The seamless integrating technology of GIS and Management Information Systems (MIS) for water resources

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Abstract Four schemes for integrating GIS with water resources MIS are proposed in this paper, and their advantages and shortages are described in detail. A ComGIS-based MIS of water resources has been established by using a ComGIS called SuperMap III. The architecture and functions of this system are discussed. It is beneficial to explore the integration of ComGIS with MIS for water resources, and this kind of integration has important referenced significance for solving any other integrating problems between GIS and other professional applications.

Keywords ComGIS; GIS (Geographic Information System); MIS (Management Information System); system integration; water resources

INTRODUCTION

GIS has been applied in the field of Management Information Systems (MIS) for water resources in recent years. The main problem is how to integrate GIS with water resources MIS. Although many specialists have studied the problem and built some application systems (Weng, 2001), most have either relatively powerful GIS analysis functions or professional model analysis functions. GIS and water resources MIS have not been integrated seamlessly and effectively (Chen, 2002). On the one hand, it is very difficult for the developer of traditional MIS for water resources to integrate GIS with MIS because they have little GIS knowledge; on the other hand, it is relatively difficult for the GIS developers to understand the different kinds of professional models of water resources management. The main difficulty for them is that traditional GIS software does not provide the programming interfaces for different professional models. Focusing on these problems, we have studied in detail the technical feasibility of schemes for integrating GIS with water resources MIS seamlessly, and proposed four technologically feasible schemes. The problem can be resolved to some extent using the technology of COM (Qian, 2002). The integrating sample system built using ComGIS has demonstrated this.

FOUR SCHEMES FOR INTEGRATING GIS WITH WATER RESOURCES MIS

Integrating scheme using extending GIS platform software

This is the easiest way of seamlessly integrating GIS with water resources MIS (Fig. 1). Any analysis functions of water resources management can be embedded into the
extending GIS platform software easily by use of programming languages provided by GIS software, such as the Avenue language of ArcView and the MapBasic language of MapInfo (Bao, 2000). After the water resources analysis modules have been embedded into the extending GIS platform software, this GIS becomes the GIS application software for water resources management (Wu, 2000). But, the software of only a few GIS platforms can be readily extended like this, and it is not easy to learn a new programming language that is not used by many people. These types of programming language are always not very efficient or powerful. It is not comfortable that they are used to develop complex GIS-based water resources MIS. Therefore, few people now use this approach.

**Integrating scheme using single GIS COM**

The technology of COM has been used widely in many fields, including GIS, in recent years. There are two kinds of GIS COM: GIS single COM, and ComGIS. Many famous GIS single COM systems, such as MapObjects of ESRI, MapX of MapInfo, and GeoMap of GeoStar, are currently used to integrate GIS with water resources MIS (Zhao, 2002). This kind of single GIS COM includes most of the basic GIS analysis functions, such as spatial query and statistical analysis functions, and spatial analysis functions. The system developers can use any of these functions, and even use them in water resources analysis modules. The technology of COM makes it relatively easy to realize most of the basic GIS analysis functions and makes it possible for experts of water resources management to also integrate GIS with water resources MIS (Fig. 2). The system developers can use any kind of familiar programming language that supports the COM technology to develop integrating systems (Marble, 2000). The disadvantage is that you must buy the single GIS COM even if you do not really need so many GIS functions. This is the main current way of integrating GIS and water resources MIS.

**Integrating scheme using ComGIS**

ComGIS is comprised of many GIS COMs that have different functions, such as a COM for map editing, spatial analysis COM, etc. ArcObjects and SuperMap III are well-known ComGIS software. The system developers can buy and use any GIS
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Traditional MIS of Water Resources

Single GIS COM-Based Modules

Water Resources Analysis Modules

GIS COM-Based MIS of Water Resources Management GIS Software

Fig. 2 Integration using the single GIS component.

Traditional MIS of Water Resources

GIS COM1-Based Modules

GIS COM2-Based Modules

Water Resources Analysis Modules

GIS COMs-Based MIS of Water Resources Management GIS Software

Fig. 3 Integration using ComGIS.

COMs according to the needs of their integration system. It is very convenient for the system developer to integrate different kinds of GIS COMs, which have different GIS analysis functions, with water resources analysis modules (Fig. 3). This type of integrating scheme has more flexibility and can save a lot of money because the users only need to buy the COMs required by their own integrating system. Figure 3 shows that many modules, which use different GIS COMs such as COM1, COM2 and so on, and water resources analysis modules have been integrated seamlessly to form a ComGIS-based integrating system.

Integrating scheme using purely COM technology

Both GIS and other analysis modules of water resources MIS have first been made into components. We can establish any kind of integrating system seamlessly, according to our needs, by assembling the components of GIS and water resources management simply (Fig. 4). This integration is the topmost goal for integrating GIS with water resources MIS, but it will be difficult to achieve in the near future because of many commercial and technological factors.

SAMPLE SYSTEM FOR SEAMLESSLY INTEGRATING GIS WITH WATER RESOURCES MIS USING ComGIS

It is obvious that water resources MIS always need some of the GIS analysis functions, such as displaying maps of the research area, spatial queries and spatial analysis (Zhao,
If these functions have been made into separate GIS components by the GIS software company, system developers could embed the GIS components into the integrating system easily, even if they are not very familiar with GIS. Although most system developers are using the single GIS component to develop GIS-based water resources MIS at present, in the near future they may use ComGIS because of its convenience and economy.

A sample system seamlessly integrating GIS with water resources MIS has been successfully established using the well-known ComGIS: SuperMap III (Fig. 5), which is made up of eight components. Six main GIS components have been used in this system, including supermap, superworkspace and superlegend, etc. Most basic GIS functions, such as editing, displaying and outputting maps, spatial queries and spatial analysis (including buffer analysis, overlay analysis and Digital Terrain Model analysis), have been embedded into the integrating system seamlessly.
Because that there are no water resources management components at present, the water resources management analysis functions can be embedded into the integrating system as relatively independent modules (Zhu, 2003). There are three main water resources management analysis modules in the system: the calculation module, forecasting module and optimal water resources management module. The calculation and forecasting modules can calculate or forecast water quantity, water level and water quality, respectively. The optimal management module includes common methods that couple the calculating and forecasting water resources models with the optimization water resources management models. They are the embedding method and response-matrix method. The integrating system also includes some other models for calculating, forecasting and managing water resources, e.g. the model of two-dimensional steady and unsteady water flow for calculating and forecasting water quantity and water level, and the Linear programming model for optimal management of water resources. The final users can choose the appropriate calculating methods and models according to their actual needs to solve different kinds of professional problems easily.

CONCLUSIONS

Four approaches to integrating GIS with water resources MIS seamlessly are proposed in this paper, and the advantages and disadvantages of each integrating scheme are discussed in detail. Integrating GIS with MIS of water resources by use of single GIS components or ComGIS are the main seamless integration methods at present. A sample seamless integration system has been established successfully using ComGIS, demonstrating that this integration method is feasible and has a lot of advantages.

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