

GeoCoast V.2.0: A GIS FOR THE INTEGRATED MANAGEMENT OF THE COASTAL AREA OF THE REGION ABRUZZO

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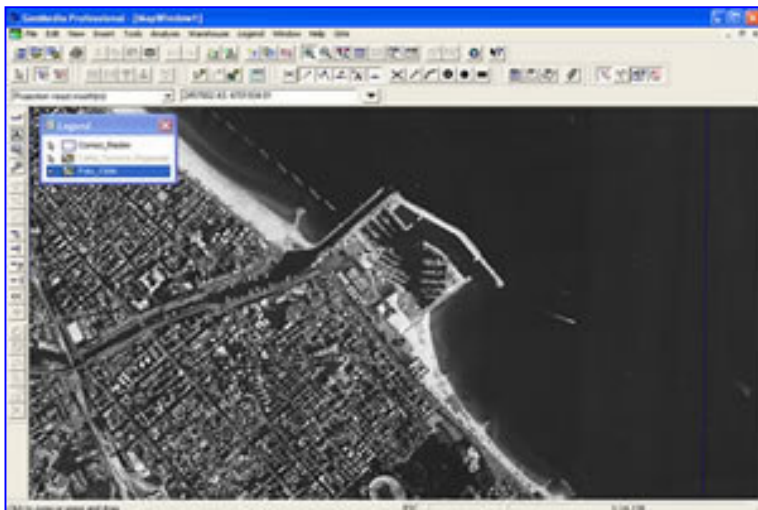
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INTRODUCTION

In the context of environmental engineering, and more specifically in the management of the coastal areas, information systems are commonly used, also in Italy, to handle large quantities of data (distributed over extensive geographical areas) and to activate the necessary procedures to manage the field in a concrete, integrated way. Geographical Information Systems (GIS), are technology advanced solutions that guarantee the integration of data referenced in space and handled in an environment with functionalities to solve problems characterized with a geographic dimension. The integration and the management of data is facilitated through functionalities that allow the reading of different (geographic) data formats and/or database systems and the possibility to transform data through analytical functionalities into information.



This article illustrates the procedures that have been used for the realization of a GIS for the management of the coastal area of the regione Abruzzo, developed with the software **Intergraph GeoMedia Professional v.5.1** through the creation of custom commands in MS Visual Basic, during the project **SICORA: Supporto Informativo per la gestione della zona COstiera della Regione Abruzzo** (support system for the management of the coastal area of the regione Abruzzo). During the course of the project, a Reverse Engineering will be done of the software available in the Region Abruzzo which was realized in the context of two previous projects named respectively **R.I.C.A.M.A.**

(**R**ationale for **I**ntegrated **C**oastal **A**rea **M**anagement) and **CIPE** (Delibera n.106/99 "Gestione integrata dell'area costiera. Piano organico per il rischio delle arre vulnerabili"). The activities of the project cover the priority objectives of regional applied research on the dynamics of the coasts aimed at the construction of a Decision Support System (**DSS**). The application that is in development has to be able to allow the activation and the development of processes to govern the coastal area, allowing the Public Administration to formulate replies to changes of the coastline in a space or time scale, which can also be due to the effects of anthropical activities.

Based on the experiences, attention will be given to the definition of the thematics to handle, to the phases of acquisition and elaboration of the data, to the possibility to integrate data that are gathered through activities of coastal monitoring (f.i. digital images of high resolution taken by commercial satellites), to the implementation of dedicated software (custom command) and to the choice of the technological solutions. It is particularly important to be able to show on a map the "diachronic" elements of the coast line the transversal profiles of the beach and of the maritime works (cadastre of the maritime works), which boundary conditions to be associated to the historical series of the meteomarine forces. A experimentation on the control of the cadastre of the maritime works will be realized on a selected part of the coastal area, on the base of historical material and of field visits, connected to the GIS systems and with the possibility to archive, update and visualize all information on maritime works.

ESSENTIAL CHARACTERISTICS OF A GIS FOR THE MANAGEMENT OF THE COASTAL AREA

A GIS has to be developed in order to:

- Manage a database structured in the best way possible to georeference the source of information (with the exact positioning of points and areas of reference) ..and of interpretative reports;
- Classify the subsequent temporal archiving of various sources of information and their respective moments of validation, updating and reporting.
- Allow the extraction of data, tables and graphics following various levels of interest and authorizations to access and manipulate the data without, however, changing the original data
- Include interpretative models of the data to allow a well-defined and fast exchange of information between various groups/disciplines and to facilitate the reading of data also to non-specialists
- Follow the continuous evolution in IT. The system should not be “chained” to rigidly to the a monopolistic hardware and software architecture, but should be open with the possibility to transfer easily the information guaranteeing an easy interaction with other technologies and software systems (interfaces with instruments for data gathering, modeling applications (external of the GIS), hypertext and documents in a web environment).

Considering the complexity of the geographical reality of the coastal areas and in particular that of the region Abruzzo, characterized with multiple factors (physical, environmental, economic, socio-cultural, legislative) it is necessary to define in advance, in function of the management objectives, the topics to handle with a reference to geographic portions of reference.

At a second stage the base or primary data (for these topics), structuring the “coast-database”, and the metadata, to manage the resources, have been defined.

PRIMARY DATA

The data needed for the Integrated Management of the coast are multiple and are inherent to the different environmental sectors, (Fig. 1); normally these data are gathered by various Institutions (governative institutes, meteorological institutes, research groupes, private operators) with different goals using instruments and procedures that are very heterogeneous. It is therefore impossible to uniform the procedures of data gathering, also due to the differences between data types, but it is possible to standardize the procedures of transferring data to the system. The appropriate software and hardware requirements have to be defined in order to handle various data types (alphanumerical, images, movies, tables, ..)

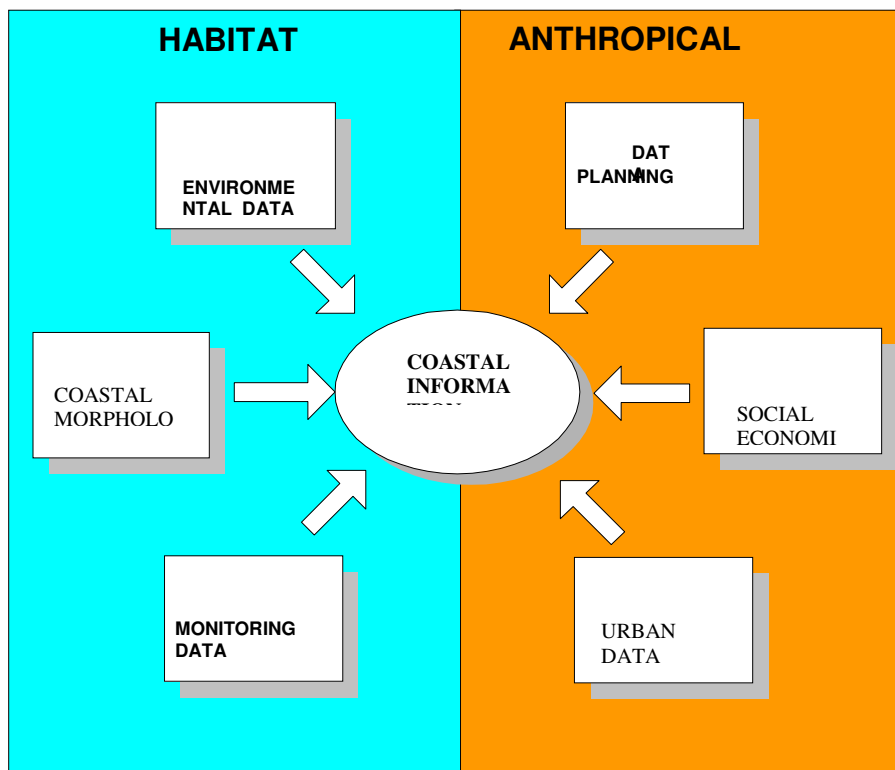


Fig. 1 – Environmental sectors of reference

Considering all natural and antropic components that play a role within the coastal area of Abruzzo, the primary data have been selected and classified in various categories:

Category	Type of data
Meteoraritime Data	<ul style="list-style-type: none"> Measures of the direction of wave propagation; Measure of the sea level;
Data Geomorphologic	<ul style="list-style-type: none"> Granulometric and petrographic indexes relatively at sediment samples. Seashore survey Transversal profiles of the beaches through topographic and bathimetric measurements
Hydrological Data	<ul style="list-style-type: none"> Main characteristics of hydrographic basins (primary and secondary hydrography); Regimes of the solid and liquid flow of watercourses
Meteorological Data	<ul style="list-style-type: none"> Measurements of wind speed and direction; Measurement of air pression, temperature, humidity, ecc.;
Environmental Data	<ul style="list-style-type: none"> Measurements of the water quality;
Anthropical Data	<ul style="list-style-type: none"> Taxable data of coast protection works and survey of waterfront infrastructures side Census data of socio-economic nature; Urbanistic data;

Tab. 1 – Primary data

For the objectives established, related to the dynamic evolution of the beach, with an area of interest that covers the complete coastal area, special importance has been given to the definition of geographic areas that have the need to exchange data from monitoring campaigns, at a regional or local scale, in order to assure the acquisition of the meteo-marine parameters not only with a satisfying spatial and temporal regularity but also with an important reduction of time and resources. It is important to notice however that for large areas the costs of realization and management of a GIS system that assures the same level of detail and functionality over the full area could be excessive. On the base of this consideration, the system GeoCoast foresees different scales of reference (see Fig. 2) to guarantee for the entire zone the knowledge of those parameters necessary for the organization of all topics under study (f.i.. characteristics of the wave propagation, location of the anthropical settlements and of the defence works) developing the database in detail only for those areas of particular interest or risk.

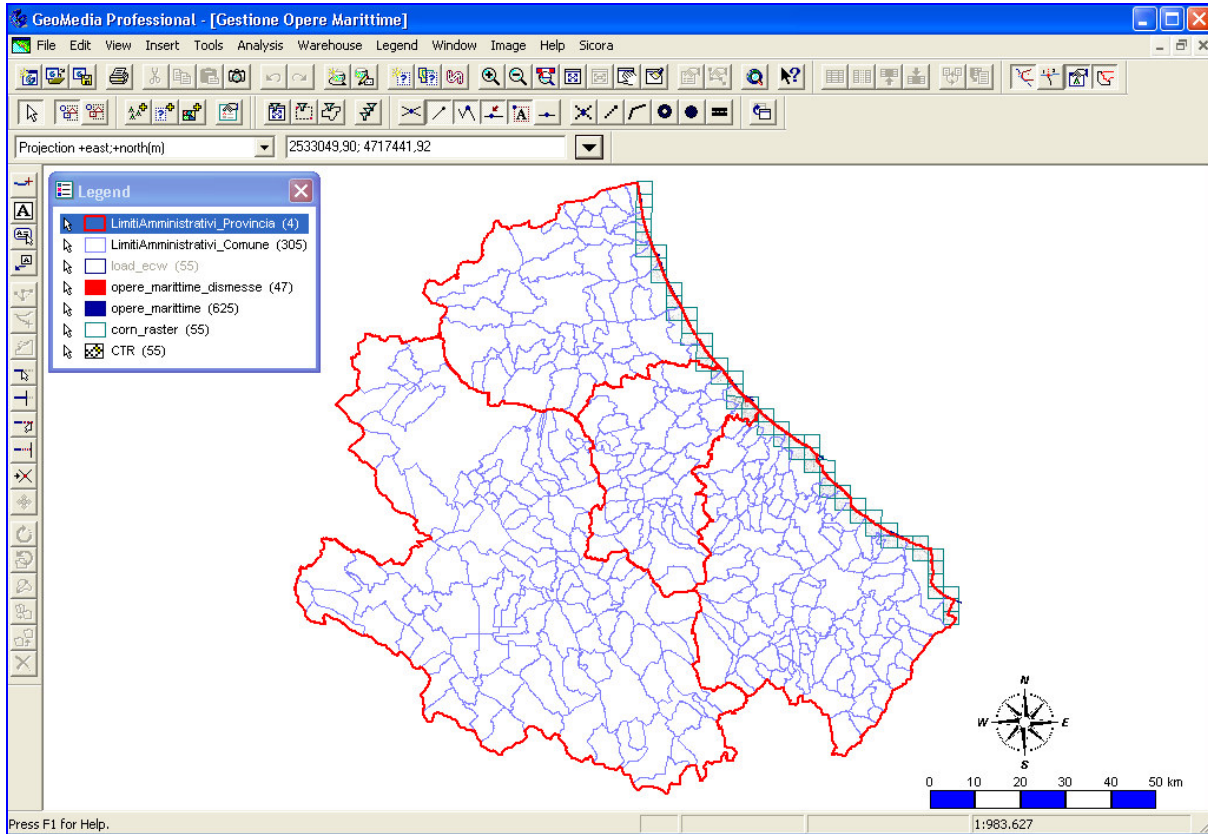


Fig. 2 – Scales of reference (Regional, Provincial, Municipal, Interest Area)

THE CARTOGRAPHICAL BASE

The cartographical base will be used to position the content of the databases connected to the GIS system. For the management of the coastal area of Abruzzo and the topics of interest a system has been developed that allows the use of the base map in combination with other cartographical documents as:

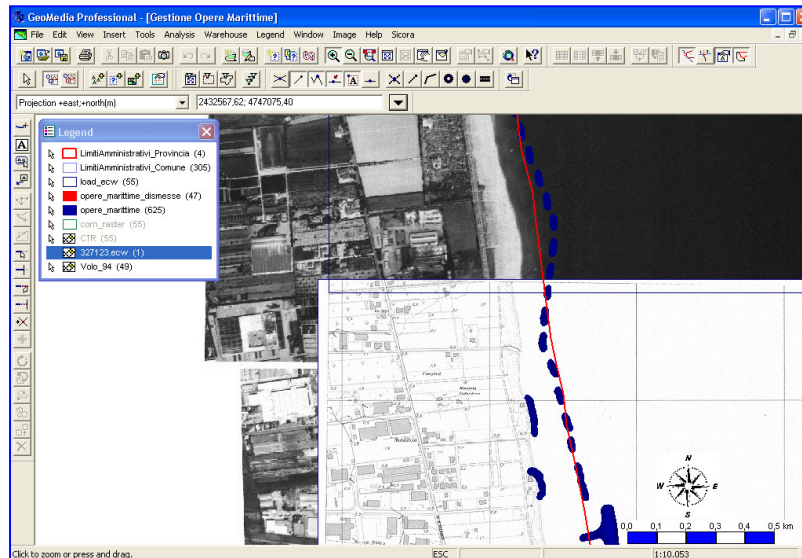
- Cartography of various scales related to the dynamics of the coast, to the water quality, to the viability, to the development of urban networks;
- Movies, photogrammetry
- Satellite images
- Maps elaborated in coastal defense projects
- Navigation maps;
- Geological and sedimentological maps

Taking into account the aspects discussed above, the requirements of the cartographical base are defined by balancing the need of a correct identification of the graphical information (function of the scale of representation of the available cartographic products) and the possibility to compare directly the different cartographic documents owned by various Institutions.

Above all, one cannot overlook the possibility to use the cartographical base to provide links with the measurements obtained through monitoring campaigns.

The original cartographical base can be archived in raster or in vector formats. The raster format gives the possibility to reproduce the original hardcopy format more faithful but has disadvantages in terms of higher costs. The vector format allows the storage of graphical objects in function of the coordinates of the points and lines of which it is composed, with inevitable simplifications, through which it is possible to recompose the original base. These simplifications are however acceptable for specific topics of interests (f.i. coastline, administrative boundaries, wet boundary of the maritime works, waterways, ...).

For the GIS system discussed in this paper, the CARTA TECNICA DELL'ITALIA MERIDIONALE (Technical Map of Southern Italy) at a scale of 1: 5.000 of an aerophotogrammetric survey of 1987 made available by the "ufficio Informazioni Territoriali e Cartografiche Regionale (ITCR)" was used. The complete regional coverage is composed of sheets in raster format for a total of 57 files that were made available in the GIS system in the original format (300 dpi) and in a format with lower resolution (100 dpi).



In these there is a general representation of the morphology, of the waters, of the urban areas, and of the works at sea. The altimetric representation of the area is supplied by contour lines with a five meters spacing.

The various phases of work that cover activities due to the choice of the cartographical base, can be summarized as follows:

- The raster sheets of the "carta tecnica regionale (regional technical map)", needed to cover the coastal area, have been merged and geographically referenced by cutting of any element which, inside the sheets, is external to the square of topographic mapping.
- From the result, composed of 57 sheets, all principal information (coastline, streets, highways, railways, settlements, rivers, protection works, bathymetry) with the coastal area (width of 4 ÷ 5 Km) have been digitized in the form of multi lines ;

The georeference and digitalization have been done in a way to enable the export and the management within environment CAD and/or GIS, in order to allow the exchange of information using common file formats (such as dwg o dxf).

THE CADASTER OF THE MARITIME WORKS

The main activity for the realization of the census of the maritime works and the successive archiving in a georeferenced cartographic system, concerns the tracing of the data and the information necessary for the analysis of the status of the works for the coastal defense. Having defined the preliminary choice of the cartographical base and its computerization, the operative phases can be summarized as follows:

- Gathering of the cartographic material related to the studies and projects in the coastal environment realized in the past (first level of census)
- Analysis and selection of the gathered material (jointly with the data producers, responsible for the realization and management of maritime works);
- Digitizing of the information collected and selected during the census activities on the cartographical base with the creation of a graphical database with various levels.
- Georeference of the images collected by airborne campaigns
- Update of the works by digitizing new elements or modifications discovered by airborne images
- Field visits for controls and meetings with the responsible Institutions (second level of census)
- Validation of the thematic map of the maritime works
- Realization of the cadastre of maritime works with indications regarding activities of updating and management;

The information gather with GeoCoast are accessible by standard procedures of **GeoMedia** or by a specific custom command. The command visualizes a window containing all available information about the coastal work that was selected (graphically) by the operator.

A short description of the information visualized (See Fig. 3):

- **Typology:** indicates if the selected work is a rising out of water barrier, a submerged barrier, or a groin;
- **Geometry:** indicates the mean length of the work and an estimate completion quote by the mean sea level;
- **Materials Typology:** short description of the structural characteristics of the work;
- **Year of achievement:** if available, indicates the year in which the work was realized;
- **Year of abandonment:** if available, indicates the year in which the work was removed;
- **Maintenance intervention:** description of the maintenance works on the structure;
- **Responsible body:** indicates the responsible Institute or manager of the coastal work;
- **Status:** indicate the structural status of the work referencing three conditions of conservation: structural conditions good, recent maintenance activities and obvious signs of damage;
- **CTR-CIPE Reference:** indicates a reference to the Carta Tecnica Regionale (CTR) "Regional Technical Map" and to the cartography elaborated within the framework of the project CIPE.

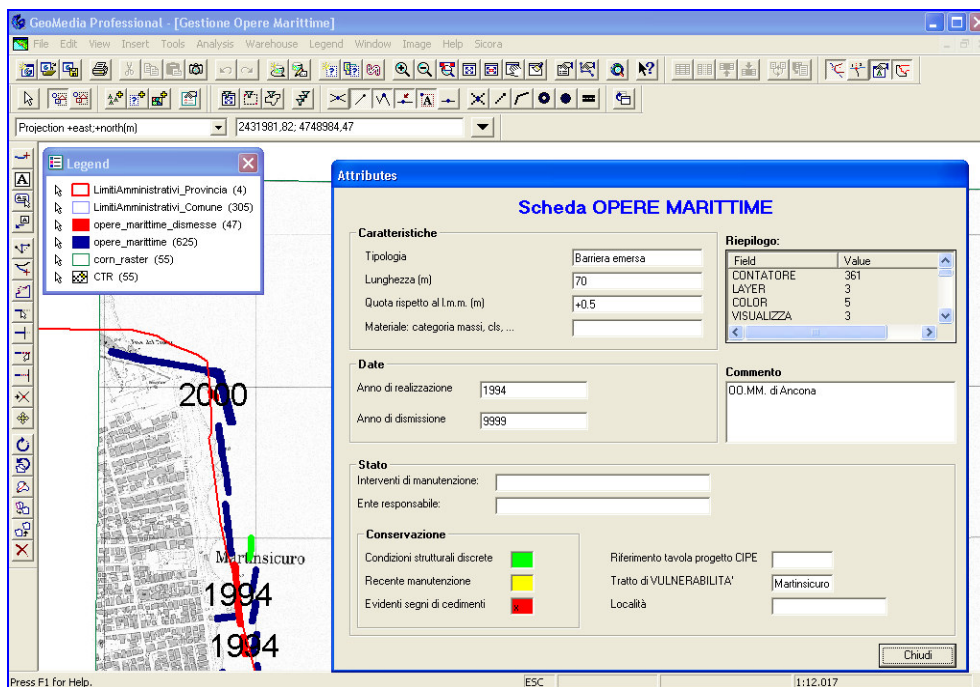


Fig. 3 – Information Window regarding Maritime Works

USE OF DEDICATED APPLICATION SOFTWARE

The possibility to associate at GIS systems application software dedicated to specific areas of study that allow the elaboration of primary data and the extrapolation of new data and information which on their turn can be archived and made available, raises high interest.

Since **the goal of GeoCoast is the management of the historical evolution of the coastal area**, various applications are being developed (that use the large quantity of cartographical material made available) with the following goals:

- Diachronic analysis of the protection works along the littoral. Through the management of the cartographical material available within the database on various time “levels”, a search procedure can be activated to select and visualize all “works” present in a specific area of the coast and before a specific date of reference (Fig. 4 e 5);
- Historical evolution of the coastline. With a procedure analogue to the previous point it is possible to select and visualize the coastlines which match a time-lap indicated by the enduser. In this case, taking into account that the cartographical data can be vectorized, procedures can be defined to quantify the variations in time. The results of these variations can be summarized in graphics and/or tables that allow an objective evaluation and comparison of the zones exposed to erosion and the trends in time. One could also foresee to use these data for the calibration of numerical simulation models of the variations of the coastline and/or of the “solid balance of warps”;
- Allow the “connection” between the database with wavemeter information of the GIS system and programs for .the transfer and the propagation of the wave motion characteristics along the considered littoral;
- Define applications that allow the representation through summary graphics (with references to the variables of interest) or tables, for user-defined time laps, of the principal information concerning the present structures of the mouth.
- Quick reading Informative reports containing characteristics of the hydrographic basin of the selected river boom (surface, permeability, maximum and medium elevation, hydrometric zero quote, distance from the mouth, hypsographic line, diagrams representative of liquid and solid flow , simplified applications for the graphic comparison of flow data.

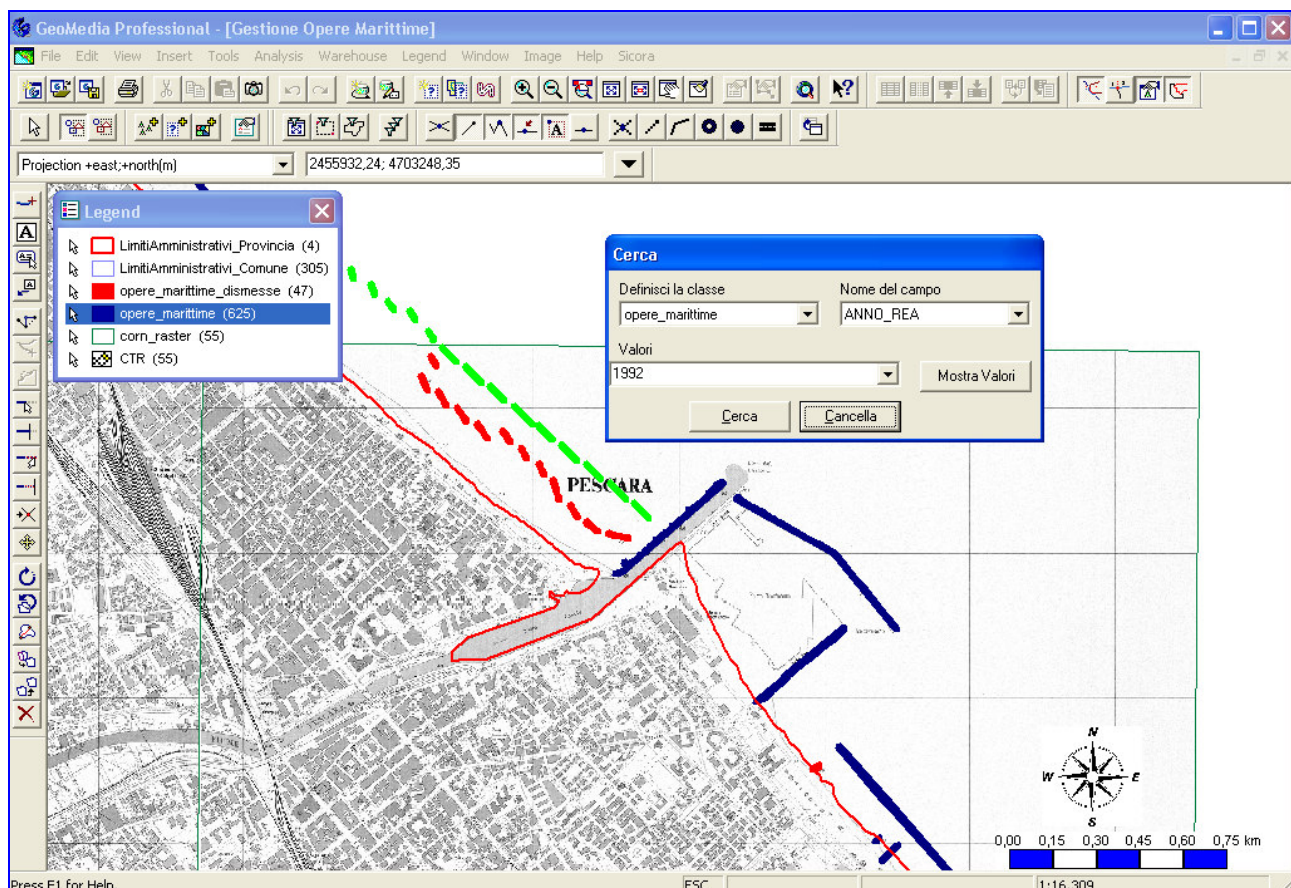


Fig. 4 – Custom command for the diachronic analysis of the protection works along littoral

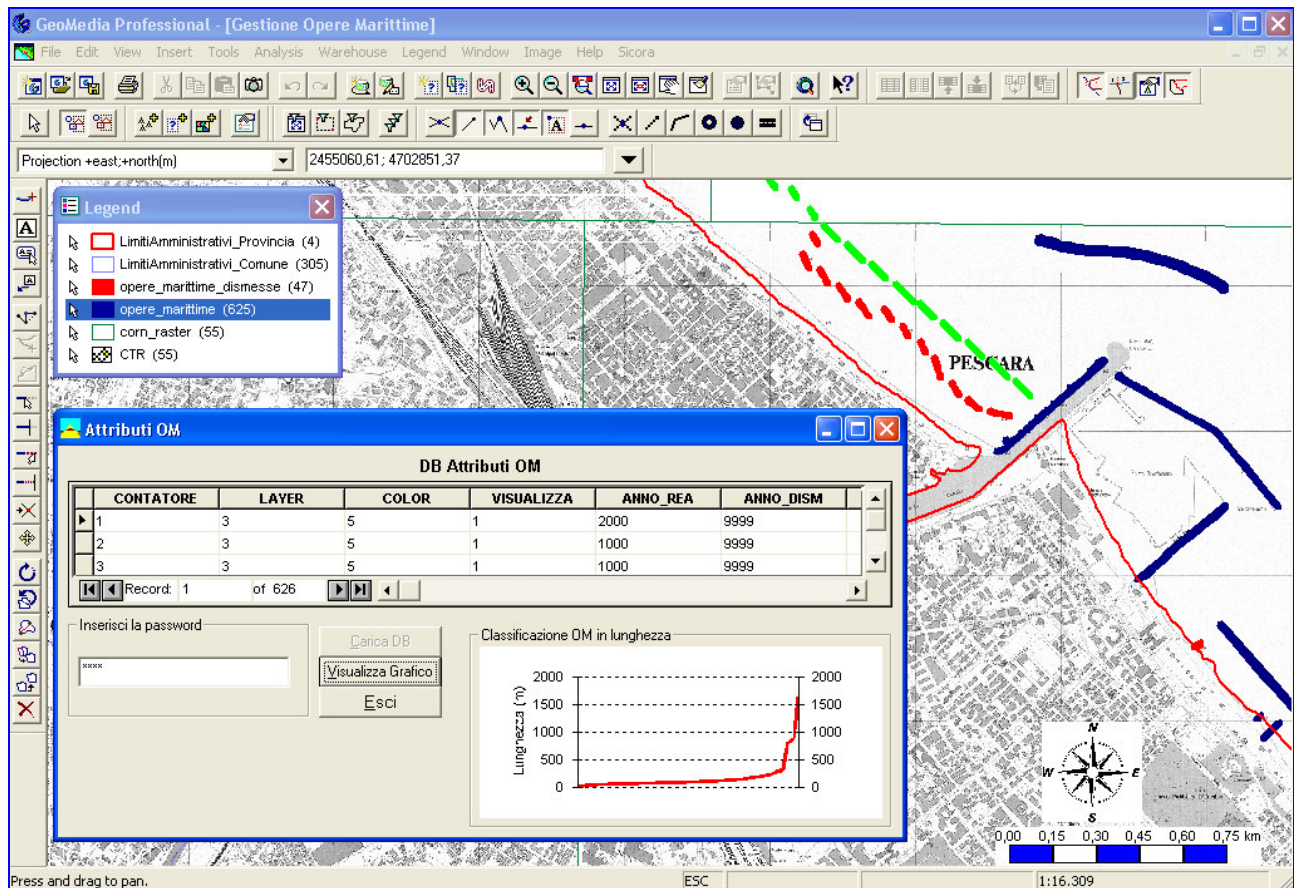


Fig. 5 – Custom command per l'analisi geometrica delle opere di difesa costiera

CONCLUSIONS

Within the processes of integrated management of the territory, Geographical Information Systems represent, aside of the possibilities to create a unique geo-referenced archive, a valuable tool for the analysis and exchange of information.

Furthermore, if the application solutions given by the planned system are easy to use, you can also foresee methods to spread the results inside public Institutions, professionals, economical operators and citizens.

We have to emphasize above all, power and speed of the system to upgrade and integrate all the data as well as the capability to manage, inside the same environment, programs and applications referred to different disciplines related to the environmental management and protection.

They allow to make analysis which before should need a big amount of time and resources, allowing a procedure of a systematic data management, following standard systems.

In the light of what we said we think useful to recommend to the public Authorities interested on coastal areas to use those systems to store and manage their data.

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