image performed with ER Mapper software, allowed to distinguish some target classes such as artificial surfaces and forests and to separate these from the agricultural plains.

The automatic features extraction was then revised by visual photo-interpretation, cross-checking other available ground truth data. Thus, manual editing allowed to refine the results and better separate each class as agreed with the final user (see Figure 2).

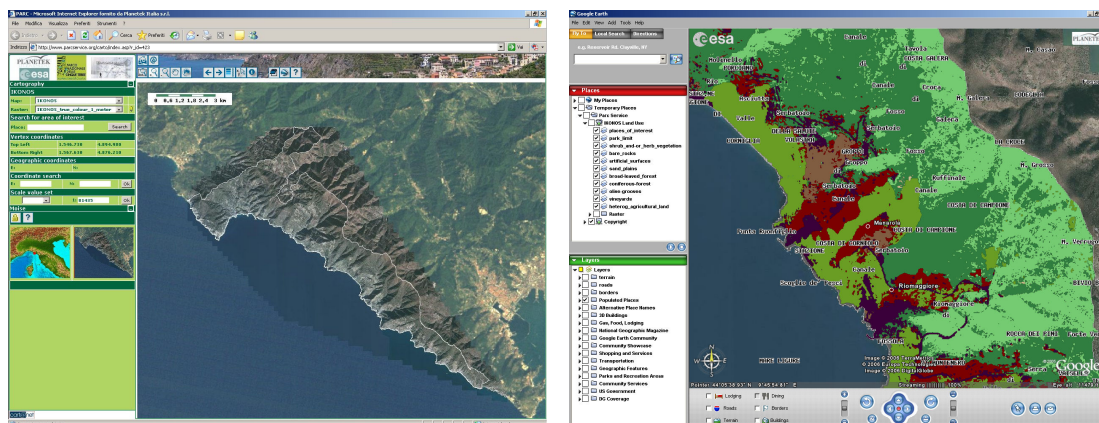


Figure 2: PARC service web pages, showing the IKONOS image on the WebGIS portal (on left) and the land use map in Google Earth environment (on right)

The final Land Use Map includes the following classes:

- Artificial surfaces
- Sand Plains
- Bare rocks
- Heterogeneous agricultural land
- Coniferous forest
- Broad leaved forest
- Vineyards
- Olive grooves

- Shrub and /or herbaceous vegetation

Among the cartographic products available at the PARC Service, also the experimental data derived by CHRIS PROBA data processing are available at the park staff.

CHRIS (launched by ESA on 22 October, 2001.) is a small hyperspectral sensor and it is used to measure directional spectral reflectance of land areas, thus allowing new biophysical and biochemical products, and information on land surfaces. During PARC project, the spectral bands analysis (i.e. VIS and NIR bands) combined with the information retrieved from the multi-angle studies over the same target area, provided an improvement for land use analysis and vegetation index retrieval. The images related to the FZA (Fly-by Zenith Angles) -36° , 0° and $+36^\circ$ have been used to produce multi-angle and multi-band products. The images have been corrected for the stripes noise and for the atmospheric effects. The acquisition related to -55° and $+55^\circ$ angles have not been taken account because the distortions, due to the mountains and to the acquisition geometry, are relevant.

This angular information, combined with the spectral bands analysis, provided an improvement for the interpretation and the classification of high resolution images over lands characterized by cultivated areas (see Figure 3 and Figure 4)

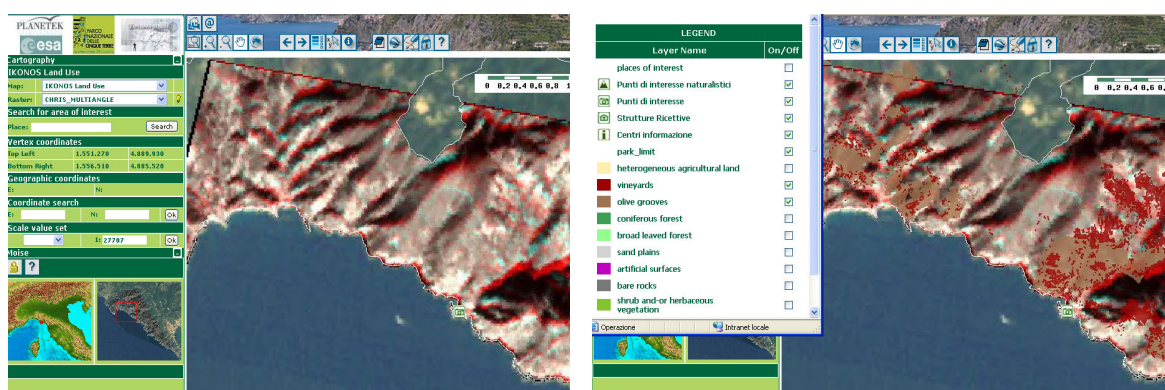


Figure 3: : On left CRIS multiangle image, the areas under cultivation are shown bright white color. On the right some of these cultivated areas are identified as olive grooves and vineyards.

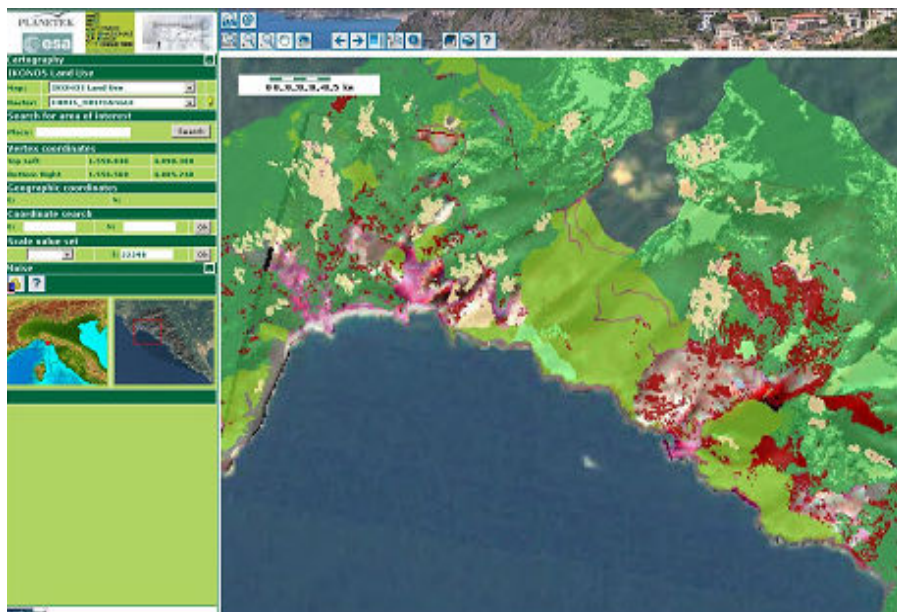


Figure 4: Land use map derived by IKONOS overlaid on CHRIS multiangle image.

Besides the EO derived products, the system makes available also the Digital Elevation Model (5m spatial resolution) of *Cinque Terre* National Park, the layers of the places of interest, and the layer of the Park Plan Zones provided by the User archive.

3. ARCHIPELAGO SYSTEM

The *Archipelago System* is an extension of PARC functionalities which have been tailored for marine application services. The application is centered around the monitoring of posidonia sea grass to become part of a 3D WebGIS for above and below sea level use.

The system facilitates the representation of the below sea level environment, so that information related to the posidonia sea grass beds can be included, managed and promoted. The system ingests data of different sources and type, namely: mapping trough EO in clear and shallow waters, geophysical data, e.g. temperature, plus general information. The user target is Archipelagos Aigaiou, an NGO organization that is managing conservation of an archipelago located in Aegean Sea. A wider use of the system is ensured by a module to implement visualization fully integrated into Google Earth (see Figure 5).

The Posidonia sea grass beds are of fundamental importance for the productivity of Mediterranean marine ecosystems and fish stocks, however their status can be assessed with great difficulty as there does not exist any efficient monitoring tool or method.

EU legislation defines that no fishing activities can be carried out in areas where there are sea grass beds, but at present this law still can not be applied since that any map with such information exists, and therefore fishing zones and no-fishing zones cannot be defined.

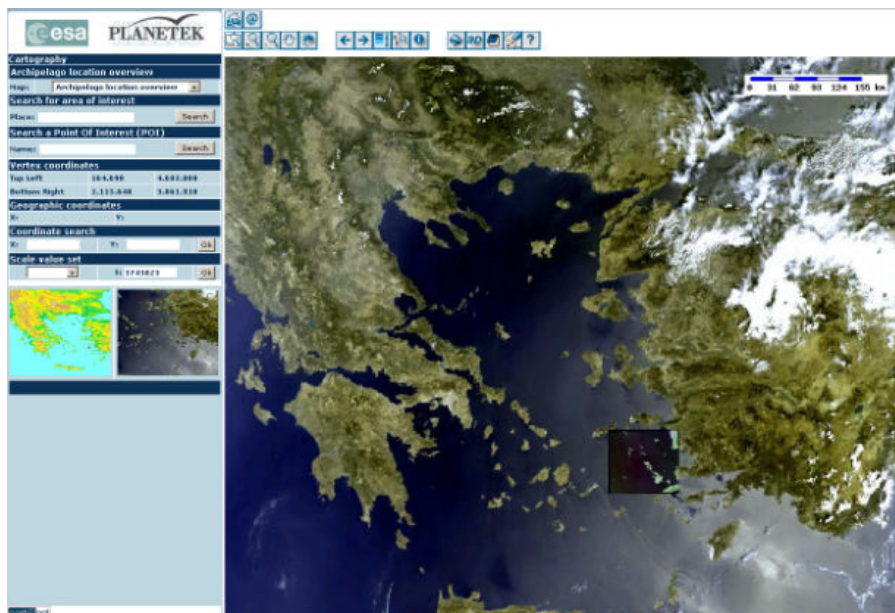


Figure 5 Data consultation webpage with an overview of the area of interest.

This is why an effective management plan in the area was urgently required. The monitoring tool which is developed in this project, enables the evaluation of the condition of the sea grass beds, provides other relevant information which is necessary for the development of an efficient management plan. The creation of the WebGIS is also useful for the promotion of the park, by introducing interesting tourist and ecological information, which could be consulted by future visitors.

The realized system offers the possibility to navigate through the marine park surface exploiting MERIS, LANDSAT and IKONOS data at different resolution. For what concerns the realization of the Posidonia Seabed map, IKONOS multispectral data, acquired on 2007-06-29, have been pre-processed, orthorectified, using Lyzenda algorithm (Lyzenga, D.R. , 1978, *Passive remote sensing techniques for mapping water depth and bottom features*. Applied Optic, 17, 379–383; Lyzenga, D.R. , 1981, *Remote sensing of bottom reflectance and water attenuation parameters in shallow water using aircraft and Landsat data*. International Journal of Remote Sensing, 2, 71–82.) and classified.

The user is able to consult in a 2D dynamic way a global map of the Archipelagos. By this kind of consultation he can view different thematic maps like:

- Land Use
- Posidonia Sea grass Beds
- Temperature Maps
- Digital Terrain Models (including subsea levels)

Besides the 2D application, a 3D application is integrated into the system so to give to the user the ability to navigate a 3D world over and under the sea level. (see Figure 6 and Figure 7).

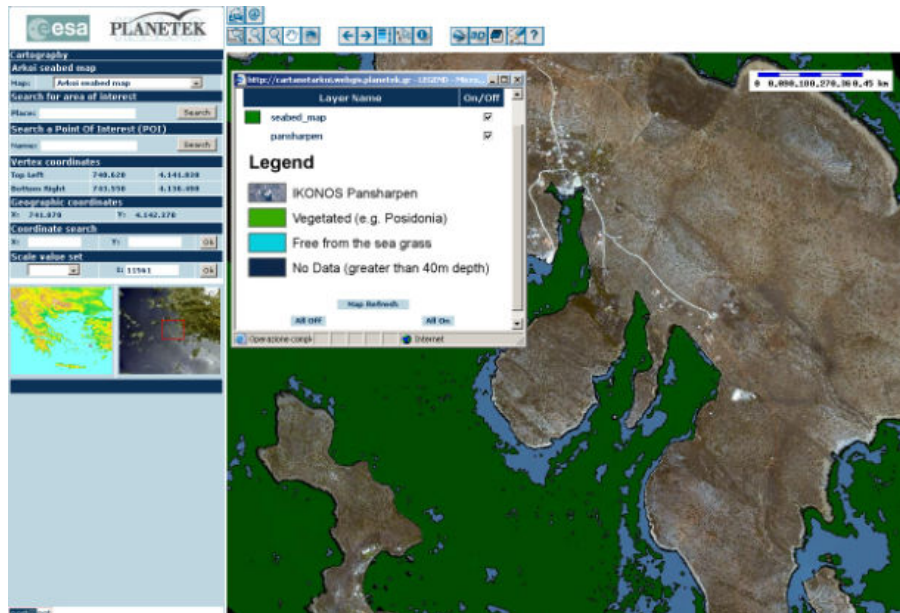


Figure 6 Posidonia sea grass map available in the website.

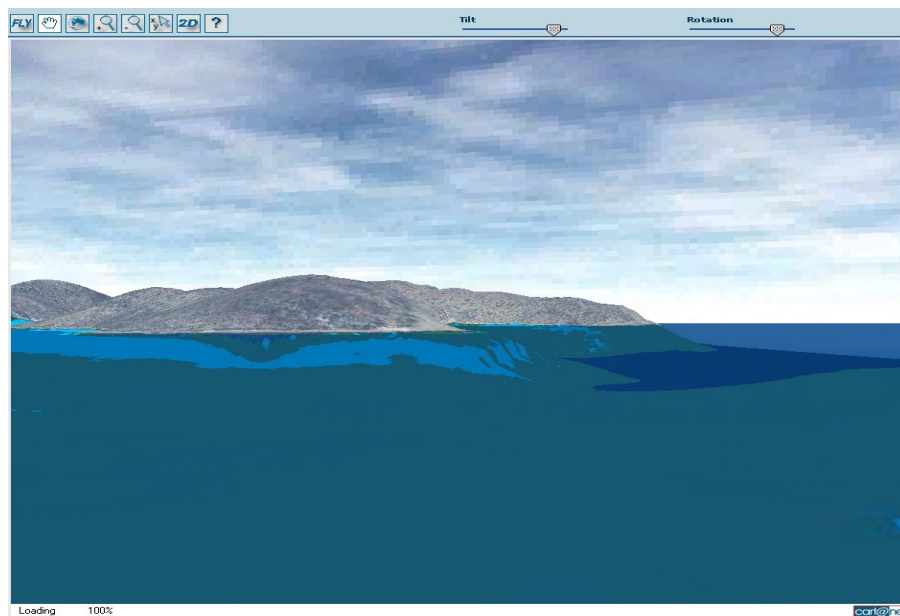


Figure 7 View in 3D just in correspondence with the sea level. The seabed with different shades of blue (i.e depth) is visible in transparency.

The website includes the possibility to put place-marks with info and pictures both over the land and through the sea depth. The database related to the Points of Interest (PoI) is to be populated

by the end-user with information retrieved during their surveys (see Figure 8)

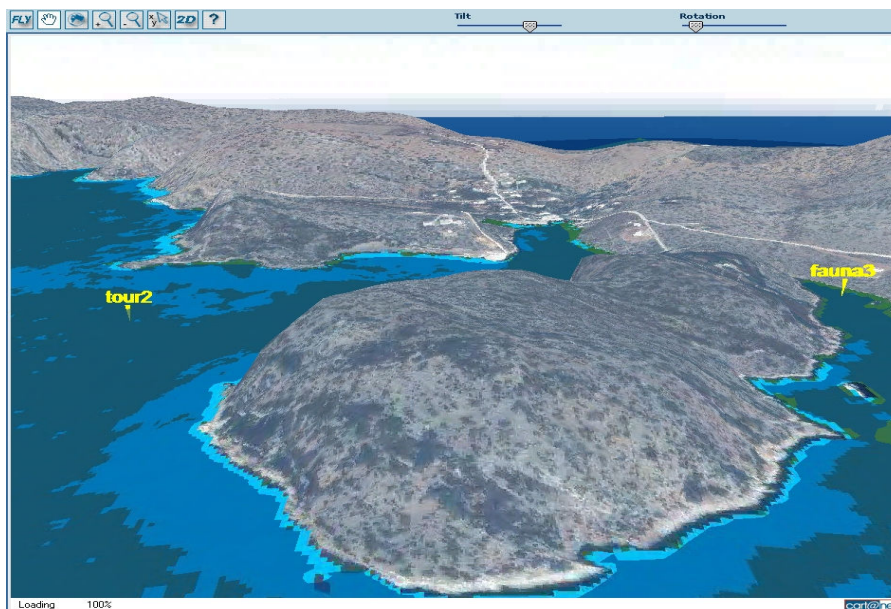


Figure 8 View in 3D over the island with some places of interest displayed on the map

All the cartographic information stored in the system can be consultable via Google Earth in a dynamic way. Google Earth is a free-of-charge and downloadable virtual globe program.

The interaction is totally dynamic and doesn't need any preprocessing of data.

Every user of the PARC WebGIS application, while navigating the 2D maps of the park, can press the Google Earth icon to start a 3D consultation of the maps.

All the user's settings during the 2D navigation are maintained when jumping into Google Earth. The first view in Google Earth is that of the last zone consulted in 2D including also the PoI and the same textual and hypermedial information shown in the WebGIS application.

The ILM allows to increase progressively the informative content of PARC WebGIS application, while the dynamic interaction with Google Earth allows to project the previous information to a global accessible and known virtual program.

4. CONCLUSION

PARC Service and Archipelago System can represent an innovative instrument for the natural areas promotion and management, easy to use by the park authorities and the public administrations. The integration of the WebGIS platform and the Google Earth application allowed to realize interactive systems which can be very attractive for the park visitors. At the same time the cartographic dataset derived from the very high resolution data processing can be a valid support for the land and sea management focused on the safeguard of the territory and the natural area monitoring.

The strengths of the two systems are the following:

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- 1) Capability to provide updated geographical information to park authorities on the state of the territory
 - 2) High level of shared information that makes more efficient the management and planning tasks of park authorities
 - 3) The combination of different sources of data and satellite images added to the interconnectivity of the customer's existing databases or information systems, allow to increase dramatically the volume of available information, therefore satisfying the most important need of the customers: the need for an adequate rate of updated information
 - 4) The high level of interaction between the users and the system allows an effective promotion of the status of the territory among a wide target of users.

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