RESEARCH OF THE LAND MANAGEMENT INFORMATION SYSTEM BASED ON WEB GIS AND SPATIAL DATABASES FOR PROVINCIAL AND LOCAL GOVERNMENTS IN CHINA

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ABSTRACT: Over the past few years, government agencies at national, provincial and local levels have given much attention to the development and implementation of land management information system (LMIS). In this paper the functions, structures, key technologies and the methodologies of development of LMIS in China are described. By analyzing the up-to-date techniques of Web GIS and spatial DBMS, the state and local levels of modern land management information systems are designed. To assist in elaborating the methods of implementation of LMIS, a typical LMIS at county and state levels based on MapInfo MapXtreme and Oracle 8i is introduced.

INTRODUCTION

Because all the procedures of land management depend on the geo-spatial information and are related to the laws, policies and rules, many modern techniques such as GIS/LIS, DBMS, computer science, intranet/internet technology, office automation (OA), and so forth must be applied to the development of LMIS (Coleman and McLaughlin 1998; Zhao 1999). By use of the LMIS most of the daily work of land management can be accomplished efficiently, safely and successfully. Meanwhile LMIS could provide the richness of date/information to the government agencies for the decision-making and everyday management work. LMIS can also provide the services to other departments of the government agencies, such as urban planning, facility management, tax collection, and so on (Land Victoria 1997; China is the largest developing country in the world, and the conflict between land use and population is very serious. It is therefore technically difficult, but also very important socially, economically, environmentally and politically to manage land resources, land uses and land activities efficiently (Zhao 1995, 1998).

The research and implementation of the LMIS based on the Web GIS, Intranet/Internet technology and spatial DBMS is in the trial stage in China. Up to now, only a few of LMIS are developed in some local government agencies in China. The reasons behind the difficulties of implementing the new LMIS include the following. Firstly, due to lacking of experiences combined with seeking to work at the level of advanced techniques, problems in the functionalities of software packages used for land data/information processing were encountered. Secondly, the data was in various formats in different systems. Thirdly, spatial data and land registration were still largely processed by manual systems. Last but not the least, few LMISs had the abilities of the office automation and were based on the technology of Web GIS.

This paper briefly describes the structures, functions and features of the new generation of LMIS. The technical difficulties of the development of LMIS are overviewed. To assist in elaborating the methods of development and implementation of LMIS, a typical LMIS based on MapInfo MapXtreme and Oracle 8i is summarized.

STRUCTURES AND CHARACTERISTICS OF LMIS

LMIS in China has four levels, national, provincial, city, and county level LMIS (Zhao 1999). Each level of LMIS consists of subsystems of cadastral management, land use planning, land use management, document management, land use control, land inventory, etc. And the data/information of land management should be shared and transferred among different levels of LMIS.

As all the other subsystems need to use the spatial and attribute data of cadastral, the cadastral management is the core of the LMIS. While LMIS is developed the following factors must be considered. First, the methods to get and process spatial data as well as attribute data, and ultimately create databases, must be studied. Second, the data flow, workflow and user's requests of LMIS should be carefully analyzed. LMIS should meet the needs of office automation (OA), Intranet/Internet based and "without paper office" in the departments of land management. Meanwhile, the systems should have the properties of user-friendly interfaces, and easy to use. Moreover, as the large quantities of land data/information, and changes to land use are very common, some technical difficulties to develop a successful LMIS are
listed as below.

- Management and application of the large amount of geo-spatial data and the spatial databases in LMIS;
- Design and implementation of Web-based LMISs on Intranet/Internet for provincial and local governments in China;
- Research of the methods of the update, application, integration and distribution of geospatial data in LMIS;
- Study of the criteria, classification and coding, metadata and management of data/information in LMIS.

We solve these problems by use of spatial DBMS such as Oracle 8i, Informix, Web GIS and Intranet/Internet technologies. In addition, the institutional and systematic peculiarities of land management in China should also be deeply studied.

As mentioned above, LMISs in China have four levels. They are national, provincial, city and county level LMIS. Up to date there are no national even provincial LMISs developed in China, although they have been put into the agenda. Considering from the investment, technologies and time frame, it is very difficult to build a complete LMIS suitable for land management at national or provincial level at present. It is more reasonable and appropriate, instead, to develop LMIS at local/regional (city and/or county) level and then progress to provincial level. And if carefully organized, a provincial-level LMIS could be the basis for a national LMIS plan and implementation. Several years ago we did a project trying to develop a cadastral management and land registration information system, named CMLRIS, which was implemented and widely applied to the bureaus of land management of counties and cities in Yunnan and other provinces in China. At present we are upgrading this system to a true LMIS to county and city level. The outlines of the LMIS we designed and are implementing can be shown in Figure 1 and Figure 2.

![Diagram of LMIS at state level](image)

**Figure 1: The LMIS at state level**
THE TRENDS IN GIS/LIS AND SOFTWARE DEVELOPMENT

With the development of information technology and GIS/LIS, we have more powerful tools and good solutions for the establishment of the LMIS. The trends of GIS/LIS and software development can be summarized as following:

- The GIS based on the spatial DBMS make it possible that spatial data and attribute data can be combined seamlessly. And all the spatial data, attribute data and raster images can be stored in only one central database without map files, that make database maintenance easy, safe and simple. These types of DBMSs include Oracle 8i, Informix and many others.

- Component GIS totally changes the implementation methodologies of geographic information systems. Users can purchase the GIS components but whole GIS platform from different vendors of GIS to implement their own systems. It makes the systems much more powerful and flexible. And if users want to update their systems they only need to replace some of the GIS components.

- Data sharing becomes easier than ever. On the basis of computer networking authorized agencies, companies and privates could be registered to operate the databases. And the spatial and attribute data can be issued on the Internet/Intranet as well.

- Open GIS make it possible that multi-resources of data can be integrated into one system. The spatial data, image data and attribute data can be stored in the same DBMS that supports different GIS platforms. So different GIS software could share data/information from the same database.

- Most of the implementation of a system is related to DBMS, but not considering the GIS platforms. So the cost of software development can be decreased, and maintenance of the system becomes easier.

- The technologies of Web GIS are more and more reliable and stable. Many software packages of Web GIS can be used such as Geomedia Web Map from Intergraph, MapXtreme from Mapinfo, Internet Map Server from ESRI, Map Guide from Autodesk, and so on.

![Diagram of LMIS at County level](image-url)
DESIGN AND IMPLEMENTATION OF MODERN LMIS IN COUNTY AND STATE LEVEL

While a LMIS is designed and implemented, the data (spatial and attribute) flow and workflow must be firstly studied (Rough 1997). Then the component GIS, Web GIS technology, GIS platforms, as well as the spatial DBMS should be deeply researched. The logic model and the strategies of the development of the LMIS should also be formulated. All the subsystems of the LMIS and their functions and the whole land management computer networks should be designed carefully. In addition the following factors should be considered while a LMIS is designed and developed.

(1) The methods of the integration between GIS and MIS should be researched so that the LMIS has the abilities of office automation (OA), spatial data processing and management.

(2) In terms of the characteristics that land information changes rapidly, the ways and mechanisms to update the spatial or mapping data and the related attribute data of LMIS should be given. So that the LMIS always has the up-to-date data/information, and the ways to query the historic data/information.

(3) According to the relationship and workflow of the departments of the bureau of land management, the levels and rights of the operators or users should be given to assure the system to run safely and successfully.

(4) The methods to connect the LMIS on Intranet/Internet should be researched, so that the publics and other departments can query the data/information of land management. And it is the basis for the land registration, land exchange, information transfer and remote office on the Internet.

(5) The strategy to develop the LMIS is to develop the low level LMIS first, then to the higher level. The qualities and integration of the spatial and attribute data should be controlled.

(6) The national, provincial, local and industry standards, as well as the coding and classification should be executed. So that the data transformation and sharing can be successfully and smoothly finished.

On the basis of the above analysis and discussion, the structures of the LMIS we designed for the county and city level is shown in Figure 3.

Figure 3: The LMIS based on the MapXtreme and Oracle 8i
CONCLUSION

The development of the land management information system (LMIS) based on the Web GIS, spatial database and Intranet/Internet is in the trial stage in China. On the one hand, due to the lack of the mature technology and successful experiences, few of LMISs that used Web GIS and spatial database technologies have been successfully developed and implemented yet in provincial and county level. On the other hand, along with the socio-economic development of China, most of the provincial and local governments have the urgent needs for the establishment of LMISs.

To promote the development and application of the LMIS in China, the methodology, structures and the key technologies of LMIS should be researched. And in association with developing LMIS, it appears fair to say that the research program has also contributed to improvements in the functions of GIS/US and spatial DBMS, the progress of computer, information, Web GIS and land management science, as well as to the development of land administration policies and procedures in China. It is therefore expected that LMIS will continue to be developed and implemented, since it is likely that local, provincial and ultimately national land management information system networks must be established in China to manage the country's land resources and realize the office automation.

REFERENCES