Design and Realization of Water Quality Information Management System Based on GIS

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Abstract—**The water environmental information possesses the characteristics of obvious geographic distribution, so managing and analyzing the water environmental information adopting Geographic Information System*(GIS)* technique is the development trend. Seeing that water quality information management system in some small and medium-sized cities only manages a large number of water quality attribute data at present, not interrelating with the geographic position, therefore it is inconvenient to carry on profound water analysis and water quality simulation. This paper, taking Fuzhou city of Jiangxi province as an example and regarding MapInfo as the platform, has explained the design and technological implementation method of water quality information management system based on GIS, providing reference for scientific management of water quality information.**

Keywords-Geographic Information System(GIS); water quality information; environment monitoring; MapInfo; system design

I. INTRODUCTION

China is faced with three serious water questions: water pollution, shortage of water resources and flooding disaster. In particular, water pollution causes a sudden drop in quality of water environment, so water pollution is a problem that awaits to be solved urgently[1]. The distribution of pollution source has the characteristic of space geographic position, so mastering the spatial distribution characteristic accurately so that to determine pollution load of each reach of the river plays an important role in water simulation.

Traditional management of water quality information is that the symbols of station point and pollution source are marked on the map to show their space geographic position, but the attribute information of water Quality source is mainly managed by some commercial software such as Oracle, not connecting the attribute information with graph information. For example, inquiring the water quality attribute information of some station point is under database system interface, but viewing its spatial information should go in another graphic system interface. In this way, on the one hand it is inconvenient to use, on the other hand it is not easy for water quality modeling and visualization. Geographic Information System*(GIS)* as modern tool for collecting, storing, managing, applying and analyzing geographic information, can realize effective management of spatial information and other kinds of information[2]. Using the powerful spatial information processing capabilities of GIS, all the inquiry and analysis results can be visualized in the form of map, text, chart and multimedia. Combining GIS with water quality information management is the trend of water quality management.

This paper, taking MapInfo as the platform, using the geographic data of Fuzhou city of Jiangxi Province, designs Water Quality Information Management System Based on GIS which is one of the main applications of GIS in environmental department. In this system, GIS demonstrates the characteristics such as fast update of the data, spatial analysis, and dynamic simulation analysis and so on, and all of these characteristics are not reached by other conventional evaluation methods.

II. SYSTEM DESIGN

A. Platform Choice

By comparing the functions of several kinds of GIS software, and considering the price performance ratio, the system intends to use MapInfo 7.0 as a development application platform. MapInfo 7.0 is a desktop GIS that has strong visibility and under an ideal environment of customer/server. The system has built-in relational database, and the data in the database are corresponded to its associated graphic elements using the function of geography code to realize the operation to the database on the basis of graph. Also the system provides development language MapBasic, which is available for secondary development directly[3].

The system uses the method of cross-platform integrated development, develops foreground executable application procedure using software development tool VisualC + + , uses Inter-process communication technology to start background commercial GIS software MapInfo 7.0, and realizes the GIS function in the application procedure.

B. User Demand Analysis

The key of establishing scientific and practical information management system lies in the designer's understanding toward user needs. On the basis of depth and detailed investigation to environmental protection department of the Fuzhou city, this system should satisfy the following several aspects of demands:

1) Reception and processing of information: each kind of information after receiving or processing by manual or software should be send into the related database.

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2) Intensive processing of information: including each kind of operation to the information data, such as storage, update, inquiry, retrieval, statistical analysis, printing, and output and so on.

3) Inquiry of geographic information: including the inquiry of space-time change information, geographic information data and so on.

C. Database Design

The database occupies an important position in the system, and the quality of the database structure design will have the influence on system's efficiency and achieving results. The reasonable design of the database structure may enhance the efficiency of the data storage and guarantee the integrity and the uniformity of the data[4]. The design of this system's database has mainly considered some factors, such as space of saving graph, the speed of calling graph, maintenance of database and so on, so that the system can be modified, expanded and optimized.

D. Attribute Database Design

The management of attribute data mainly uses Microsoft Access database which is a multi-table database on the whole and is connected reasonably through the key field between tables. The attribute data of this system are mainly derived from some related professional departments in Fuzhou City, such as meteorology, environmental protection, water conservation and so on. The main contents include not only the data of monitoring station and monitoring point, such as information table of monitoring station, contrast table of code and name, information table of monitoring units, but also each kind of monitoring data that reflect the water pollution, such as name of the river, monitoring place, monitoring time, solid suspension, dissolved oxygen, temperature, content of phosphorus and mercury and so on. In addition to this, the data of population, geographic name remark are also included in the database.

E. Graph database design

The graph data are mainly derived from Administrative Zones Map and City Map of Fuzhou city. The main contents include administrative boundaries *(city boundaries, county boundaries, village boundaries, and basin boundaries)*, a special topic layer of water treatment *(pollution source, monitoring section, reaches of the river)* and so on. The collection and edition of the graph data, data conversion, graph splicing and so on are realized in MapInfo software.

F. System function design

The system is designed for environmental monitoring station, so it should satisfy the business requirements of the monitoring station and improve its working efficiency. The overall framework of the system is shown in Figure 1.

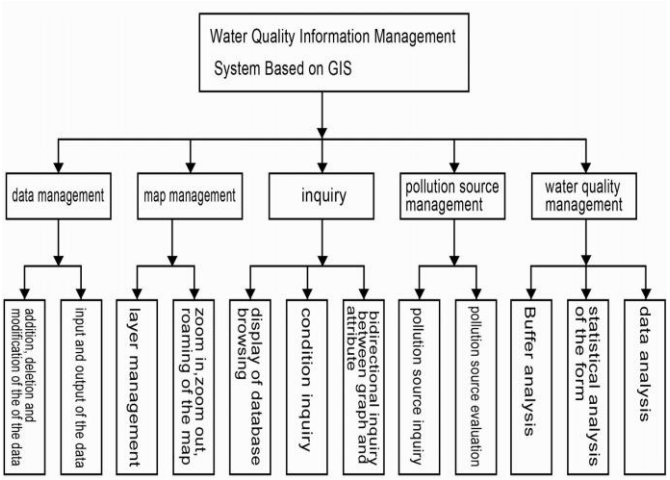

Figure 1. General Framework of System

III. REALIZATION OF THE SYSTEM'S MAIN FUNCTIONS

On the basis of the system design, the application procedure is designed, and then debugged, and finally Water Quality Information Management System Based on GIS is developed. Part of the system's function is briefly introduced as follows.

A. Function of Data Management

The data management of the system is divided into attribute data management and the spatial data management.

The management of attribute data is mainly realized through the form of tables, as shown in Figure 2.

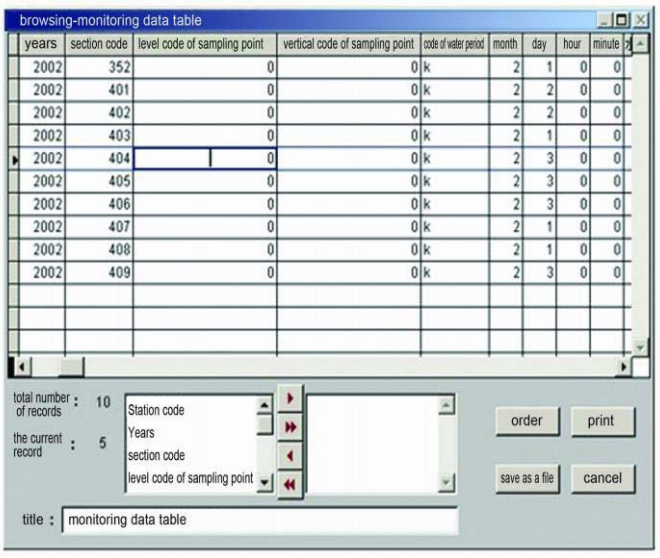

Figure 2. Data browsing

Users can carry on some operations by one record or record set to the attribute data, such as browsing, modifying, adding and updating. Meanwhile, the system also establishes a joined channel between attribute data and spatial data to realize the positioning from attribute data and spatial data.

The management of spatial data mainly manages each kind of special topic layer of environment, including zoom in,

zoom out, roaming of the map and so on. In addition, it can also realize the addition, deletion and modification of the layer element, and according to user's request, the corresponding spatial information and the attribute information will be read in the database.

B. Function of the Information Inquiry

According to the results of user demand analysis, the system has realized the following information inquiry ways: value inquiry, field inquiry, bidirectional inquiry between graph and attribute text and condition inquiry.

1) The value inquiry appears by the way of dialog box. Users can input value condition that needed to inquire, and the system will give data record set that conformed to the condition by the form of table.

2) Field inquiry carries on the information inquiry according to some field value set by the system. The related information can be obtained so long as the user selects the goal needed to inquire in the area that the system sets.

3) Bidirectional inquiry between graph and attribute text can realize two ways of inquiry. The first is inquiring attribute information by graph information, and the corresponding attribute information is displayed in the form of list so long as the user selects any layer object. The second is inquiring spatial object by attribute information, and the corresponding spatial object is displayed highlighted so long as the user inputs the attribute information needed to inquire.

4) Condition inquiry is if users give certain conditions, the spatial object that meets the very condition will be positioned quickly by the map and displayed highlighted, as shown in Figure 3.

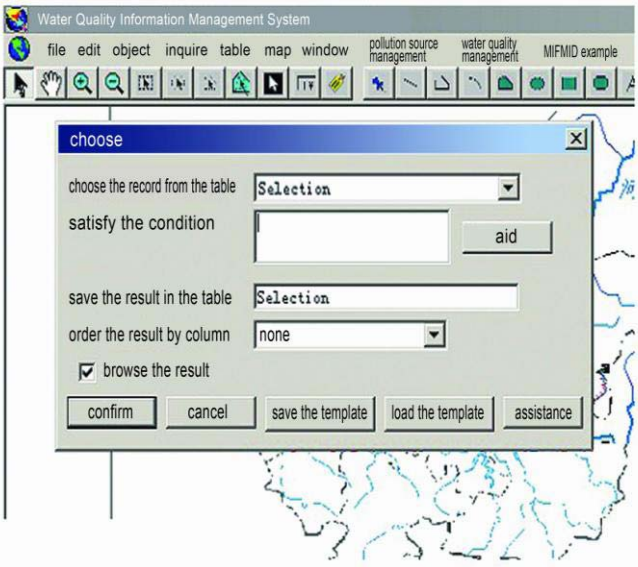

Figure 3. Interface of condition inquiry

C. Buffer Analysis

The Buffer analysis is mainly realized by the window of spatial analysis window. Selecting the layers needed to be analyzed, datum element*(including point, line, rectangle, circle)*, mode of spatial analysis in the corresponding table box, and inputting the corresponding search scope in" Search Tolerance", then users only need draw anywhere the corresponding datum element on the map, the system will display the search scope by specific filled way, and color the objects that obtained by the specific color, and then the analysis result will be described in the status bar, as shown in Figure 4.

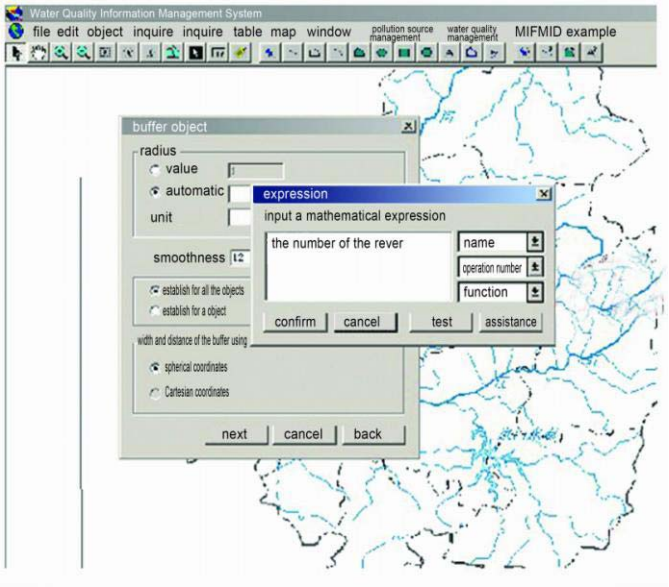

Figure 4. Buffer analysis window

IV. CONCLUSIONS

Taking Fuzhou City of Jiangxi Province as the background and MapInfo as the platform, using the soft development tool VisualC + + to call the basic functions of MapInfo, the paper has established Water Quality Information Management System Based on GIS which applies successfully GIS technology to water quality information management. The test result shows that, this system can express the condition of the water quality environmental pollution vividly and intuitionisticly, improving the working efficiency of the water quality information management.

If further expanding this system, further professional analysis model and water quality model has to be researched and developed so that the system can achieve a more professional analysis and evaluation function.

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