The Research of Management Information System for Water Resources Environment Evaluation

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***Abstract*—The degradation of water resources is an outstanding problem in current economic and social development in China. The management information system (MIS) based on geographic information system (GIS) lends support to water resources environment evaluation, by reducing pollution and increasing utilization of water resources. Moreover, the system proposed in this paper provides decision support for the water resources exploitation and overall planning. This paper shows the system structure and introduces the application of remote sensing technique and GIS in that realm. And we elaborate on the construction of decision support sub-system (DSS) for water resources management and scheme evaluation.**

Keywords-water resources environment; magagement information system; geographic information system; remote sensing; decision support

I. INTRODUCTION

The value of water as a resource that underpins economic activities is evident in all economies, but it is much less evident in economic statistics. Its value and that of related ecosystem services are poorly understood and rarely explicitly factored into tradeoffs and decision making [1]. Currently, the water permission management is established according to "Water Law of the People's Republic of China" and "Water Permit System Implementation Methods". It is put into action by all levels local water administration sections. Otherwise, these water permission management systems mostly focus on license approval, granted and printed etc. Obviously, the current systems refer nothing about the spatial information and relevant data, such as social economic data, precipitation, temperature and geography etc. The incompletion of these information systems caused a lot of inconvenience to the scientific management of water resources. Moreover, it also limits the governor's capability about the supervision and decision of water fetching in every area and valley.

The comprehensive management information system based on GIS combines the water resources management and geographic spatial analysis together, providing reasonable allotment and effective utilization of water resources. It's meaningful to the assessment, anticipation, control and supervision of water quality, and provides a dependable basis for the future decision making and policy making [2] [3]. This paper is organized as follows. The system structure and framework is illustrated in Section 2. In Section 3, we discuss remote sensing technique, GIS and the brief system scheme. At last, the decision support sub-system is presented in Section 4, while conclusion in Section 5.

II. THE SYSTEM STRUCTURE AND FRAMEWORK

A. *The System Physical Architecture*

This management information system adopts simple and direct server deployment. It could be deployed in Internal LAN with high compatibility, providing stable and fast channels to the outside world. Its physical architecture is showed in Fig 1.

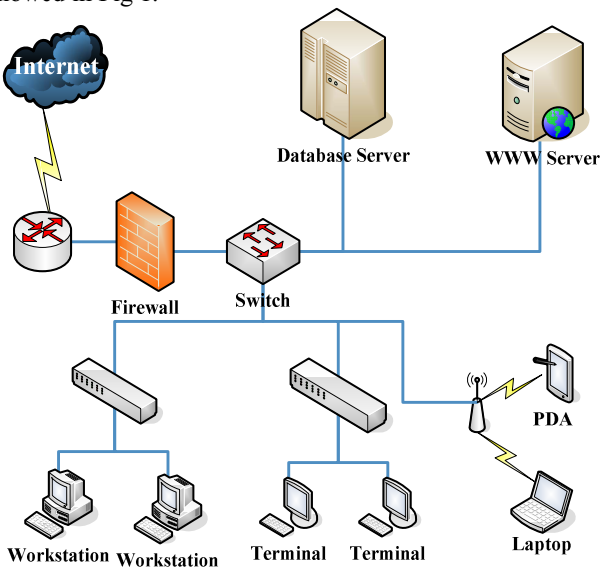

Figure 1. The System Physical Architecture

B. *The System Functional Framework*

The management information system for water resources environment evaluation based on GIS is composed mainly of six parts in function, shown in Fig 2.

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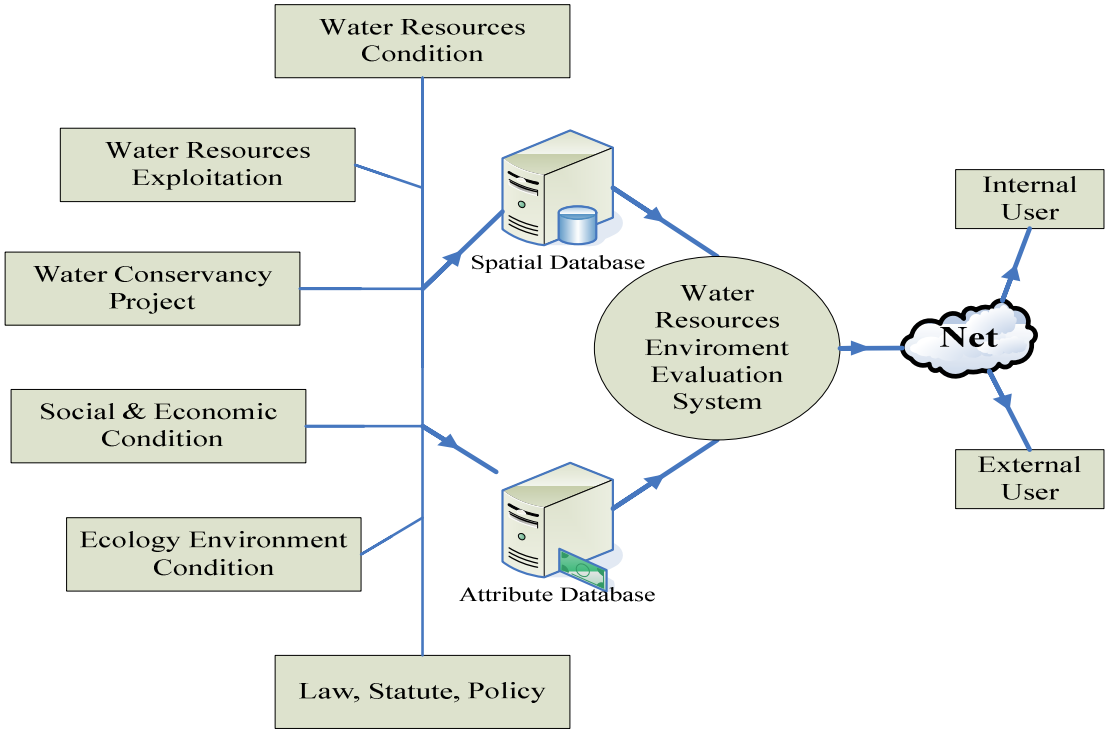

Figure 2. The System Functional Framework

III. GIS FOR WATER RESOURCES ENVIRONMENT EVALUATION

Geographic Information System for water resources environment evaluation is the foundation of this management information system in our study. This chapter introduces the related core techniques and main structure modules of our GIS.

A. Remote Sensing Technique

Remote sensing generally gets some characteristics of the targets on the ground, by transmitting and receiving electromagnetic wave (including light wave) from satellite or airplane, and puts that information into analysis. Nowadays, the domestic remote sensing platform of GIS is usually carried by airplane, observing the topography through CCD camera. As for surface water problems, high resolution imagery from IRS series and spot satellites provide basic information for the parameter of conditions for different hydrological regimes and for water resources evaluation [4].

The water resources evaluation system in our study set up the fundamental information database by remote sensing photos taken from the shuttling airplane, which works with the fundamental topographic database. The greatest advantage of remote sensing technique is fetching large-scope information in a short time, while the information could come out by image or non-image method. Further more, remote sensing could be utilized in the observation of some dangerous area hard to reach by mankind. Besides that, remote sensing observations over traditional measurements for water quality monitoring provide both spatial and temporal information of surface water characteristics. With present advanced satellite sensors, a large number of water quality information about chlorophyll-a, suspended sediment, yellow substance, turbidity, Secchi disk depth, wave height, color index and surface water temperature can be observed on a regular basis [2] [4].

B. GIS Technique

GIS is a new branch of science, which integrates space science, survey and the mapping science, geography, information science, computer science, environmental science and management science [4]. And GIS operates and deals with geographic data. Geographic data describe the position and attribute of spatial elements on the earth surface (including aerosphere, hydrosphere and shallow surface of lithosphere). In other words, two kinds of geographic data exist in GIS: spatial data, reflecting the geometry specialty of spatial elements; attribute data, providing information about spatial elements. GIS is a convenient and effective tool for organizing different forms of the data. And different modules of the assessment system for GIS can integrate and relate any data with a spatial component, regardless of the source of the data. With GIS we can get some feature or pattern through mapping. This intuitionistic result may give us some elicitation [5]. It is widely used in many areas and trades, providing effective treatment for spatial information and powerful decision support service.

In recent years, GIS is applied extensively in water resources environment management. For example, GIS could find out unpolluted water body, wetland and so on. The water environment information has the space and layer

attributes. And GIS could show the water environment condition of different districts more clearly, reflecting the spatial trend of water environment quality. In the city, the city water resources management system based on GIS includes: city water resources information digitalization, information resources pools, which is easy to access and query, and water resources simulation and optimization models, which could simulate the decision procedure and validate the decision scheme.

C. The System Construction Scheme

This GIS of water resources evaluation mainly consists of: spatial information database, remote sensing information database, attribute database and some application software about all kinds of data management.

1) Spatial Information Database: Including basic map database and thematic electronic map atlas. Basic map database adopts 1:250,000 national system data. It consists of canton outline, city, residential area, river, lake, reservoir, roads and so on [6]. Thematic electronic map digitizes profesional geographic data, which is produced according to the need of water resource and ecosystem description, matching and stacking basic electronic map. It consists of : all kinds of water conservancy arrangement, all levels of drainage areas outline, hydrologic station, precipitation station, evaporation station, water quality inspection station, water body function zone and so on.

2) Remote Sensing Information Database: It processes with data by remote sensing based on spatial information database, and constructs remote sensing images and ecosystem images to work with the related basic geographic data.

3) Attribute Database: It is constructed based on water resources and ecosystem integrated information. It consists of social economic condition, water resources situation, water conservancy condition and so on.

4) Query Terminal System of Water Environment Evaluation: For internal users, it mainly manages attribute database, spatial database, and their related information, which is based on C/S structure. On the other hand, the model for external users based on the B/S structure could provides comprehensive query about water environment through Internet.

IV. Decision Support Sub-System

This decision support system is composed of water environment evaluation sub-system, water resources overall planning sub-system and so on. Water environment evaluation sub-system gives great contribution to the information management, spatial analysis and scheme evaluation in the decision support system.

A. Information Management

This decision support system combines GIS and database management system, which carries out interactive management between characteristic data and spatial information. It achieves informationized management to surface water and groundwater resources, water resources quality, the total exploitable amount, return water quality and water quantity data of construction projects; provides supplementary decision support for decision-makers [7]. It strengthens people's comprehension to information, by information management visualization.

B. Spatial Analysis

Spatial analysis produces new characteristic information through overlaying vector graphs. For instance, given related valleys irrigation distribution diagram, precipitation station distribution diagram and rainfall volume data, the decision support system could produces the rainfall distribution diagram of different irrigating districts by spatial analysis of GIS, which overlays rainfall distribution diagrams and irrigation distribution diagrams. By the same method, we could get the groundwater exploitation of irrigation districts, with the help of groundwater exploitation diagrams and irrigation distribution diagrams. Given these diagrams, we could get the staggered water-demanded of different irrigation areas, while the crop distribution and production functions are taken into consideration. This process is showed in Fig 3.

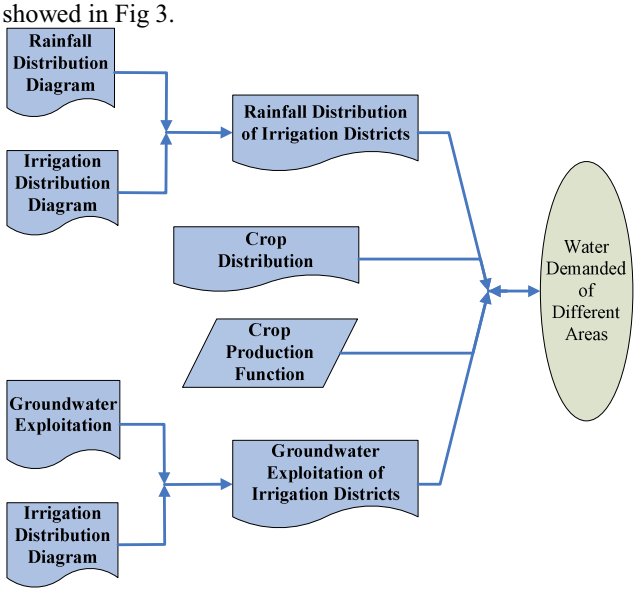

Figure 3. Water Demanded of Irrigation Areas by Spatial Analysis

C. Scheme Evaluation

Scheme evaluation is a key process in the decision support system. It aims to provide a direct and easy decision way to the leaders, by integrating a great deal of result information. In this decision support system, water resources evaluation subsystem plays summarization, comparison and analysis about the district rainfall, the groundwater resources measurement and the water resources exploitation etc, which gives reference to water resource evaluation. After that, water environment overall planning subsystem adopts historic evaluation, present condition analysis and other

methods to make out an optimized scheme. This operating process is showed in Fig 4.

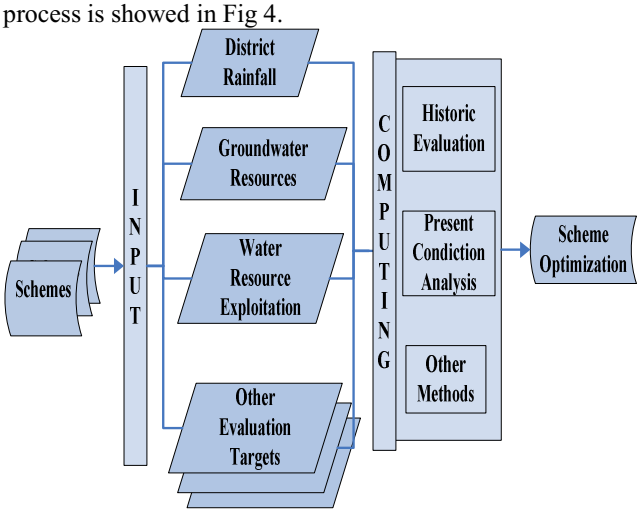

Figure 4. Operating Process of the Decision Support Sub-System

This subsystem posses multiple functions such as comprehensive analysis, project drawing up and crossed evaluation, which provides great help for the water resources overall planning. It also lends great support to adjustment, redaction and integration of water resources policy and professional plans.

V. CONCLUSION

We propose a management information system based on GIS for water resources environment evaluation in this article. The system functional framework and physical architecture are presented at first. And then we introduce GIS and RS techniques adopted in this system. Finally we show the great potential and importance of this system in the area of water environment management through the decision support subsystem. All in all, water environment evaluation system based on GIS offers mighty support to water resource comprehensive management, water resource exploitation and water pollution control. It is a successful application of information technology in water resources management.

However, the constructing of MIS for water environment evaluation is a rather complicated project, which needs great expense and long time. The system constructing cannot complete at once but progress step by step. And it would be improved gradually. Problems are found and solved during its application, which make the system more feasible and practical.

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