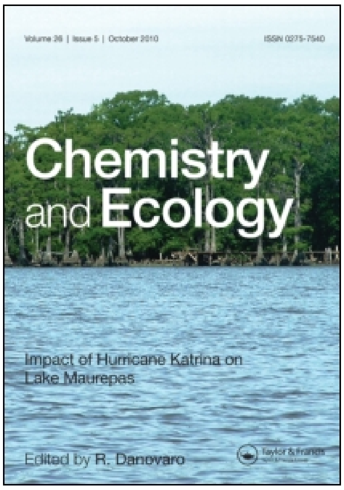

Chemistry and Ecology
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713455114

'Archeoegadi': A GIS for the marine archaeological survey in the Egadi Islands

Daniele Gravili[a]; Roberto Ialuna[b]
[a] URS Italia SpA—Divisione CEOM, Palermo, Italy [b] SYNDIAL SpA, Milan, Italy

To cite this Article Gravili, Daniele and Ialuna, Roberto(2006) ''Archeoegadi': A GIS for the marine archaeological survey in the Egadi Islands', Chemistry and Ecology, 22: 4, S397 — S402
To link to this Article: DOI: 10.1080/02757540600738534
URL: http://dx.doi.org/10.1080/02757540600738534

Chemistry and Ecology
August 2006, Vol. 22 (Supplement 1), pp. S397–S402

Taylor & Francis
Taylor & Francis Group

'Archeoegadi': A GIS for the marine archaeological survey in the Egadi islands

DANIELE GRAVILI*† and ROBERTO IALUNA‡

†URS Italia SpA—Divisione CEOM, Via Bonanno 100, 90143 Palermo, Italy
‡SYNDIAL SpA, Piazza Boldrini 1, 20097 S. Donato Milanese, Milan, Italy

(Received 16 March 2005; in final form 24 March 2006)

An important step in successfully locating an archaeological target is the definition of the search box. Then, the establishment of a target area involves aggregation and comparison of information from multiple sources. 'ArcheoEgadi' was a feasibility study to verify the application of geophysical and magnetic equipment and GIS system in marine archaeology. The main results of 'ArcheoEgadi' were a detailed map of the sea bottom and help setting up the equipment parameters for detecting operations on archaeological sites hidden by sediments and marine flora on the sea bottom. In particular, a relevant result was the discovery of the wreck of an 11th-century Arabian vessel.

Keywords: Underwater; Archaeology; Geophysics; GIS

1. Introduction

Underwater archaeological research is increasingly becoming more interesting and current, both for archaeological and historical data, and in terms of the importance of modern techniques and instrumentation use.

To date, marine archaeological surveys were carried out using a traditional methodology, i.e. direct observation from divers in shallow waters or mini-submarines (autonomous underwater vehicles) or remotely operated vehicles (ROVs) in deep waters.

In the last few years the use of equipment derived from geophysical surveys for scientific purposes, above all for the offshore operation (e.g. laying and installation of submarine pipelines) has become very common. Moreover, GIS tools are starting to be used for planning and management purposes.

What are the objectives in using such tools? First, because a consistent part of the archaeological world heritage is under the sea bottom, the environment can create an obstacle to direct target vision. In addition, such instrumentation helps to cover very large areas in a short time and allows studies to be to operated in deep waters without the need to use submarines. In this way, we can reduce running costs compared to surveys carried out with traditional visual

*Corresponding author. Email: daniele_gravili@urscorp.com

Chemistry and Ecology
ISSN 0275-7540 print/ISSN 1029-0370 online © 2006 Taylor & Francis
http://www.tandf.co.uk/journals
DOI: 10.1080/02757540600738534

methods only. However, the use of visual inspection methods still remains indispensable but will concern mainly spot checks for suspected targets only.

The most important step in successfully locating an archaeological target is the definition of the search box, the area where a target is most likely to be found. Establishment of a target area requires aggregation and comparison of information from multiple sources [1].

In this context, with using a GIS, it is possible to control navigation, to verify the acquired data set, and to check the coverage of the whole searching area. Moreover, it also helps to aggregate, analyse, and compare data, improving the confidence level in identifying archaeological targets and planning rapid visual inspections.

One such example of 'non-conventional' equipment and a GIS system for archaeological surveys has been used in the context of an agreement between the Cultural and Environmental Sicilian Regional Authority and CEOM (Centro Oceanologico Mediterraneo, already the property of ENI when this project began, now Divisione CEOM, a recent acquisition by URS Italia SpA). A feasibility study, entitled 'Research and recovering project of the archaeological heritage to realize marine archaeological routes in the Western Sicily', has been developed.

During June 2000 to March 2001, the 'ArcheoEgadi' campaign took place in the marine area of the Egadi Islands (off the western coast of Sicily). This site was the scene of a naval battle between Romans and Phoenicians, and is well placed as an important centre for the trading routes in the Mediterranean Sea.

The main results achieved in 'ArcheoEgadi' were a detailed map of the sea bottom to verify the application of these technologies in the archaeological field and the establishment of parameters to detect the archaeological sites hidden by sediments and marine flora on the sea bottom. In particular, a relevant result was the discovery of the wreck of an 11th-century Arabian vessel that probably sank next to the Bull's Shoal during a storm. The wreck is about 25 m in length and 5 m in width, is in very good condition, and is located at a depth of about 70 m. Further details of this work can be found elsewhere [2].

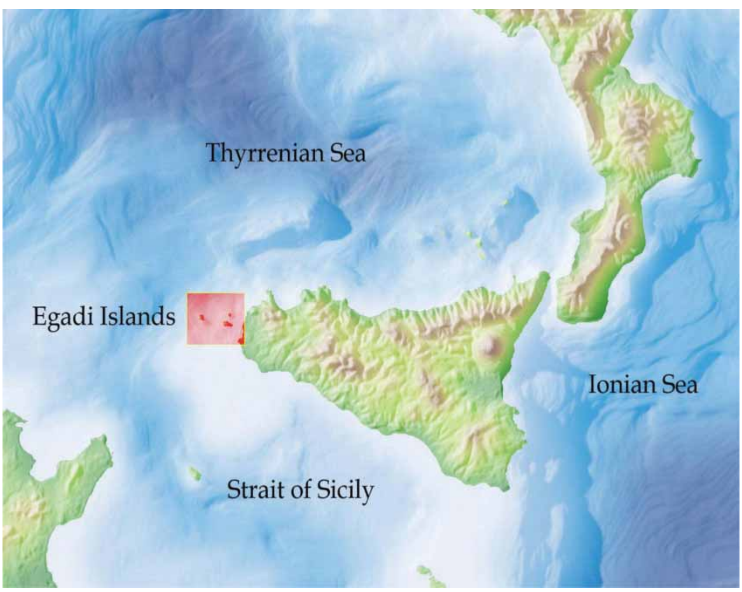

Figure 1. Survey area.

2. Material and methods

During the development of the project, CEOM provided their geophysicists and engineers with geophysics and magnetometric equipment and with the support of GIS tools, while SCRAS conducted visual inspections.

The main objectives of the project were:

(1) to assess the effectiveness of the use of GIS tools in planning and organization of marine archaeological surveys;
(2) to assess if the modern geophysical equipment can yield information about the sea-bottom morphology and bathimetry with the necessary resolution to locate possible archaeological targets;
(3) to provide an informative system to permit both visualization and cartographic production of data, and to use specific tools for the analysis of various information.

2.1 *Phases of the research*

The project was developed in four phases:

2.1.1 Planning (March–June 2000). The first phase of the research was based on the study of historical data to find information on possible archaeological targets and to define the search area. In this context, the use of GIS tools permitted the organization and aggregation, in a geographic environment, of information from different and heterogeneous sources and therefore the planning of the underwater survey.

2.1.2 Survey and processing data (June–July 2000). Once the search were areas were defined (about 40 km^2 around Favignana and Levanzo islands) and the campaign planned, the characteristics of the seafloor were surveyed using acoustic and magnetic equipment. A side-scan sonar was used for geomorphological reliefs, a sub-bottom profiler for stratigraphic analysis, a multibeam echosounder for bathymetric reliefs, and finally a differential gradiometer for differential magnetometric reliefs. At the end of this phase GIS helped to identify possible targets which might have hidden various archaeological sites.

2.1.3 Visual inspections (December 2000). On the basis of GIS analysis, it several visual inspections were possible using a class ACHILLES ROV equipped with a camera.

2.1.4 Managing data and cartography (January–March 2001). All the data were inserted in the 'ArcheoEgadi' GIS used for the production of thematic charts to provide evidence of any archaeological sites and information on the geomorphologic, stratigraphic, bathymetric, and magnetic characteristics of the Egadi Islands area.

2.2 *Bathimetry*

Designated areas were mapped with a SIMRAD EM3000 high-frequency multibeam echosounder to ensure the highest possible resolution. Multiple swaths were collected across the feature to provide 100% coverage and a minimum of 30% overlap. The multibeam data were collected using Merlin, then cleaned, processed, and displayed with Neptune and exported, with Cfloor, in GIS format.

2.3 *Morpho-stratigraphy*

Morphological and stratigraphic data were acquired with a DATASONIC SIS-1000, a fully integrated Seafloor Imaging sonar system that uses advanced Chirp technology to produce high-resolution side-scan sonar images and sub-bottom profiles. All the imagery data were collected and processed using Triton ISIS SW and mapped to support mosaic generation of the seafloor morphology [3]. Mosaics were generated using DelphMap SW after all sonar data had been collected and integrated with differential GPS data (which tracks the surface vessel's position and, by extension, the position of the side scan sonar vehicle). Next, the mosaics were also imported in ArcView and plotted at the required scale for determining areas of interest and high importance.

2.4 *Magnetometer*

The instrument used for the magnetometric survey was a G-881 GEOMETRICS magnetic marine horizontal transverse gradiometer. The gradiometer used a couple of G-881 synchronized magnetometers. The resultant low-noise output characteristics improved the detection of targets under silty or sandy bottoms. For logistical problems, it has been used only in two small areas near Isola Grande (Trapani), with no other equipment, and no significant results appear to have been obtained. In any case, this is a survey method which we still need to improve in both acquisition and elaboration phases.

2.5 *GIS*

The 'ArcheoEgadi' GIS, performed to manage, analyse, and present the geographic and descriptive data acquired during bathymetric and geomorphologic surveys, was made up using the ESRI's geographic information system software ArcView3.2a. The ArcView programming language Avenue and the Dialog Designer extension were used to personalize the user interface. The spatial analysis was carried out using the ArcView Spatial Analyst and 3D Analyst extensions. Finally, the database Oracle 8 was used to manage the descriptive information acquired during the project (in particular, historic and bibliographic information).

Figure 2 shows the architecture of the system. It is possible to identify:

- the acoustic and magnetic equipment used during the survey;
- the positioning system based on a differential GPS which allows precise georeferencing of the data;
- the data-acquisition system to receive and archive data; and
- the GIS used to process, manage, and display data information acquired and to produce thematic maps.

2.6 *Functionality and examples*

One of the main characteristics in a GIS is the large availability of tools, which allow documents to be linked by different natures (tables of a database, films, and layouts) and geographic entities to be represented in a graphic manner (SSS and Multibeam navigation, ROV lines, and immersion points) making an integrated informative system.

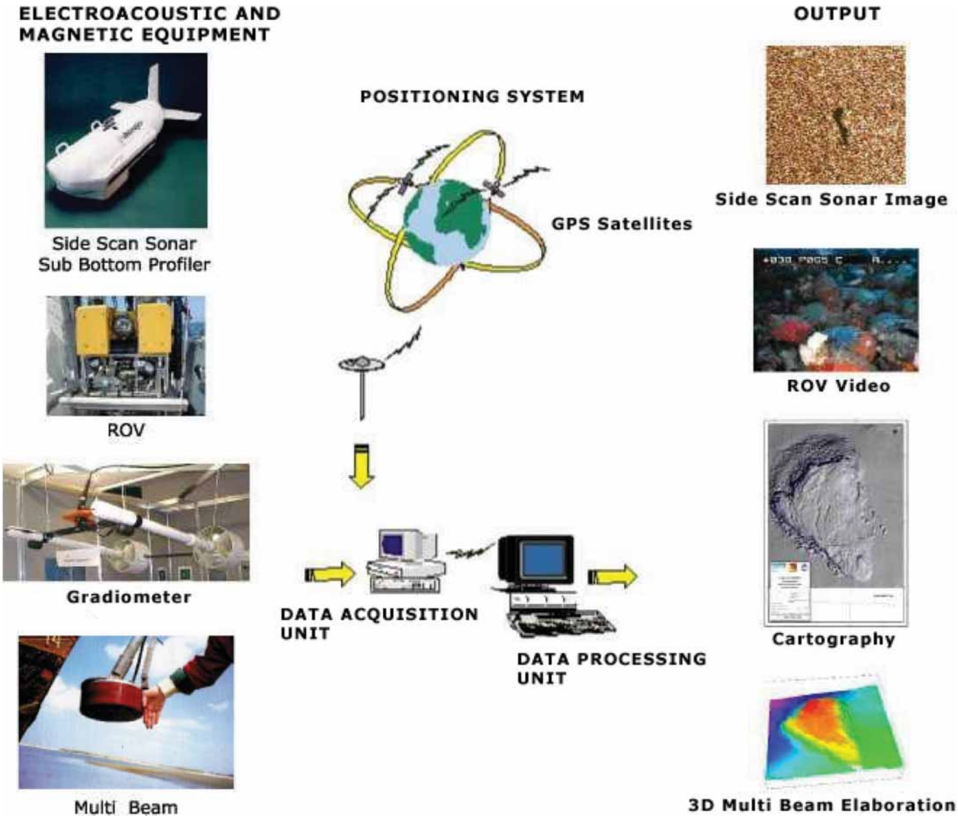

Figure 2. 'ArcheoEgadi' architecture.

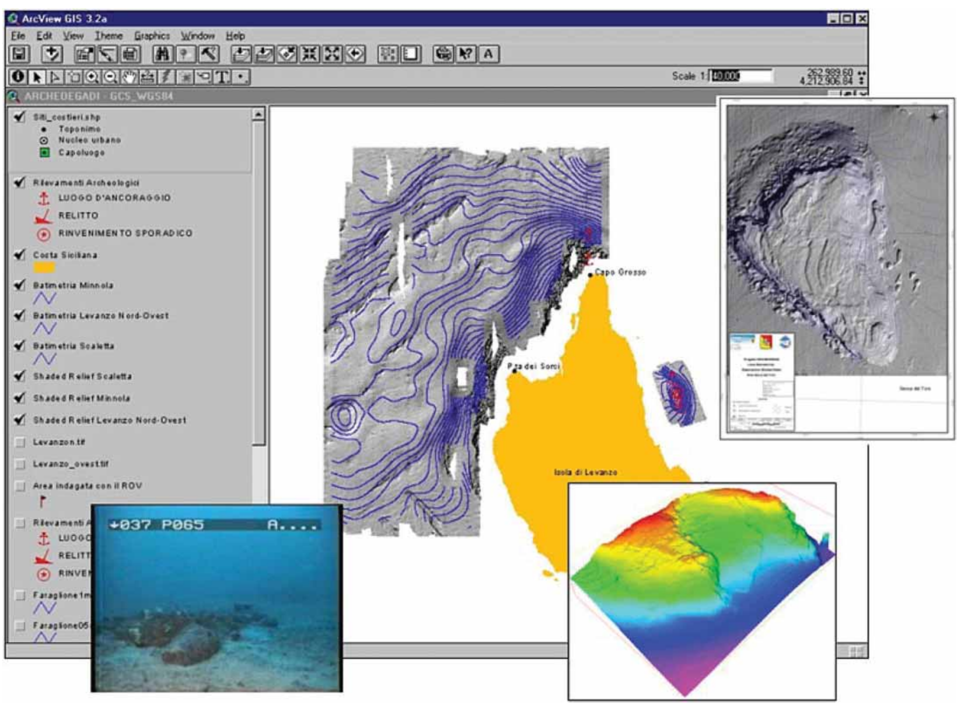

Figure 3. Example of the 'ArcheoEgadi' user interface.

'ArcheoEgadi' is an example of this ability. In particular, it is characterized from the following functions:

- automatic and interactive management of the electro-acoustic and magnetic information acquired during the survey and of the recorded videos;
- automatic and interactive management of cartography;
- ability to make queries and analysis with a high level of detail; and
- exporting and printing of cartographic data in the most common formats.

Figure 3 shows the user interface which 'ArcheoEgadi' provides to access to the data simply by clicking the mouse.

3. Results and discussion

The 'ArcheoEgadi' survey allowed us to verify that electroacoustic instrumentation can help to determine the morphology and bathymetry of the sea bottom with a resolution suitable for identifying 'anomalies' that can hide the presence of archaeological targets.

In any case the interpretative skill of the elaborated signal should be improved, increasing the collaboration between the instrumental operator and the archaeologist to set at the best the calibration parameters, to plan the navigation routes (zones of interest, routes, and spaces between transects) and to define criteria and objectives of the cartographic elaboration.

For this kind of study, a GIS can assist greatly in the planning at-sea operations, reducing costs, avoiding hazardous consequences, and ensuring that an area has been thoroughly covered.

ESRI's GIS software suite, in concert with combined geophysical, magnetic, and geological methodologies, can constitute an integrated systems approach to mapping seafloor features, providing an efficient and economical way to image the seafloor and producing data which can be used to address many problems associated with deepwater searches, salvage, and marine archaeology.

In our project, this approach has permitted the discovery of several archaeological targets, the most important of these being the wreck of a Sicilian–Arabic ship of the 11th century that had sunk about 3 km south of Favignana Island.

References

[1] M. Cooper, L. Crenshaw, T. Penman, E. Saade, Searching for the German U-559 submarine with GIS. In *ARCNEWS–ESRI International User Conference Issue*, Vol. 24, No. 2 (2002).
[2] S. Tusa, G. Lino, S. Zangara, D. Gravili, A. Urbano. Acoustical underwater researches in the Egadi Islands. In *Acts of the 4° Colloque d'Archéométrie ARCHEOMETRIE 2001*, La Rochelle, France (2003).
[3] J.P. Fish (Ed.). *Sound Underwater Images: A Guide to the Generation and Interpretation of Side Scan Sonar Data*. Lower Cape Pu. Co., Orleans, USA (1990).