Master Plan Study on the Integrated Environmental Management in Baku City in Azerbaijan Republic
- Environmental GIS Database Building -

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Abstract

The Metropolitan City of Baku and its surrounding areas of Azerbaijan have witnessed a tremendous economic development since the second half of the 19th Century, thanks to its wealth in petroleum resources available in Baku and other oil fields.　Unfortunately, the drastic economic development undertaken without the proper environmental considerations caused various problems, such as wide-area environmental damages.　To solve these problems, the Government of Azerbaijan made a request for formulation of the Master Plan Study on the Integrated Environmental Management in Baku City, to the Government of Japan.

In the formulation of the Master Plan for the Integrated Environmental Management, a large number of information related to maps, the nature, society, and environment is handled.　This Study was implemented to introduce the GIS (Geographic Information System) for an efficient management and use of the diverse information, and to build the environmental GIS database.　In addition, the website to disclose the environmental information was launched by the counterpart, namely the Baku Committee on Ecology and Nature Utilization Control or "BCE."

1.　Outline of the Study

1.1 Background and Objectives

The economy of the Metropolitan City of Baku and its surrounding areas of Azerbaijan has witnessed a drastic development since the second half of the 19th Century thanks to a wealth in petroleum resources available from the Caspian Sea and its shore area.　However, environmental considerations were not adopted properly for the technology used for oil drilling and refining, and this results in adverse impacts on the environment.　Especially, since the independence from the former Soviet Union in 1991, a wide range of environmental damages were caused, such as harmful sediments in abandoned oil fields and old industrial zones, impacts on human health, and aggravated natural environment disasters.

Under these circumstances, the Government of Azerbaijan made a request for formulation of the Master Plan (M/P) for the Integrated Environmental Management in Baku City, to the Government of Japan.　The Study Team built the GIS database on environmental pollution based on various types of information (mapping, natural, social, and environmental data) that were collected and obtained in formulating the M/P to provide the basic data necessary for BCE (Baku Committee on Ecology and Nature Utilization Control) as the counterpart (C/P), to offer a guidance and proposals on the environmental issues.

1.2 Study Area

The study area covers the lands that fall under the jurisdiction of BCE, as shown in Fig. 1.　It amounts to approximately 2,192 km2 and has a population of 2.02 million inhabitants (as of 1999).　The study area consists of 11 zones.

1.3 Organizations for Implementing the Study

The organizations for implementing this Study are as follows:

For the Japanese side:　　　　Kokusai Kogyo Co., Ltd.
For the Azerbaijan side:　　　Baku Committee on Ecology and Nature Utilization Control (BCE)

1.4 Period of the Study

From January 2000 to March 2001 (15 months)

Fig. 1 Study Area

2.　Environmental GIS Database

The database on the environmental pollution was built using the GIS to ensure the C/P, BCE to offer guidance and proposals on the environmental issues to other national agencies in charge of city planning and land use plans.

The environmental GIS database built in this Study was divided into 6 layers, namely (1) Basic data; (2) Natural conditions;(3) Social conditions;(4) Environmental information (pollution sources); (5) Environmental information (pollution diffusion status); and (6) Environmental information (pollution maps).　These layers of information were configured on the standardized coordinate system to use the overlay function of the GIS.　This ensures an easy retrieval of data on the same points; for example, the observed information and the environmental passport on factories can be retrieved momentarily.　The contents of each layer of information will be described below.

Fig. 2 shows the configuration of the environmental GIS database built for this Study.

2.1 Basic Information

The basic information is used to understand the geographic conditions of the area under study, including the main roads, rivers, and geographic names.

2.2 Natural Conditions

The information related to the natural conditions is used to define the relations of the pollution sources and pollution diffusion conditions with the natural conditions, and it allows to understand easily the relations of air pollution with topographic and meteorological conditions, and of water contamination with the groundwater.

2.3 Social Conditions

The information related to the social conditions is provided to understand the relations of the administrative boundaries with the corresponding population, specified districts, land use plans, water supply facilities, and health statistics.   The digital data of this information facilitate its statistic processing and its visual display, for a better understanding.

2.4 Environmental Information (Pollution Sources)

Each factory located in the study area is compelled in submitting its environmental passport to the relevant agency. The environmental information related to the pollution sources includes the digital data on environmental pollution, to be managed as the environmental pollution information using the GIS.   Through the retrieval function of the GIS, any factory that causes emissions exceeding the reference value involved in the environmental pollution can be monitored momentarily.   In addition to the environmental passport, the information related to other environmental pollution sources, such as power generation plants, oil fields, large-scale agricultural lands, waste disposal facilities, drainage facilities, are provided as digital data.

2.5 Environmental Information (Pollution Diffusion Conditions)

The pollution diffusion conditions depend upon air, water, and soil pollution. Since the observed data is point-by-point type, it is difficult to monitor the pollution conditions over a whole area.   The digital data can be represented two dimensionally using the GIS, and the pollution diffusion conditions over an entire area can be monitored.

2.6 Environmental Information (Pollution Maps)

The environmental pollution maps represent the conditions of air, water, and soil pollution using the environmental GIS database built on the information, as obtained in 2.1 through 2.5 above.   The integration of the above types of information with any simulation models imported into the GIS allows the production of an integrated environmental pollution map.
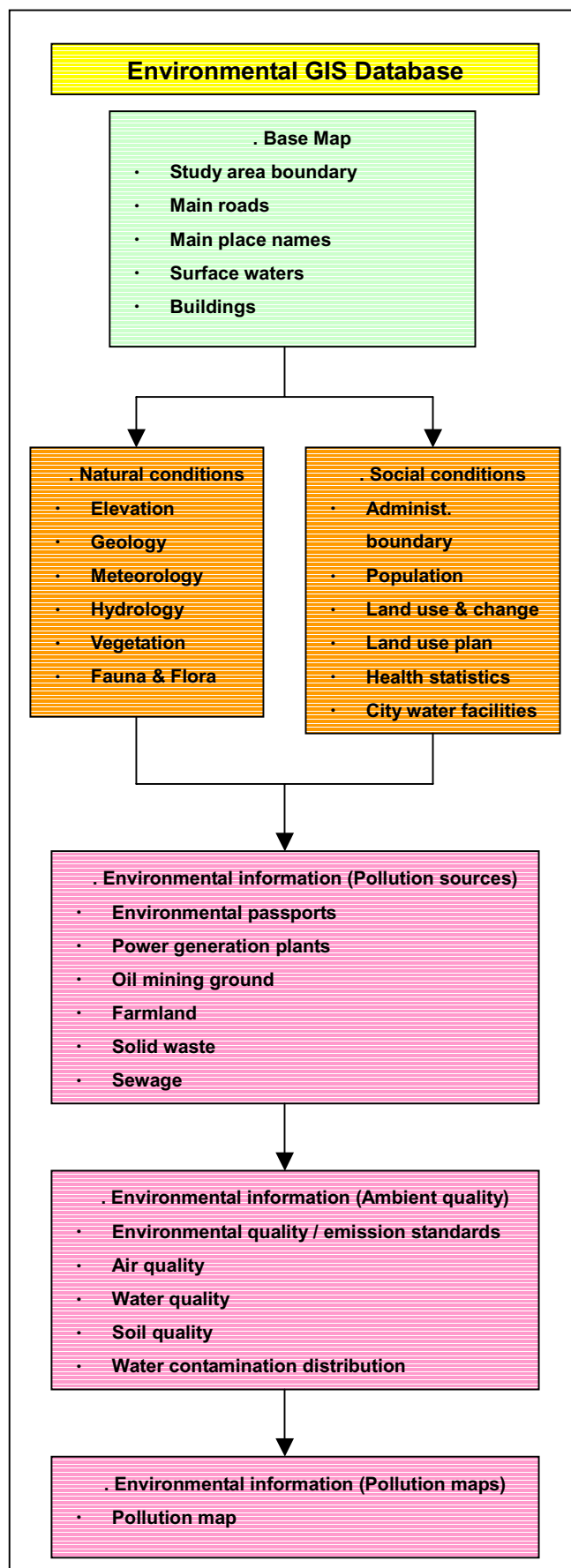

Fig. 2   Configuration of Environmental GIS Database

3. Hardware and Software Used for Building the Environmental GIS Database

3.1 Hardware

The hardware used for building the environmental GIS database is as follows:

(1) PC server:　　　　1 unit
(2) PC client:　　　　2 units
(3) A0-size color plotter
(4) A3-size color scanner
(5) A3-size color printer
(6) Networking equipment (hub, LAN cable)
(7) Power supply stabilizer

The PC server is used to manage the built database, but normally, only the manager can use it.

The PC client is used for the operators to build the environmental database.

All the PCs and their peripheral equipment were networked.

3.2 Software

In selecting the software to build the environmental GIS database, the software used in other international organizations within Azerbaijan was examined.　In consideration of the GIS software widely used in many countries, the ArcView GIS 3.2 from ESRI was introduced in this Study, as listed below.

(1) ArcView GIS 3.2 :　　　　2 sets
(2) ArcView Spatial Analyst 1.1:　2 sets
(3) ArcView 3D Analyst 1.0:　　2 sets
(4) Microsoft Office Professional:　3 sets

4. Environmental GIS

Some applications of the environmental GIS are described below.

4.1 Output Example of Environmental Passport Database

The environmental passports collected and incorporated in the database are provided for about 290 companies.　As shown in Fig. 3, the distribution of factories holding the environmental passport and the types of information possessed by those factories can be monitored momentarily using the GIS.

4.2 Output Example of Air Quality Database

In the study area, there are 9 monitoring stations that are provided to control the air quality.　The air quality data observed during 10 years, from 1990 to 1999, are available for monitoring.　The observed air quality data consist of approximately 15 items, including NO_x and SO_x.　All the air quality data were incorporated in the GIS to build the air quality database.　As a result, the information could be displayed using the GIS, as shown in Fig. 4, allowing the atmospheric changes of NO_2 for 10 years to be monitored momentarily.
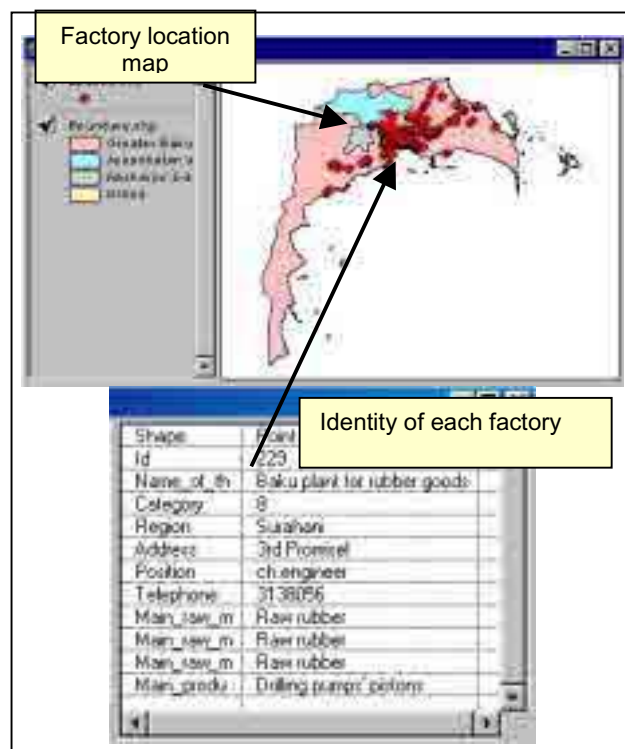
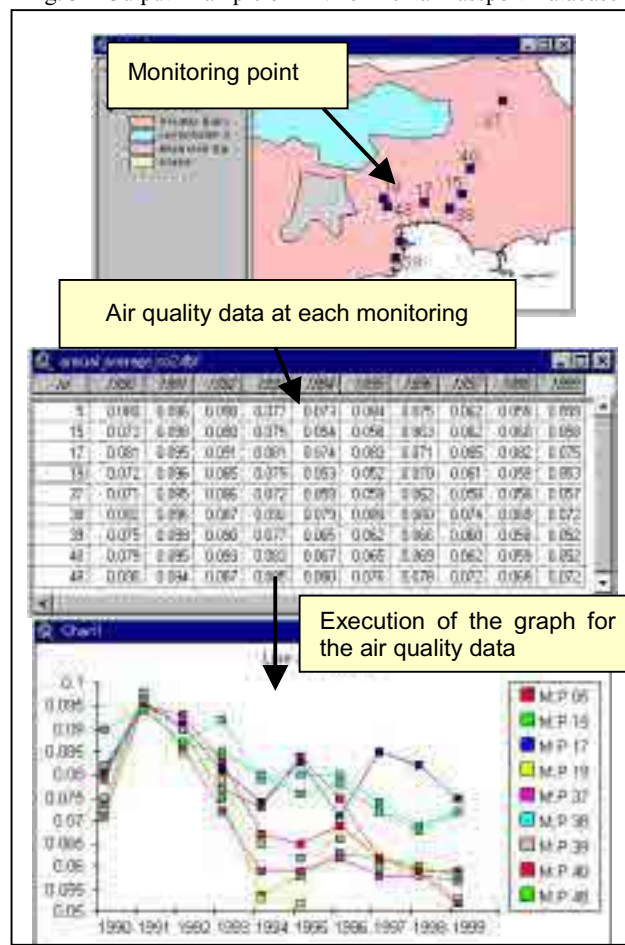Fig. 3　Output Example of Environmental Passport Database

Fig. 4　Output Example of Air Quality Database

4.3 Output Example of Administrative Boundary Database

When considering the environmental pollution, the change of population represents important information. The study area consists of 11 zones, and the statistic information on the population in each zone had been provided every 5 years, since 1972. However, this information had been managed through an analog method (paper) and it is hard to verify the changes of population in each zone in such a manner. Therefore, the statistic population information was digitized and displayed using the GIS. Fig. 5 shows an output example of population database by administrative unit.

Fig. 5　Output Example of Population Database by Administrative Unit

5. Considerations in the GIS Introduction

All the foreseen problems would not be solved by digitizing the information through the GIS. However, when building the database, it is necessary to define the objectives and to digitize the necessary data in order to attain the desired objectives. What is needed for establishing the GIS database is not only to complete the system, but to update also the information from time to time, through addition, deletion, and correction. An organization to manage and operate the system would be also required. Therefore, the following three points must be considered for introducing the GIS, namely (1) Maintenance of GIS;(2) Use of GIS;and (3) Management of GIS.

5.1 Maintenance of GIS

It is necessary to update the database regularly for the maintenance of the GIS. Further, one must recognize that the database contains two types of data, namely the data available from the organization operating the GIS and those available from outside the organization. The data available from outside, in particular some environmental ones, may be non-disclosed confidential information, which should always be considered.

5.2 Use of the GIS

The environmental problems represent a great concern for the citizens. The GIS database in the environmental field is not only used within the organization responsible for the environment, but it should be used also by outsiders. For instance, the environmental GIS database built in this Study should be disclosed to the external organizations, such as the educational agency, for the environmental education and the knowledge of the citizens, using the Internet.

5.3 Management of the GIS

Several proposals for introducing the GIS in many countries have been undertaken, but some have failed to introduce the GIS properly. The reasons for failure were as follows: (1) An insufficient budget for the GIS maintenance;(2) An inadequate education of the staff in charge of the GIS;and (3) a retirement and transfer of staff in charge of the GIS.

The three reasons as mentioned above should be considered carefully when carrying out the introduction, maintenance, and management of the GIS.

6. Conclusion

The Master Plan on the Integrated Environmental Management in Baku City in the Azerbaijan Republic was formulated, and the GIS database on various types of environment information was built.

It would be preferable in the future, that BCE updates and manages this environmental GIS database for an effective use in order to solve the environmental problems in the Baku City and its surrounding areas.

Lastly, we would like to thank sincerely for the precious cooperation offered to the Study Team by the Government of Azerbaijan and its related agencies, the Japan International Cooperation Agency (JICA), the Ministry of Foreign Affairs, the Ministry of Environment, Japanese Embassy in Azerbaijan and JICA Uzbek Office.

GIS OF NATURE CONSERVATION INFORMATION CENTER, THE MINISTRY OF FORESTRY, INDONESIA

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Abstract

Nature Conservation Information Center (NCIC) of the Ministry of Forestry, Indonesia, was established in 1997 as a part of Biodiversity Conservation Project (BCP) being implemented by JICA. NCIC is responsible to collect, store and disseminate various data on the conservation areas in Indonesia which are under the administration of the Ministry of Forestry. In order to improve the use of map data, NCIC has introduced a GIS. The GIS is being used mainly to digitize existing maps and transform them into a single coordinate system. And in the future GIS at NCIC will also be used to analyze collected map data to provide information for planning and decision making practices. In this paper, background of the BCP and the role of NCIC's GIS are being introduced.

1.   Introduction

Indonesia consists of nearly 17,000 islands which are distributed over a large area. In latitude the area extends nearly 45 degrees and in longitude 20 degrees. Elevation also ranges from 0 meter to 5,000 meters. Because of this geographic diversity Indonesia has one of the richest biodiversity in the world.

However, its natural environment is deteriorating in an alarming pace due to various development or natural resource exploitation activities. Deeply concerned with this rapid deterioration of natural resources, Indonesian government signed Convention of Biological Diversity in 1992 and Indonesia Biodiversity Action Plan was enacted in 1993**.** Following these initial and basic actions aimed at the protection of biodiversity, the Indonesian government asked the Japanese government for its technical assistance in the field of biodiversity conservation. The purpose of the requested technical assistance was to strengthen the capability of two government organizations playing important role for biodiversity conservation in Indonesia. One is the Directorate General of Forest and Nature Conservation in the Ministry of Forestry which is responsible for the administration of conservation areas and the other is Biological Research Center of the Indonesian Institute of Science which is collecting and storing basic data on biological resources in Indonesia.

In complying with this request, Japan International Cooperation Agency (JICA) commenced the Biodiversity Conservation Project in 1995. This project is being implemented as a project type technical cooperation program. At the same time, buildings, facilities and instruments were provided by Grant Aid program of the Japanese government. Now, the project is in its Phase II and will be completed in June 2003.

Project activities can be categorized into three components. One of them is information processing component.

In every activities for biodiversity conservation, it is very important to know the exact situation of target areas or target species. Without having correct data on the subject of conservation rational and efficient actions cannot be taken. A large number of scientific researches and conservation activities have already been conducted in Indonesia, but the results of such researches and activities have not been managed well and therefore have not been used efficiently.

For example, the Biology Research and Development Center has nearly 4 million specimens of flora and fauna but the center did not have any efficient system to search and use specimens and related research papers. Also, the Ministry of Forestry did not have any system or efficient mechanism to collect and use data on conservation areas.

To improve these situations, two information centers were established under the Biodiversity Conservation Project. One is Biodiversity Information Center (BIC) of the Indonesian Institute of Science and the other is the Nature Conservation Information Center (NCIC) of the Ministry of Forestry. Main activities of BIC within the project is the establishment of databases of flora and fauna specimens and as well as publications such as research papers and books. Therefore, their database is basically for non-spatial information.

On the other hand, NCIC's main activity is to establish databases which can support the activities of the Directorate General of Forest and Nature Conservation. For the management of conservation areas, maps are most important information. In this paper, the activities of NCIC is introduced.

2.   Role of NCIC

Role of NCIC can be summarized as follows:

1) Collection of existing data on the 385 conservation areas in Indonesia which are under the administrative control of the Ministry of Forestry.

2) Storage of collected data in spatial information database and non-spatial information database. Map data are converted into GIS formats before storage.

3) Analysis of collected data.

4) Promotion of the modern skills in conservation area management. The promotion activities include technical training of field office personnel.

5) Provision of data to users outside NCIC.

6) Publication of data to the general public.

Following the adoption of de-centralization policy by the Indonesian government and also due to serious economic down turn, forest resources in Indonesia have been exploited in an alarming pace particularly by illegal operations. Illegal logging operations are rampant even in conservation areas. Under these circumstances, the Ministry of Forestry is expected to carry out rational counter measures based on accurate information in a short period of time. NCIC is the organization which can make this possible by providing up-to-date data for planners and decision makers.

3.   GIS in NCIC

In order to fulfill its duties as described above, NCIC is now constructing two computerized database management systems. One is Relational Database Management System to store and use non-spatial information and the other is GIS to handle spatial information.

3.1   System Configuration of GIS at NCIC

Hardware and software for GIS at NCIC are as follows:

Major hardware:
- Windows work station :4
- SUN UNIX Workstation: 1
- Large size digitizer: 1
- Large size scanner: 1
- A0 size plotter: 1

Major software:
- ArcInfo, ArcView, MapInfo, ERDAS Imagine, ER Mapper

3.2   Data Collection

Most of maps being used at field offices are analogue maps which cannot be updated easily. And if maps of various scale, coordinate system or accuracy are used, comparing the contents of the maps or overlaying them for detail analysis is impossible or difficult.

NCIC is trying to standardize maps being used for conservation area management. NCIC is also trying to store and manage all the maps of conservation areas at NCIC in order to store and provide high quality map data to users. GIS of NCIC is now being used mainly for this data standardization and storage purpose.

3.3   Data Provision

NCIC can provide map data to field offices, main user of map data, in the following two modes according to the capability of users.

3.3.1   For field offices which already have GIS

NCIC provides base maps or thematic maps in digital formats. Even the field offices which have GIS, only very limited number of them have large size digitizer to digitize A0 or A1 size maps. It is not practical that a field office is equipped with large size digitizer which should be transported to Jakarta for repair or maintenance. It is practical and economical that NCIC undertakes such digitizing work and provide processed data.

3.3.2   For field offices which have not introduced GIS

NCIC will provide map production and data analysis service. In this case map data will be provided in the form of paper maps or raster format data which can be used on ordinary computers.

The similar service can also be used for the preparation of presentation materials to be used in conferences and data to be presented in reports.

4.   Future Activity Plan

4.1   Establishment of a method of using GIS for conservation   area   management

NCIC is trying to establish a method of using GIS for the management of conservation areas in Indonesia. In general, GIS is a useful tool in the following two types of job.

➢ Preparation of thematic maps
➢ Map overlay analysis

In the case of conservation area management in Indonesia, samples of above two jobs will be as follows:

(1) Preparation of thematic maps

Mapping of habitats of endangered species or eco-tourism spots will be good examples. Rangers will measure locations by GPS. Both location data and attribute data will be entered into GIS to make new thematic maps.

(2) Map overlaying analysis

Typical example is the preparation of a zoning plan. In many Indonesian national parks, villages exist within the park boundary. And because park boundary is often not clearly defined or marked, land use conflict occurs. In making a zoning plan, a series of discussion with local residents is essential. GIS can make alternative zoning plans reflecting the development of discussions. This cannot be done easily if paper maps are used.

Another example is the preparation of trails plans for eco-tourism. One of the most important factors to be considered in eco-tourism activities is not to disturb habitats of endangered species. If GIS is used, both habitats and eco-tourism trails can be displayed on a single map and, therefore, route plans can be laid out easily.

4.2   Transfer of techniques for the extensive use of GIS

In order to improve the skill of C/P in GIS operation a number of training has already been carried out. Now, most of the C/P of NCIC can teach basic GIS operational skills to rangers and officers of local offices and NCIC started to function as a GIS technical center. Training of C/P of NCIC will be continued so that capability of GIS can be fully exploited.

Picture 1 The exterior appearance of the NCIC

The Study on Coastal/Marine Habitat and Biological Inventories in the Northern part of the Red Sea Coast in the Kingdom of Saudi Arabia

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Abstract

The object of the study is to conduct a basic inventory survey on the coastal and marine habitat in the Northern part of the Red Sea coast in Saudi Arabia in order to supply basic information of the conservation and management of the natural environment and its biological diversity.

1. Introduction

This Study aims to conduct a basic inventory survey of the coastal and marine habitats and bio-data in the northern part of the Red Sea coast, in order to provide basic information and its biological diversity. The results of the Study through socio-economic survey will be utilized to devise a framework for the conservation and sustainable management of this coastal marine environment, which is having an inevitable impact on the marine ecosystems.

This study has been conducted to help the Kingdom of Saudi Arabia to develop the database and construction of the GIS system for marine creature protected areas in the Red Sea.

2. Study Area

The Study area is covering the northern part of the Red Sea coast, encompassing approximately 1,000 kilometers (Fig.1) long, from Jeddah to the Gulf of Aqaba Jordanian border. The Study Area has a width of 1 km from shoreline to land and up to 15m depths in the marine environment.

An Model Area is selected to conduct a detailed biological study in order to understand the ecosystem of the area.

Fig.1   Study Area

3. Study Frame

This Study consists of the following four phases.

Phase I: Gathering existing Data (Dec.1997 - Jan.1998)

Phase II: Inventory Study of the Entire Study Area (May1998 – Nov.1998)

Phase III: Model Area Study (Feb.1999 – Jun. 1999)

Phase IV: Preparation of Biological Inventory maps (Jul.1999 – Jan.2000)

The objectives of Phase I which was conducted from December 1997are to accumulate and review references and existing data, to carry out a reconnaissance field survey in the Study Area and to obtain an overview of the entire Study Area.

The objectives of Phase II are to conduct an inventory survey and a socio-economic survey of the Study Area, categories the habitats, analyze aerial photographs in order to draft a habitat map for the entire Study Area, digitize 1:150,000 chart for the GIS, and input some of the results of the inventory and socio-economic surveys. This Phase considered the preparatory stage for Phases III and IV.

Phase III aims to supply basic information on the conservation and appropriate management of the natural environment of representative area in the Study Area and its biological diversity based on collected information and the results of the analysis in Phase II.

In Phase IV, all data collected during Phase I, II and III are analyzed and this information presented as GIS database and habitant maps of both the entire Study Area and the Model Area.

4. Field Survey

The aerial photo was utilized because the study area is large. Although the aerial photo includes information, such as distribution of vegetation, land use condition, sea bottom condition, and coral reef and algae distribution, the photography area has being restricted to the belt near the coastline. So, by utilizing video photography from airplane and satellite imageries habitant maps was completed. Further information obtained by the ground truth surveys was also added to finalize the maps.

In order to achieve successfully the objectives of the Study, the Study Team is divided into the following three groups, each with its own specific role and objectives.

Marine team: Coral, seagrasses/algae, fish, benthos, marine mammals and marine turtles

Terrestrial team: Mangroves/ terrestrial vegetation and birds

Social Environment team: Dealing with social and economic considerations that either influence, or are influenced by the natural resources of the Study Area

5.   Utilizing GIS

User-friendliness is one of the most important factors in computer software. If the software is user-friendly and easily accessible for use by persons with little programming experience, users will gain maximum advantage from GIS.

Commercial GIS software meet a wide variety of GIS need, but you might still need to customize a simple, easy-to-use. In order to obtain the maximum capability for use with GIS, it was necessary to customize the software. For example you can combine a series of steps you can frequently perform and execute them with a single click button (Fig.2).

Fig.2   Customizing GIS system
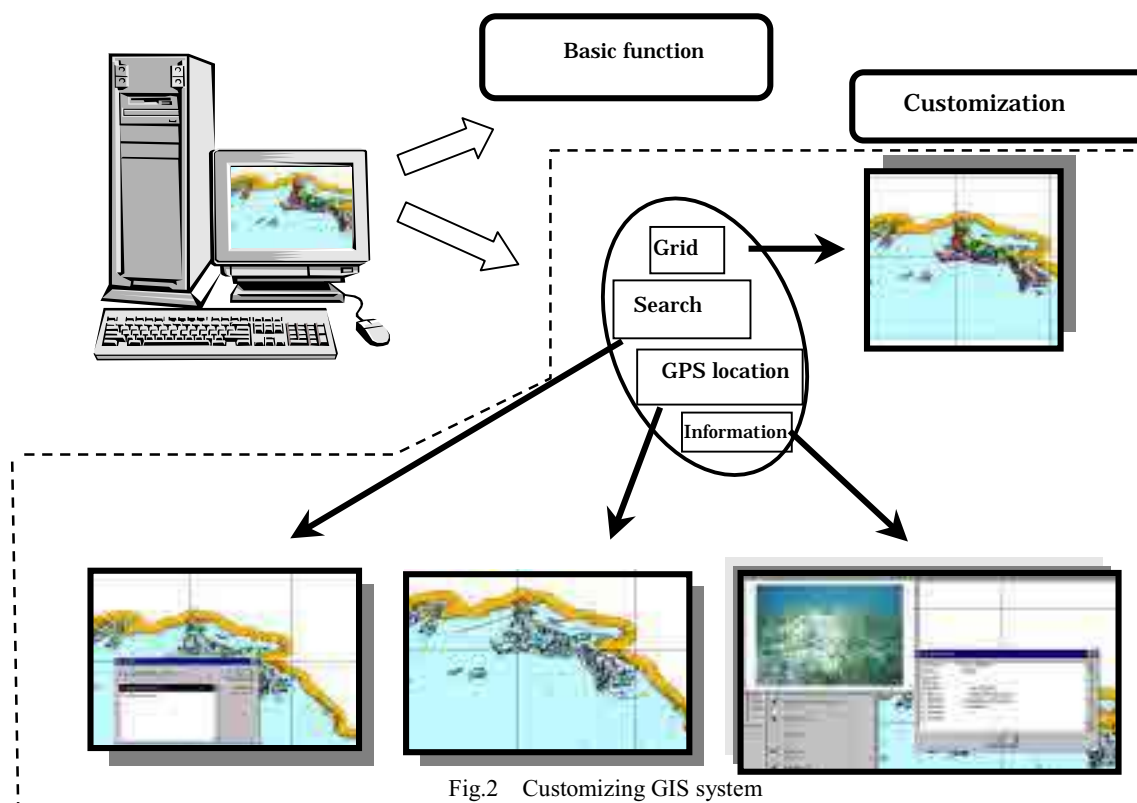
5.1   Customized items
Grid: Icon to overlay mesh on the map.
Search: Icon to search inventory data (using inventory code, classified name, scientific name, observed date and location)
GPS location: Icon to draw a line using GPS data.
Information: Icon to show inventory information

5.2   Counterpart Training
GIS is a tool for processing and displaying digital information. Therefore, a series of GIS counterpart training sessions was conducted to improve counterpart's skill and allow them to make better use of this system.

6.   Result of GIS

By collecting, analyzing and managing data on the natural resources of an area, the current status of those natural resources is made understandable. In order to do this smoothly and effectively, the GIS is employed. Data from dozens of sources can be consolidated on GIS overlays and the relationships between various factors such as social environment and biological resources can be examined. It is also possible to monitor changes in those factors over time. This enables us to understand environmental issues affecting the target area. Another advantage of using GIS is that it can present very complex and technical data visually, making it very easy to understand for not only professionals but also non-specialists.

6.1   Habitat maps
The habitat maps made in this study were based mainly on the aerial photographs. Further information obtained by the ground truth surveys was added in order to drown up the habitat maps of the Study Area (1:100,000) and the Model Area (1:50,000).

With this habitat maps, basic information for the environment and biological diversity in the northern part of the Red Sea coast was revealed. This provides a very clear idea of the marine environment of the Study Area (Fig3).

6.2   Summary Map
In order to make preliminary site assessment using the Study results, a series of habitat map data were

integrated for conservation of a summary map. On the summery map, areas of special interest in terms of conservation of the natural environment are to be identified. The compilation of appropriate data from the Study into one map is the easiest way for decision makers or protected area planners to gain a visual understanding of the current status of the natural environment (Fig.4).
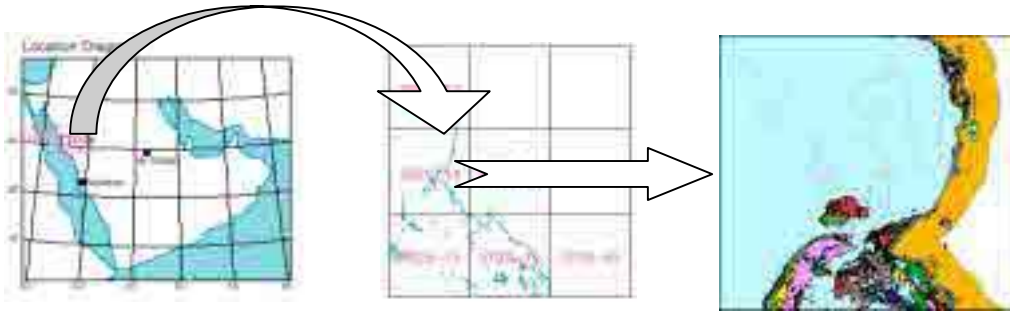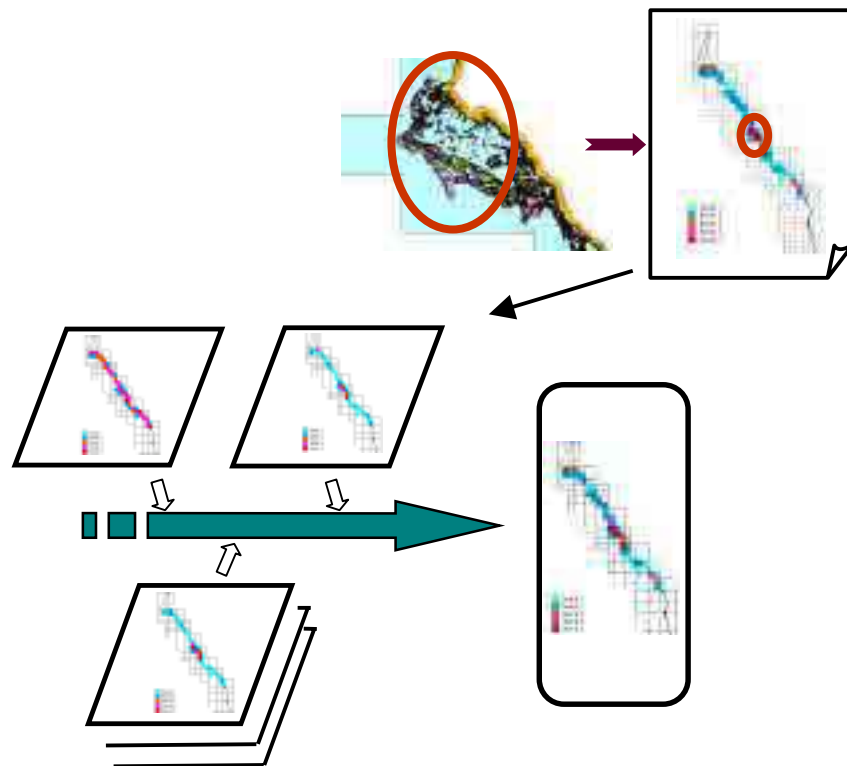

Fig.3 Making Habitat Map

Fig.4   Evaluation using Summary Map