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Designing and Implementing a Countywide GIS in Western Greece

ABSTRACT

The County of Kefalonia is in the process of implementing a Geographic Information System (GIS). The project initiated with the collaboration between the county staff and the research team of the Laboratory of Urban and Regional Planning of the University of Patras. The team was charged with the design of the overall concept and the basic components of the proposed GIS and the scheduling of the necessary tasks for implementing the system. The project comprises technology transfer and qualification of the planning staff, for supporting the use of the system. The intention of the project is to provide the county planners with an effective tool for improving decision-making process and services provided. This paper describes the development stages of the system and outlines the experience gained so far.

INTRODUCTION

Background

The County of Kefalonia is situated in Western Greece and consists of two main islands (Kefalonia and Ithaca) and of approximately 126 small islands, islets and reefs with areas ranging from 430 square meters to 78 square kilometers. The County encompasses 907.26 square kilometers and a population of 32,474 (census 1991), in 9 municipalities (former 78).

Figure 1. Location map

GIS Initiatives

The County of Kefalonia required a GIS to assist in the day-to-day management of its jurisdiction and to develop a series of applications. The county staff not being trained in GIS, relied on the cooperation with the research team of the Laboratory of Urban and Regional Planning of the University of Patras in the form of a Research Project, funded by the European Community through the Greek Secretariat of Research (SIN96, measure 2.2).

DESIGN OG THE PROJECT

Project Description

The project comprises two distinct phases:

The first phase, already completed, includes the overall design of the GIS environment, geographic data collection techniques and the development of a broad range of applications such as managing archeological and tourist sites, evaluating medical services and the like. Standards and procedures for the implementation stage are also adjusted in cooperation with the end users' needs. County staff training, as well as delivery of the GIS data and the applications developed by the research team are also included in the first phase.

The second phase of the project is currently in progress, within the County Planning Bureau. This is an implementation phase, which involves initial investment in GIS Hardware/Software and Computer equipment. Installation of the digital coverages delivered and enhancements to GIS applications according to the different county departments needs are also part of the second phase. The research team or other GIS consultant will assist the implementation of the system. In a further stage, the system will be integrated to the daily activities of the county departments.

GIS Design

The design of the system is based on the current needs and future requirements of the different county departments. The basic concept of the system's design is to provide up-to-date data to all system users and application developers. The development of the system comprises the acquisition and conversion of a great number of numerical and graphical data for the county area, along with statistical data and other information provided by completed or ongoing project works. With these data available, a wide range of county operations can be performed.

The GIS helps in visualizing data in a variety of forms: general or thematic digital maps, graphs/charts and tabular data, for use by county departments and the public. Continued development of customized departmental applications and data distribution tools are also envisioned. Taking advantage of the capabilities of the new system, countywide problems can be faced through spatial analysis, population projections, proximity mapping and modeling operations.

Developing the Information System

The development of the GIS included the following tasks: at first, the construction of the base map by acquiring and converting geographic information. Additional statistical and other descriptive data were also acquired and integrated into the system. Applications development was the next task. The third task included data delivery and preparation of Software/Hardware requirements. The next task was staff training and technology transfer along with proposed additional customized application development.

Source Documents

The main source information used to capture the geographic information for the County of Kefalonia consists of eight "general use" map sheets at scale 1: 50 000, compiled by the Geographic Department of the Ministry of Defense (HAGS, edition 1977). Demographic and other statistical information was gathered from the 1991 census of the National Statistical Service of Greece (ESYE) and linked to the above geographic data layers.

Additional data concerning archeological sites and monuments, environmental information (e.g. sites of NATURA 2000, see figure 2), parks and recreation, medical services provided, fire protection zones and views were also acquired and incorporated into the system.

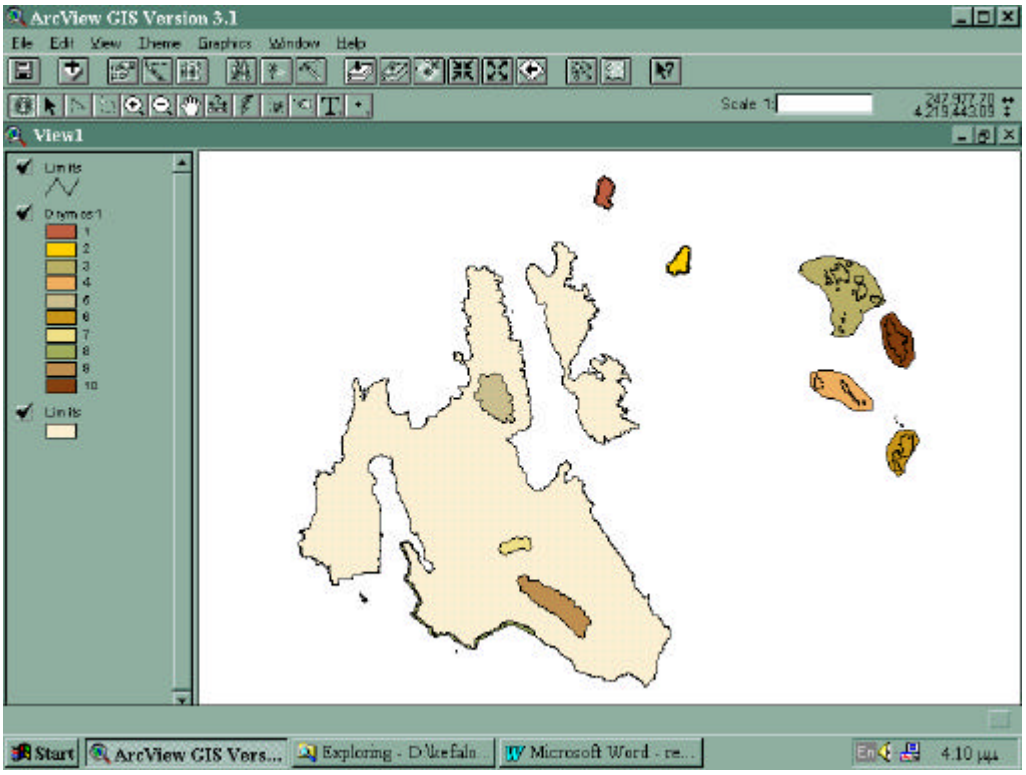

Figure 2. Sites NATURA 2000

Database Content

The digital base map consists of topologically structured digital data sets and associated attribute data, using the Hellenic Geodetic Reference System (EGSA '87). The following graphic features (in Arc/Info point, line and polygon format) were obtained by the system along with selected photos:

- Road Network
- Road surface types
- Contour lines
- Hydrography
- Cities
- Residential zones
- Parks
- Archeological sites
- Churches and Monasteries
- Medical Services
- Caves
- Fire observation points
- Light houses

- Ferry routes
- Airport
- Gas stations
- Beaches
- Environmental data (sea water quality, etc)

The tabular database has been built using a variety of sources of information. As the system expands in a further stage, the county departments and users will enter their own information.

Table 1 lists folders and subfolders by workspace, showing the Database structure.

Table 1. Database Content

FOLDERS	SUBFOLDERS	DESCRIPTION
Original-data	**8 map sheets subfolders**	**Geographic data from source map sheets 1: 50 000**
Tin-surfaces	**2 tin subfolders**	**Z dimension: altitude, time laps**
Shapefiles	**Proximity, time cost subfolders**	**Analysis results**
Network	**Data files/additional data for network analysis applications**	**Network analysis products**
Images	**Different images**	**Different images for hot spot applicatio**
Data-esye	**Population census** **Zip files** **Land use files**	**Statistical files**
Main-data	**Info tables and Coverages**	**Basic data for analysis and further processing**
Grids	**Visibility, population density, elevation**	**Grid applications**
Lattice	**Raster Dataset**	**Lattice applications**
Texts.doc	**Text files**	**Documents**
Legend	**Different legends**	
Excel.xls	**Excel.xls files**	**Additional data**

The **Original-data** folder contains all layers of information produced by the conversion process of the 1: 50 000 original source maps.

The **Tin-surfaces** are analysis products, displaying quantitive spatial data in three dimensions. The applications developed used realistic surface models, visibility options from different observation points and visualization of data in 3D (figure 3).

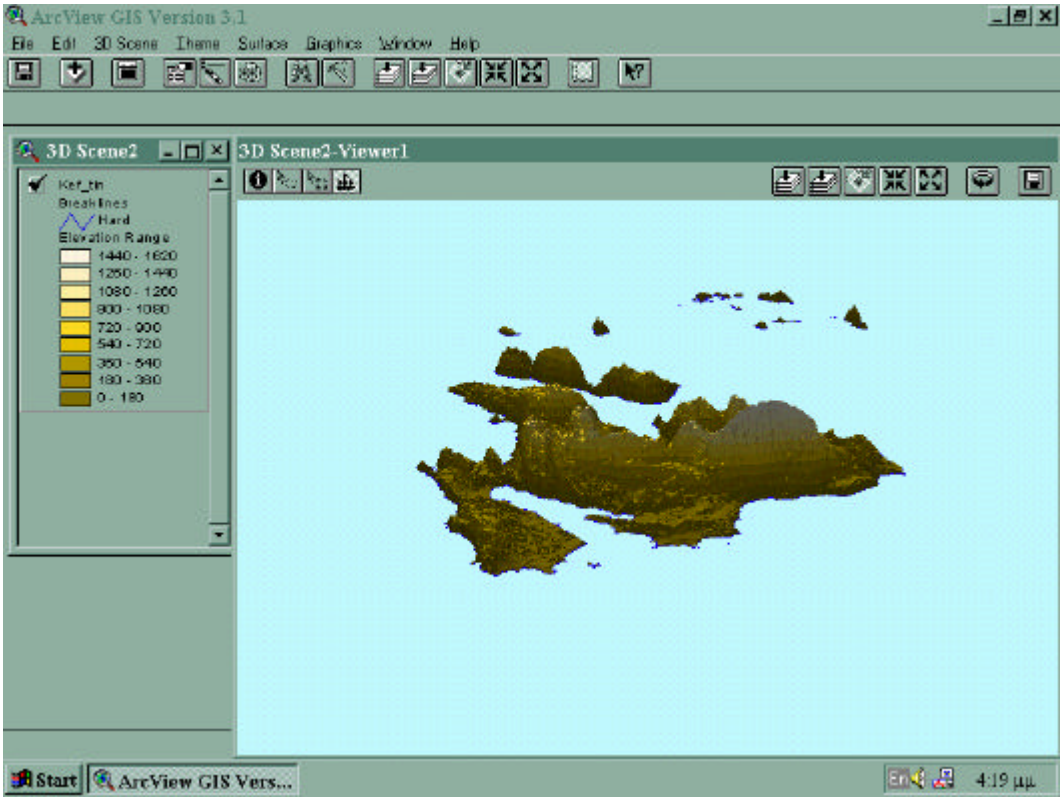

Figure 3. 3D surface view of Kefalonia

The **Shapefiles** data are thematic layers of information, produced during the analysis process, very often in the form of temporary files (e.g. proximity to ambulances in figure 4).

The **Network** data folder includes efficient travel routes from the network analysis applications, where distance is expressed in terms of cost.

The **Images** data consists of digital photos for hot spot applications; thus clicking on the linked geographic features, the relative photographic information is displayed.

The **Data-esye** folder contains all statistical information provided by the National Statistical Service of Greece (census 1991) distributed to the former 78 municipalities, currently joined into 9 major municipalities (figures 5a & 5b).

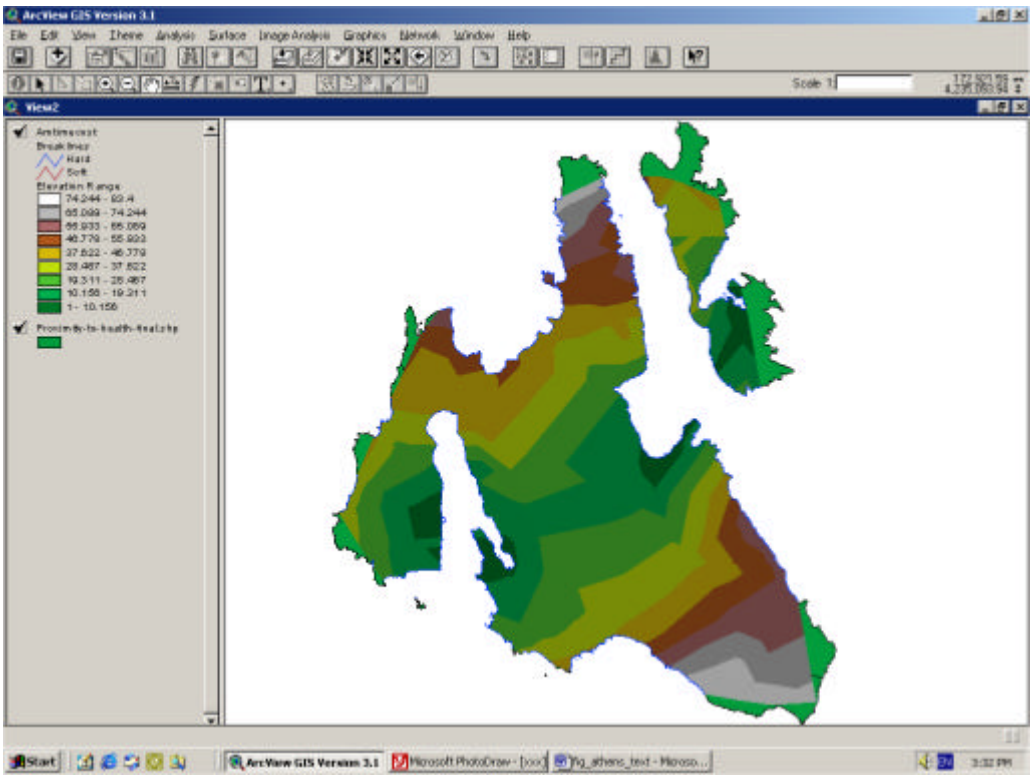

Figure 4. Proximity to ambulance

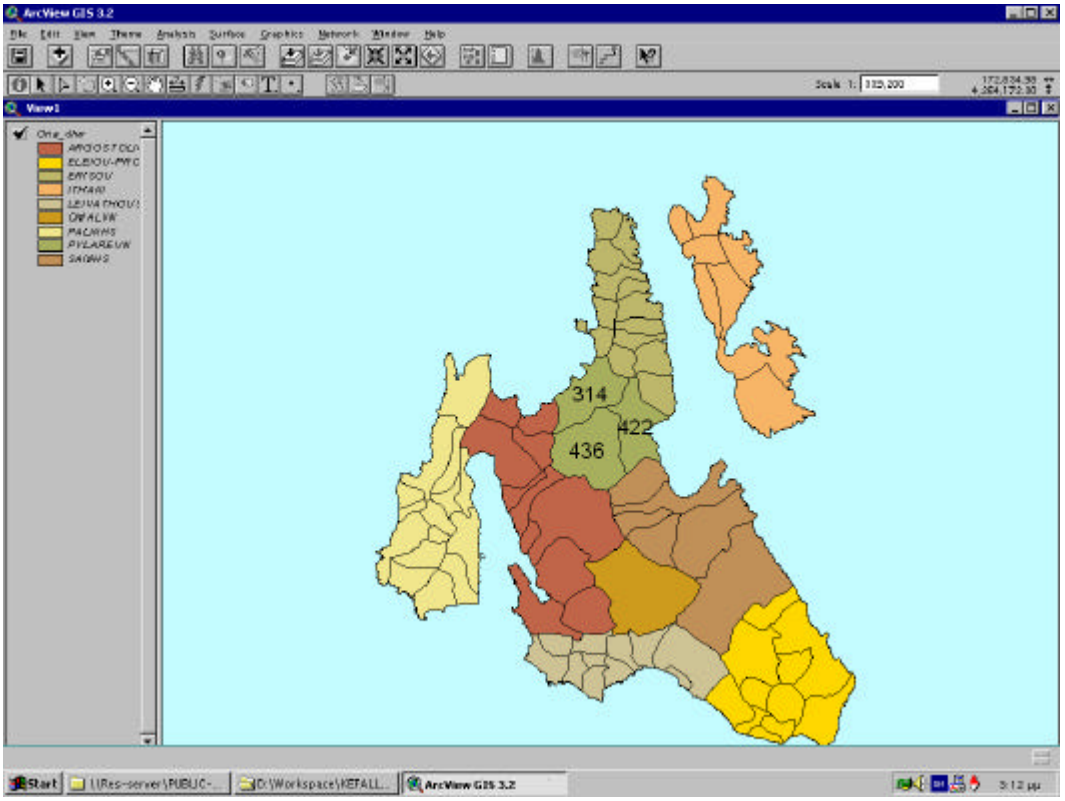

Figure 5a. Former 78 Municipalities

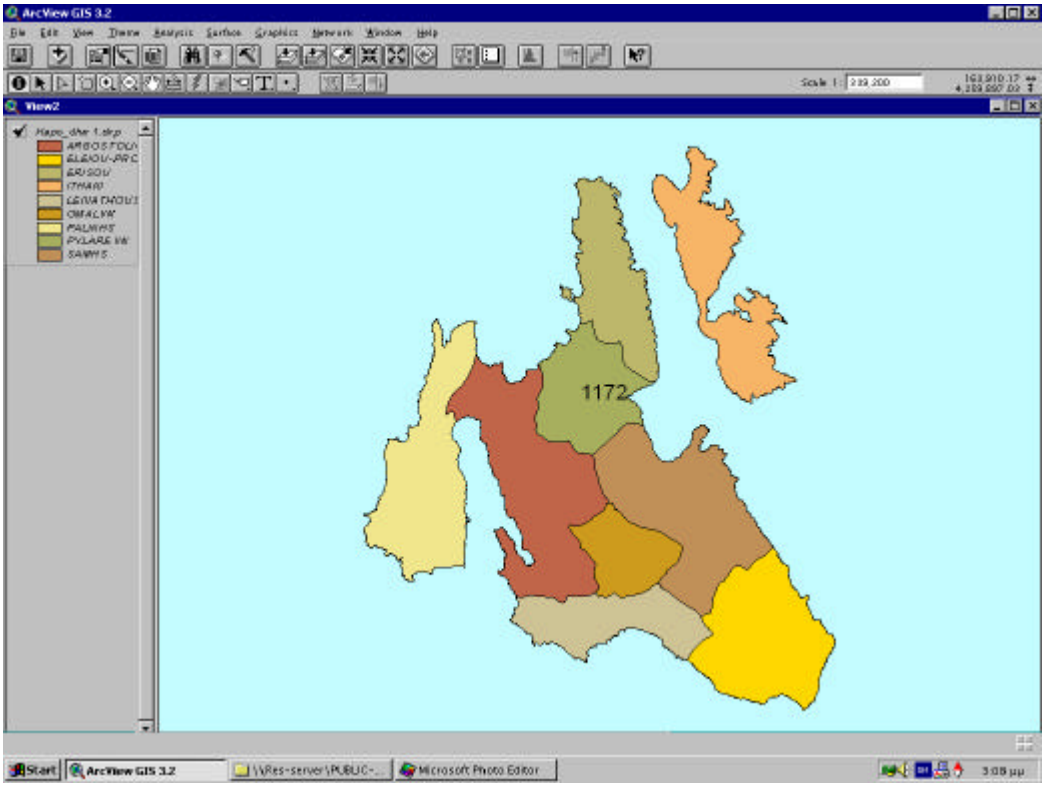

Figure 5b. New Municipalities' territorial jurisdiction

The **Main-data** layers are based on the Original-data and are used for spatial analysis of all geographic information. These data layers are shown on Table 2.

Table 2. Main-data layers of information

Address	Road network for addressmatching applications
Cp_all	Point coverage: churches, light-houses, etc
Drymoi	Polygon coverage NATURA 2000
Elevation	Line coverage, contour lines every 10m
Kanabos	5 Km x 5 km grid in EGSA '87
Limits	Polygon coverage for coast lines
Net_all	Polygon coverage of residential zones
Obs	Point coverage of fire views
Oria_dhm	Polygon coverage of former municipality limits
Oria_eparxies	Polygon coverage of provinces
Ot_all	Main Road Network
Ot_all2	Road and coastal facility lines
Phy	Physiography polygon coverage

Observation	Polygon coverage of fire observation visibility
Ydro	Hydrography coverage
shapefiles	Layers: archeology, tourist areas

The **Grids** data are application products for visualizing phenomena along a range such as population density, elevation, and pollution. Lattices data are similar to grid, representing a variable in point format (figures 6, & 7).

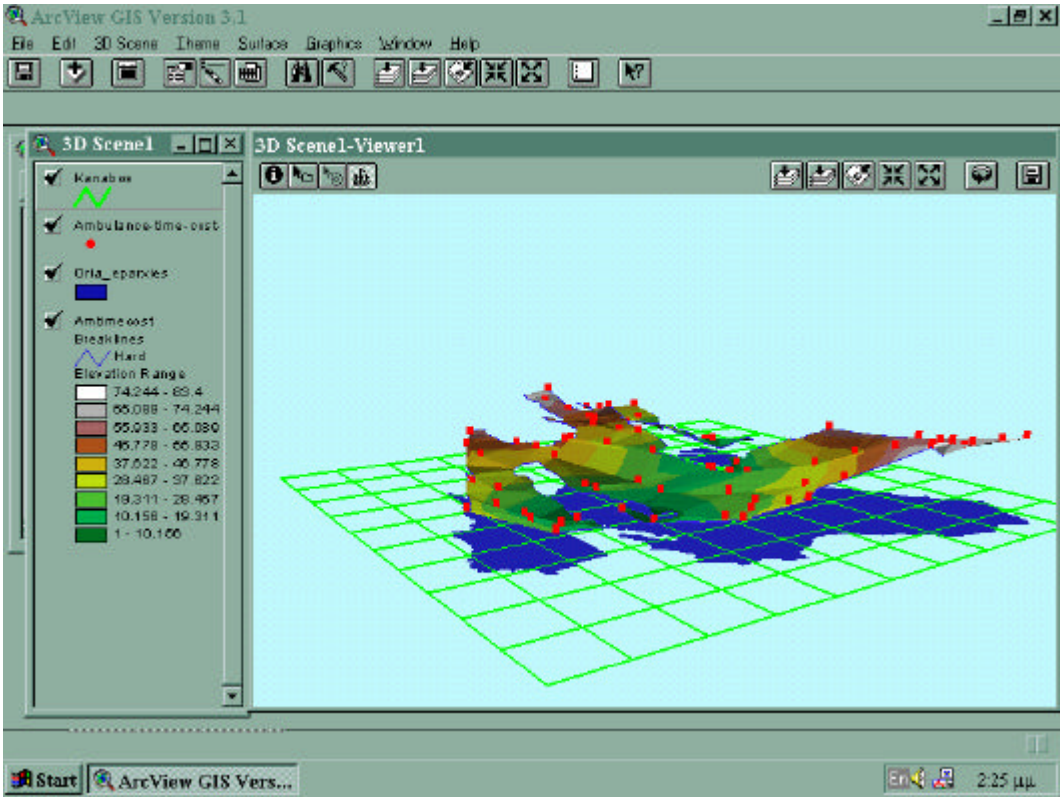

Figure 6. A perspective display of medical services provided

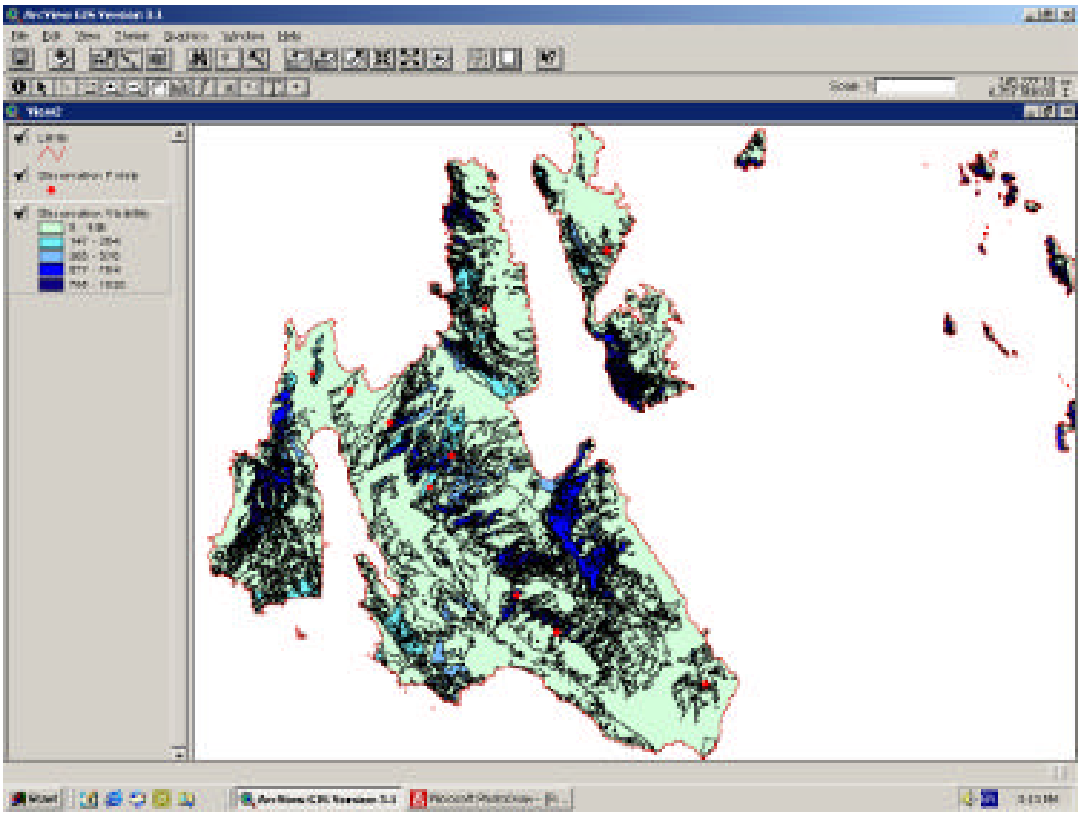

Figure 7. Results of fire observation point's visibility

APPLICATIONS

From the main data converted, a number of applications have been developed showing the benefits GIS has to offer in a countywide level. These applications were built using PC Arc/Info 8 and ArcView 3.1 & 3.2 with its extensions as primary GIS software. Each ArcView extension: Spatial Analyst, Image Analysis, 3D Analyst and Network Analyst, contributed in an individual or combined way to the whole analytical process. Below are some examples of the applications developed.

By using the digital road network, we created time buffer zones for defining service area limits of the existing health care system.

In another example, demographic data provided by former municipality area jurisdiction were grouped according to new municipality limits, using *geoprocessing* as the basic analytical tool. This extension offers the ability of managing statistical and geographic data within one or more layers of information.

Geocoding is also a powerful tool for network analysis, specifying locations by address. Geocoding converts an address into a point and adds it to the view. By working through this tool, we assigned addresses and postal codes to the road network, in order to specify accident locations, route the nearest ambulance to the accident and give directions to the driver.

A *multimedia* application was also developed concerning the archaeological sites and monuments of the island, as well as caves and historic sites. Digital photographic material (video can also be incorporated) was linked to the above sites, using ArcView Avenue scripts. The application can be extended for tourists and visitors, helping them to find out the best places to visit on the island (figure 8a& 8b).

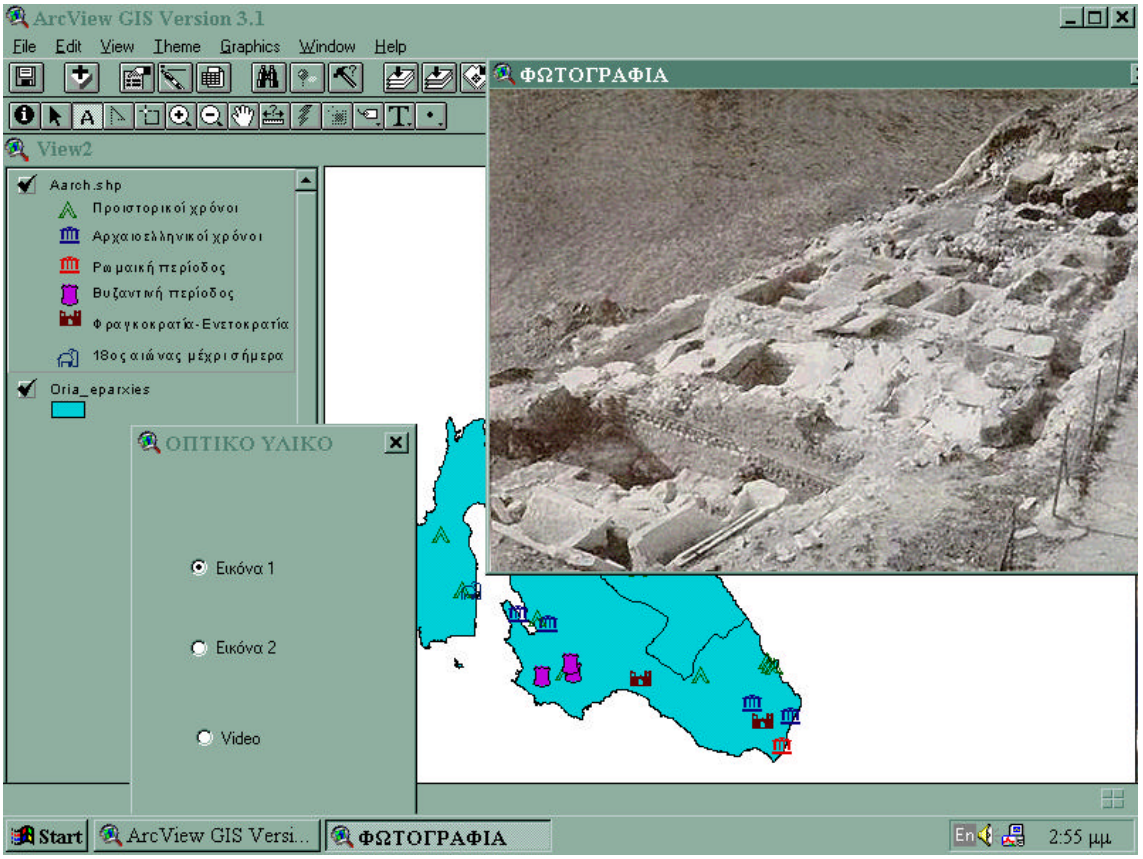

Figure 8a. Clicking on the site can pull out a variety of information about archaeological sites and monuments, including photographs and other multimedia material.

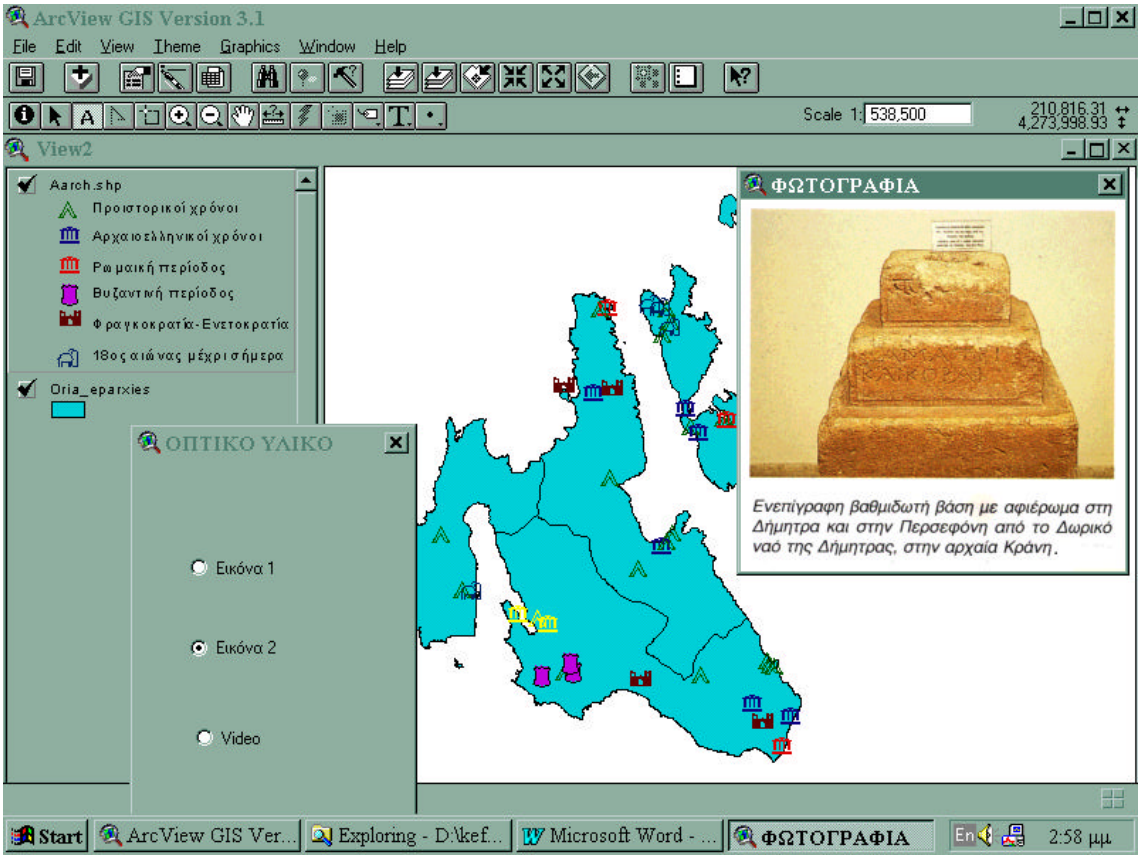

Figure 8b. Another example of seeking the archaeological database

From the digital elevation model (DEM) we created visibility areas for the existing fire observation points. Adding information on vegetation type and growth, an improved model could be formed.

In another application we used *location-allocation* techniques in order to analyze service and demand centers and therefore select locations for new centers, schools, health services, and so on.

STAFF TRAINING

The GIS will be managed as an information system under the direction of the County Planning Administration, providing service to all county departments. To make the most effective use of the system, county people involved with the GIS were trained by the research team of the University on GIS technology. A hands-on practice was also provided using the GIS layers produced for Kefalonia. Furthermore the staff training should include on-the-job experience, aiming at increasing staff retention and skill levels.

CONCLUSION

It is obvious that county daily tasks and services should take advantage of features and capabilities of the new system. Implementing countywide GIS does not mean doing everything at once. It requires a number of things to be planned and obtained. A well designed system structure and an appropriate number of trained staff is one component. Keep the system up-to-date as possible and integrate utility and other data is another component. Encourage departments to proceed with GIS activities is also important for the success of the system.

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