Urban GIS implementation for coastal zone problems in Varna

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ABSTRACT

City of Varna, like many other coastal cities along the Black Sea and Mediterranean Sea, has a lot of problems related for many years to the environmental protection, including those with coastal zone management. Recently, the coastal slope problems due to land-slides apeared as very urgent and difficult to be sold. The present paper describes a method to solve some of the problems by analysing the data collected. A data layer representing complete hydrologic network including transport lines through slopes, lakes, streams, rivers, is a necessary component of many hydrologic and coastal applications. The coastal area of the city has significant importance – sea ports, resorts, cargo terminals. Most of them add environmental problems to the Black Sea in adjacent territories and the region as a whole. The attempt described is to solve these problems on the ground.

This paper describes a process to analyze the area searching for a decision. Making front-end application using ESRI's ArcView 3.0a/Avenue we prepared user-friendly procedures to automate most of the functions. This application generates maps using data collected during the last two years. The data acquisition is performed according the Bulgarian standards. Converting procedures are created and tested as well. Finally, technology for updating data is approved.

INTRODUCTION

Geographic Information Systems (GIS) are tools for managing, analysing and displaying geographic data and data which can be related to geographic objects. A description of GIS may be found in [1]. The combined power of present day GIS and computers is such that organisations can use a GIS (combined with other data base systems) as the core of all data operations. Since 1996 through transfer of data collected from various departments within the Ministry of the regional development and private organizations, Municipality of Varna, in cooperation with other State and local partners, has begun research, inventory and monitoring, information sharing, and technology transfer. The research focuses on Information Technology, implementing geographic information systems (GIS), Urban planing, land slides and coastal erosion, utilities, development and application of spatial analysis techniques for urban and coastal zone management problem related studies.

Current GIS technologies in use within the Municipality of Varna are designed to provide managers with the on-line data and computerized techniques necessary to make

informed decisions. Major GIS activities in the Municipality include:

° Compilation and analysis of digital models and databases for coastal and urban planing;

° Integration of developed databases with existing digital databases from various sources into a comprehensive GIS;

° Development of multifunctional service and decision support systems for citizens and managers using these data.

The present research investigates the design and the development of a distributed information system that will assist managers to solve urban and coastal planing.

COAST AND SLOPES – PRESENT SITUATION

Coastal slope management covers a broad spectrum of activities which aim to help engineers, planners and administrators make constructive decisions for the management of slope areas. Slope problems may result from such events as earthquakes, intense local rainfall, coastal erosion and bad drain systems. Most of the models produce large quantities of data results that are difficult for people without special background to understand. GIS systems can solve such a problem. Some examples of slope disasters started in late 60-s can give an opportunity to look into the problem and to make the right decision.

Lack of waste water system in some areas is a problem that city of Varna had to solve. The result was that landslides appeared in the coastal zone. For example, Cape Galata near Varna started to fall in 1987 due to lack of waste water system and slow saturation of the ground during the years.

Several areas to the North of the city center had the same problem in 1996-1998. Part of the coastal area near to St. Constantine resort became unusable including the 300-meter of the panoramic road to the Golden Sands resort. Slides in these areas vary between 5 and 20 meters during the last 10 years. Some banks were formed and moved to a distance more than 30 meters including houses and trees. The soil structure of these lands became another important cause for intensification of the slope problem. That is why underground water became one of the most important reasons for intensification of the slope problems in the beginning of 90's. There are systematic observations since 1960 about the coastal area of the city of Varna and closed lands by several academic, national and regional organizations. State owned "Geozashtita" was created as an organization to control and analyze landslides, abrasion and coastal erosion at the region as well as to make decisions for land protection.

The problem is that there is no constant monitoring system to collect slope data on the field and to evaluate coastal areas on the base of multi factor analyses. The present paper proposes system to approach this problem.

SOME DECISIONS USING GIS METHODS

City of Marceille GIS - solving disaster management and urban problems. In 1971 the city of Marceille created an organization

(ICOREM) and technology to work on digital models using new technologies in particularly GIS [5]. During the last 25 years ICOREM became a kernel for many organizations in the region unifying the GIS method and applying it to some disaster and hazard problems – water floods, fire disasters – most frequently happening hazards in that region. A system was created to collect and to maintain data on the place. Using terminal and workstations, different organizations conducted their part of data acquisition and processing their results with existing data. The first pilot GIS application in Varna was released in cooperation with ICOREM in 1996.

The GIS of Palma de Majorca – a successful implementation of new technology and organization. In 1984 by the structural funds of EU and by help of ICOREM Palma de Majorca, Spain started to develop a GIS system to help the process of decision-making in planning and disaster analysis and preventing. The system is based on cadastre and graphic information. This winning technology prevents the entering of similar information from different places and decreases errors. Time and data sharing minimizes response and decision-making time. Based on perfect communications (fiber-optic, more than 520 terminals around the city) all integrated data in IMI from participants at this system created more than 600 data layers. Participants in the system have "read access" to some data of the others and "full access" to all own data [5].

Information about the organizations like National Coastal and Marine geology Program-developed by the Federal Department of Ecology of U.S.A. can be found on the web. Powerful Environmental Protection Agency (EPA) created in 1995 a nationwide GIS application based on more than 400 IBM RS/6000 and Arc/INFO workstations placed around the U.S.A. to collect data, analyze and shelter the environment. GIS technology for risk management and prediction became most popular tool for problem solving [2], [4].

VARNA GIS APPROACH

Advanced computing techniques of searching, processing, representation, transmission, and logical inference from known data to possible courses of action provide the potential for significantly increasing the capacity of multiple organizations in a community to coordinate actions more effectively. Carefully designed, a network of computers and collected data working together can support a network of organizations engaged in response operations activated by any emergency event [Fig. 1].

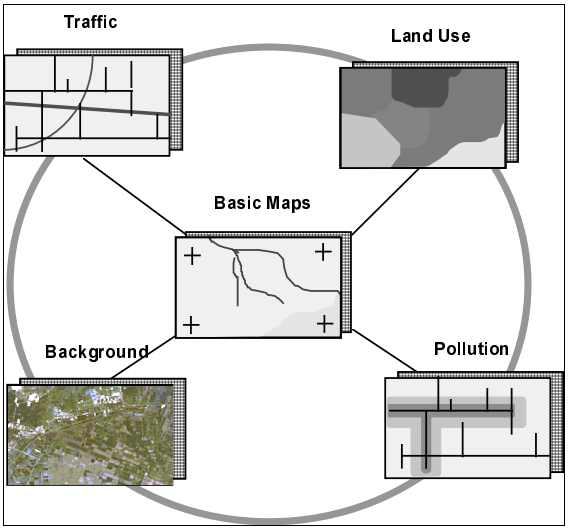

Fig. 1

Implementing GIS, ArcView 3.0a software and Avenue OOP language is used to customize user-friendly interface and front-end application for decision-makers. Some of data are prepared by Arc/INFO 7.2 software on Windows NT platform, the others are made on local products. We also include as managing platform MapInfo-MapBasic because it is used in one of the organizations involved in this project. Both ArcView and MapInfo software applications are developed additionally to be most suitable for end users.

We created simple search procedures of text and spatial data, information about major parameters of spatial data. We continue to develop the systems by importing different statistics data into existing spatial model. Several specific layers represent water sources, roads, resorts, recreation areas, rivers, and water pipes and their geocoded data [Fig. 2].

Fig. 2

Additional software is installed to make possible spatial and network analysis as well as 3-D analysis. The added software for ArcView 3.0a was Network Analyst, Spatial Analyst, and finally 3-D Analyst. By means of GIS applications buffer zones are created around the slope and coastal erosion areas.

Communications between involved organizations based on 2,44 GHz 100mW wireless routing-modem system are created. This step increases ability to work on demand by network of different organizations implementing advanced technologies to collect data and to create distributed data bases.

A kernel team to implement GIS technologies is created. Training program for new users is published. Trainers for GIS applications are trained. A network of organizations working with GIS became more popular.

COLLECTING DATA

The project addresses the problem of decision making under conditions in which systems of organizations - public, private, and nonprofit - evolve rapidly in response to major needs. This sequence requires timely, accurate search, processing, and integration of information from multiple sources to enable the coastal planing managers to act adequately.

The system of data collection is based on accepted in Bulgaria data standards for digital models – Regulations 5 & 31 – CAD and ZEM file formats, as well as standard vector, raster and text file formats – DXF, TIFF, .txt and .dbf. CAD files are created from different applications used by local data creators – private organizations involved in creating landuse zoning, urban planinig, and coastal development. Drivers to import-export CAD data both for ESRI products ArcView, Arc/INFO and MapInfo are created also. A pilot project sponsored by World Bank to develop Bulgarian Black Sea coastal area started in 1995. The chosen

software was ArcView. The collected Arc/INFO 1:5000 scaled maps data for the region of Varna were imported into the present system.

Data used for creating the applications are from many different sources:

- Aerial photos used to create a digital model scaled 1:2000. This program used aerial stereo photos produced in 1993. They covered all coastal area including part of urban area of the city. After approximations of the digital maps to the existing grid of the area was reached accuracy equivalent to scale 1:1000;

- Existing maps scaled 1:2000. In some organizations including Geozashtita there are paper working maps in scale 1:2000. Coastal erosion and slopes are marked frequently on these maps. Using these working maps and digitizing them a new layers with history of the slope movement during the years were created;

- All cadastral plans scaled 1:500 are scanned. There are 195 cadastral plans covered Varna and coast, including slope areas. This coverage was scanned on Xerox A0+ gray scale scanner with 600 dpi resolution according bulgarian regulations;

- Ready-made digital models of some parts of the city and the coast. According regulation 31 some lands in slope areas made because of former owners restoration law. There are 9 lands ready to use in coastal area where slopes are occurred in the last 3 years.

MAKING NEW MODEL OF COASTAL AREAS

It is clear that a new model needs some basic requirements like specialized and trained team, detailed knowledge of hazard coastal and slope problems, additional databases, well-developed hardware, software and communication equipment, data acquisition system, data exchange between involved organizations through defined standards for data transfer.

Development of the system makes possible probability of prediction of disasters, creation of buffer zones around the related areas, activities of decision-makers for risk management of these areas.

Implementing activities to accomplish above described model requires the following activities:

- Studying geomorphology of slopes, coastal erosion applying new technology, assessment of possible disaster events and revise their impact in restricted areas;

- Identification of risk and hazard prediction of coastal zones from the developed permanent working data acquisition system, as a part of preventing monitoring system;

- Risk analysis and developing a new schema for utilization of the risk zones by common Terrestrial Urban Plan, merging collected data, creating digital model, local regulations and building rules, standards, and knowledge base. Promoting these new ideas and results in the Plan;

- Creating a prevention program, restriction classification, migration plans, and regeneration of impact areas.

These actions are part of a utilized GIS started to collect data, implementing technology, and creating a team to work with the system.

In order to improve the present model of coastal area it is intended further research based on including of relevant aspects related with coastal abrasion caused by the sea (including waves, wind, etc.). For that purpose joint team of researches on behalf of Municipality and BSHC Hydro laboratory is recently established. Some possible contribution from foreign colleagues for that quite ambitious project will be welcomed.

RESULTS

The Municipal IT Department's mission in spatial analysis is to research and to develop new spatial analysis applications, techniques, and methodologies related to urban planing, coastal erosion, slope analysis, and utilities management. These applications, techniques, and methodologies are then transferred to urban planing managers and risk-management services as computerized decision-making tools. To accomplish this mission, IT Department relies on the input from state owned and private organizations. It also tries to create expert knowledge in that area and related information. Finally, IT Department maintains a strong training program for users through workshops and formal courses.

The presented research allows us to build a technological system that shifts to network of organizations and jurisdictions operating with collected data.

The most important results of the research could be summarized generally in essential topics as follows:

- Basic digital model is created [Fig. 3, Fig. 5] including all water sources in coastal area [Fig. 7] having a great importance in coastal erosion and landslides;

- A technology for updating of digital model is approved by all participants gathering information;

- Communications between organizations are functioning properly. Note: Some of the organizations have wireless connection to common database, the others used distributed database with short period of updating;

- Transfer data model under adopted data standards is applied connecting different data sources;

- Driver program applications for converting data formats in both directions are created for all participants;

- A digital model with accuracy 7,5 cm scaled 1:1000 is created [Fig. 8];

- Coverage of whole coastal area of the city of Varna is complied [Fig. 4, Fig. 6].

CONCLUSIONS

There are clear interests, benefits and uses for higher quality and a broader variety of information to support urban and coastal planning in Varna. For many types of data, especially GIS data, CAD format is a logical choice for cadastral data jurisdictions. Although there are costs associated with data assembly and redistribution, these will be overridden by benefits to the existing data and applications based on this standard. Close cooperation between state agencies in data development and sharing, especially with GIS data, made this project possible expecting further development. Usage of these data especially in environment protection and coastal and slope management makes them important tool for the managers of involved in the project organizations. By this research shore line of the coastal zone may became a joint line for the interest of the researches from both sides – sea side and land side studying the slope and coastal erosion problems. This complex approach based on GIS technology with united databases will be a new case study.

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REFERENCES

[1] ArcUSER, 1,1999, ESRI
[2] Geographic Information Technology in Cities and Counties, A Nationwide Assessment; L. Warnecke, C. Kollin, W. Lyday; American Forest, 1998
[3] INCO-Copernicus Project CP960252, Intermediate reports(1 & 2, 1997) and Final Report, 1998, L. Dimov
[4] Government Technologies, FIRM Support for accurate map in GIS, B. McGarigle, 11, 1999
[5] ECOS Ouverture ED24 CASIG, Report, L. Dimov, 1996
[6] Understanding GIS. The ARC/INFO method, ESRI Inc., 1997
[7] Regulation N: 5, MRDA, 1995
[8] Regulation N: 31, MAFAD, 1995

Fig. 3

Fig. 4

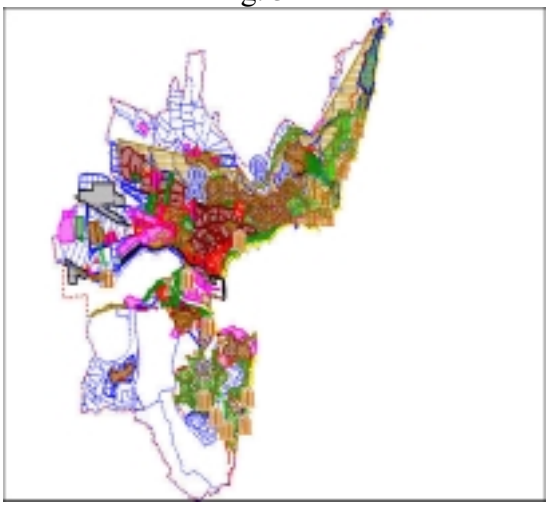

Fig. 5

Fig. 6

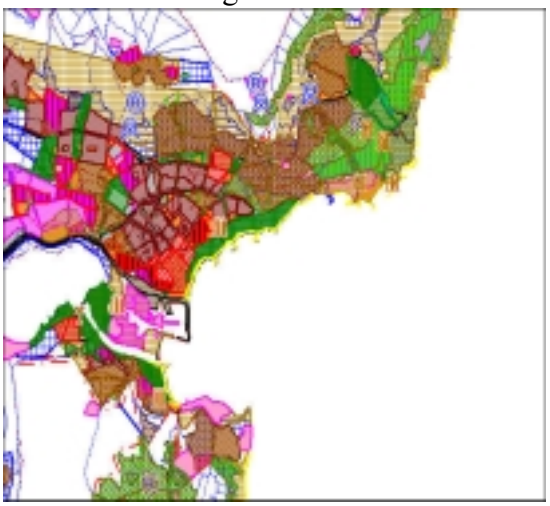

Fig. 7

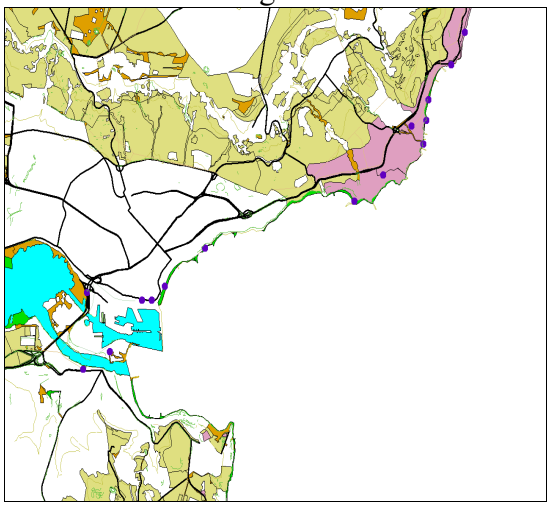

Fig. 8