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The Open Cybernetics & Systemics Journal, 2015, *9*, 105-109 105

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Study on "One Map" Organizational Model for Land Resources Data Used in Supervision and Service

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Abstract: Featured by diverse formats, sources, platforms and mathematical bases, the land resources data belong to a typical heterogeneous data warehouse. It is very important to establish the organizational model for land and resources management and supervision of resources. After thoroughly analyzing the characteristics of land resources data, this paper puts forward the establishment of "One Map" organizational model for land resources data used in supervision and service in four principles, that is, "comprehensiveness, integrity, sharing, timeliness" to analyze the characteristics of update and sharing relationship between the "One Map" database with Business Database, Monitoring Database and Index Database. Taking Chengdu city as an example, the ETL and data update management technology are employed to construct the initial "One Map" database and realize its update management. In this way, "One Map" comprehensive database is constructed with the full coverage of space, business and sector, which have covered more than two kinds and 51 items of land and resources data. In addition, these have covered 160 key elements, more than 90 million records and up to 3TB data so as to provide the data support and information service for analysis of land and resources management and supervision of resources.

Keywords: Four principles, Land resources, One map, Supervision and service.

1. INTRODUCTION

Ever since it was commenced in 1998, the informatization of land and resources has accomplished fruitful achievements by carrying out survey and evaluation on governance management and informatization of social services in an all-round way based on the construction of Golden Land Project, "Secondary Survey" and " One Map", which realized the network for administrative examination and approval and openness of government affairs, and preliminarily established the comprehensive supervision platform of land and resources and the basic framework of "One Map" database [1]. Land resources data lay the spatial information basis for the informatization of land and resources and are applied in all the links and aspects of land and resources business process [2]. Thus, building the database with unified standard and sufficient data is the key to informatization.

The business of land and resources involves monitoring arrangement, survey & evaluation, planning, utilization and protection, etc. to obtain all kinds of basic data and special data covering land resources, mineral resources, geological environment and comprehensive affairs management for the matters of "acquisition, supply, application, guarantee and investigation" [1]. All data are constantly increased and improved along with business handling and demand changes [2]. Hence, it appears very important to establish the stable, efficient and scientific organizational model for data and management of all kinds of basic as well as specific data in the overall manner [3-8]. As one of the first pilot cities for China's "Golden Land Project", Chengdu City officially started the construction of "One Map" comprehensive supervision platform for land and resources in 2009. Based on the achievements and basic practice of constructing the "One Map" database, this paper proposes to organize the management of "One Map" database in four principles, that is, comprehensiveness, integrity, sharing and timeliness, so as to realize the full coverage of information service in terms of space, business, type and range.

2. DATA AND ORGANIZATION OF "ONE MAP"

2.1. Data of "One Map"

Building of the "One Map" database has the ultimate goal to serve the management of land and resources and employ science and technology for supporting and organizing the management of land and resources. For this reason, the data of "One Map" must follow the management objectives of land and resources to form a comprehensive database with the full coverage of space, business and sector [4, 9, 10]. This database is classified into non-spatial and spatial data in terms of type; into non-business and business data in terms of content; into survey data and examination & approval data in terms of source; and into basic and specific data in terms of use. The main contents of "One Map" database are shown in Table **1**.

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1874-110X/15

Table 1. Construction contents of "One Map" database.

Classification	Contents	Remarks
Basic Data	Basic geographical data (administrative divisions, water system, traffic, landform and terrain), remote sensing image, rural land survey, urban land survey, etc.	Basic data refer to the basic and important non-business data.
Business Data	Land utilization planning, farmland acquisition data, land supply data, land utilization data, cultivated land protection, land law enforcement, geological environment and mineral resources	Business data refer to all kinds of business management data generated in the daily management of land and resources.
Monitoring Data	GPS field survey data, remote audio & video, rainfall monitoring, groundwater level observation, land displacement monitoring, video surveillance, etc.	Monitoring data refer to the business or survey data obtained in the real-time manner or dynamically through all kinds of sensors.
Index Data	Total amount of cultivated land, total amount of construction land, number of suspected violation cases, quantity of land registrations, quantity of mortgages, amount (or households and area, etc.) granted in cultivated land guarantee fund, and land area price, etc.	Index data refer to the specific figures that can reflect or measure the management objectives of land and resources, and are often classified into single indexes and compound indexes.

"One Map" database contains comprehensive data. It is constructed by gathering, sorting out, extracting, uploading and converting all kinds of land data into different categories, with different contents, from different sources and for different uses. Due to the sufficiency and diversity of all data, the database is made a typical heterogeneous data source. Moreover, it is very difficult to sort out and classify the data, so it is necessary to consider it comprehensively in an orderly and hierarchical manner and make good use of the existing achievements of informatization. Hence, all kinds of data must be sorted out in four principles, namely, comprehensiveness, integrity, sharing and timeliness, while establishing the "One Map" database.

(1) Comprehensiveness means that the database should not only cover the basic management of land and resources, *e.g.* land survey, remote sensing image and basic geographical data, etc., but also involve such businesses as cultivated land protection, land utilization planning, rural property ownership reform, mineral resources planning revision and compilation, prevention and reduction of geological hazards, etc.

(2) Integrity means to supervise the whole life cycle of each parcel in the management of land and resources, including the whole process from formation and circulation of parcels to termination, and establish the connections of data in various land businesses to form a unified whole according to the requirements for "quantity, structure, layout and sequence".

(3) Sharing refers to the joint utilization of achievements in the management of land and resources. Internally, the achievements of land acquisition can serve land supply and land utilization, while the achievements of land supply and land utilization can serve land acquisition as well. Externally, all kinds of data or information are converted by integration of resources and processing into standard or normative information service products and can be used according to needs and authority.

(4) Timeliness refers to the dynamic and timely update of "One Map" database according to the features of data and the demand of business management. The modes of data update are established for data of different types, sources and businesses to guarantee the timeliness of data and timely learn about the current state of land and resources utilization and its changes.

2.2. Relations between "One Map" Database and Business Databases

"One Map" database is constructed in four principles, so it is not a simple copy of business databases and there is not any relation of containing. Comprehensiveness reveals that "One Map" database covers all the sectors and businesses [11-13]. Integrity means to supervise the life cycle of each parcel on the basis of comprehensiveness, identify the relations among sectors and businesses, and establish the connections between "One Map" database and business databases and among businesses, so as to build a large comprehensive data warehouse featured by "physical separation but logical integrity". The relations between "One Map" database and business databases are shown in Fig. (**1**).

While building the organizational model for "One Map" database, it is necessary to protect the existing investments in informatization, prevent any repeated work and maximally utilize the existing achievements. Hence, all business management systems should be reserved together with the management and application of their supporting databases in various businesses. The ETL technology of data is employed to extract the spatial information of achievements in various businesses and capture the key and important data. The quality of data is inspected according to the regulations for building the "One Map" database before uploading the data into the database. In the operation and application of various business systems, "One Map" can also support these businesses. Taking land supply business as an example, it is necessary to calculate and analyze whether a parcel to be supplied satisfies the plan and whether the current ownership of the parcel matches with the actual information, etc. Thus, "One Map" database can be utilized to automatically extract the remote sensing images from the data of business

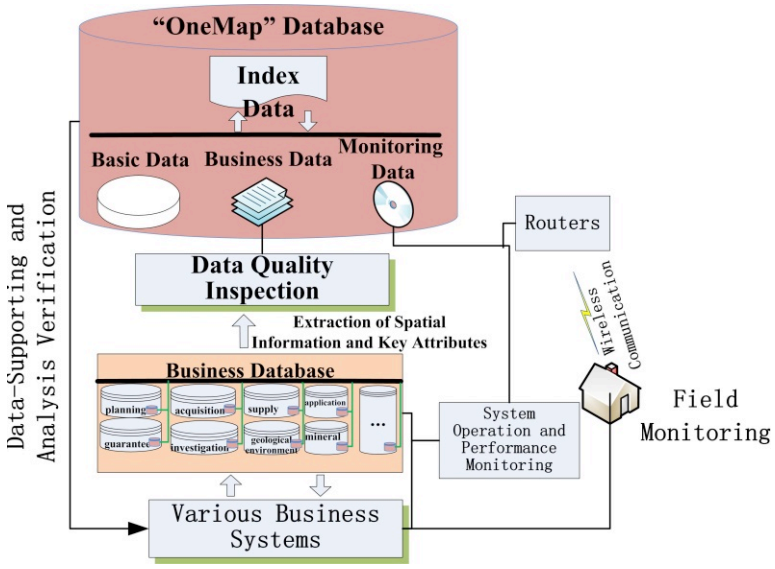

Fig. (1). "One Map" database and business databases.

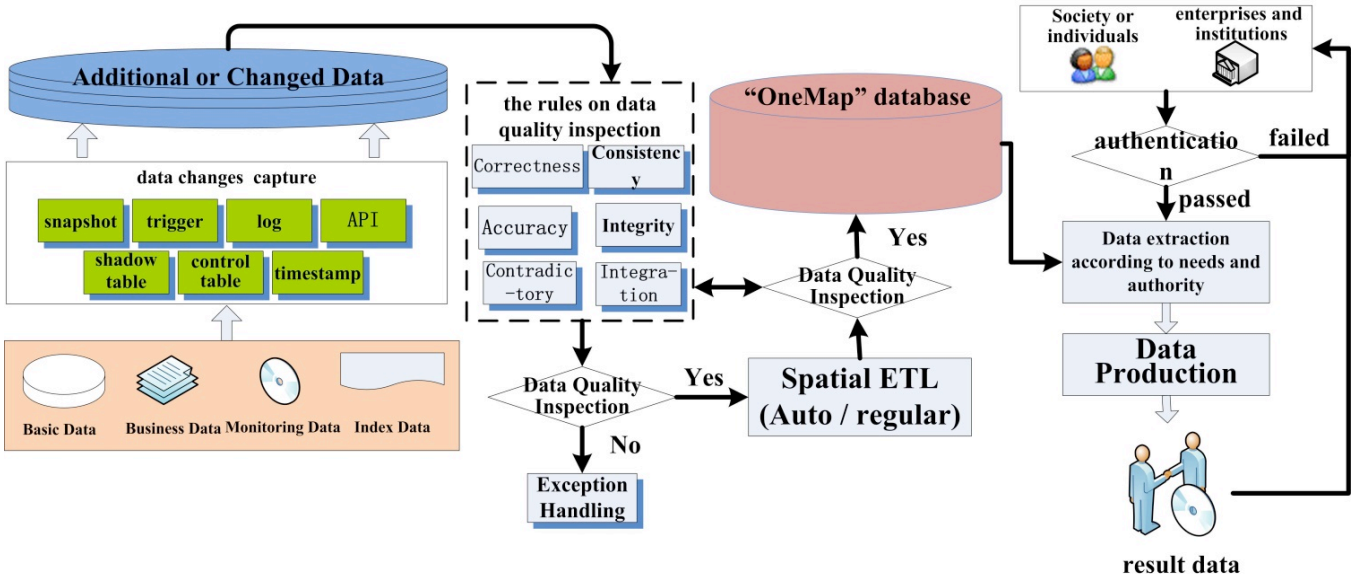

Fig. (2). Update and sharing model of "One Map" database.

achievements including land acquisition and the basic information including current state of land utilization, land use planning, range of land available and acquired land, etc., so as to provide the supporting data for business handling.

2.3. Data Update and Sharing of "One Map"

"One Map" database is not isolated. Keeping the timeliness of data is the research focus at home and abroad and also the core of organizational model for "One Map" database [11, 14, 15]. Along with the handling of businesses related to land and resources, all data are constantly updated and increased, and all business data are closely related to the "One Map" database. Thus, it is urgently necessary to realize the dynamic update between business databases and "One Map" database and maintain its timeliness as shown in Fig (**2**).

In their research, Yang *et al.* [16] claimed that data changes are captured mainly in 7 ways, that is, snapshot, trigger, log, API, shadow table, control table and timestamp. Based on the features of "One Map" database, one or several ways are developed or utilized to extract additional or changed data, and the quality of changed data is inspected according to the rules of data quality inspection. After inspection, the ETL technology is utilized automatically to upload, convert and store the qualified data into the "One Map" database, so as to realize the linked or real-time update of the "One Map" database. To guarantee the consistency and integrity of "One Map" database, data quality inspection is carried out again after the ETL processing.

The data of the core research results of informatization not only possess the important properties of resources, but also very important economic and social benefits. By employing data encryption and processing technology, the "One Map" database can realize the sharing and use of its data according to needs and authority, so that the achievements can eventually provide data service and information product for society, individuals, enterprises and institutions.

Table 2. Statistics of "One Map" data update.

Type of Data		Mode of Update	Update Period	Amount of Data ('0000 pcs)	Annual Growth ('0000 pcs, %)
Basic Data	Urban Land Survey	Incremental	Daily	77.72	20%
	Rural Land Survey	Centralized	Annual	1315.67	0.23
	Remote Sensing Image	Centralized	Annual	0.56	0.2
	Basic Geographic Data	Centralized	Annual	464.45	15%
Special Data	Land Utilization Planning	Centralized	Irregular or Annual	5997.61	5%
	Urban Planning	Centralized	Irregular or Annual	10.25	Irregular
	Farmland Acquisition Data	Incremental	Daily	0.32	Irregular
	Land Supply Data	Incremental	Daily	0.12	Irregular
	Land Utilization Data	Incremental	Daily	128.66	Irregular
	Cultivated Land Protection	Incremental	Daily	5997.61	0.1
	Land Law Enforcement	Incremental	Daily	4.21	20%
	Geological Environment	Incremental	Daily	0.58	20%
	Mineral Resources	Incremental	Daily	0.05	Irregular

3. DATA STORAGE AND DATABASE CONSTRUCTION

By analyzing the "One Map" database in four principles, this paper puts forward the organizational model for "One Map" land resources data and it is also necessary to realize the stable, efficient and scientific data storage and construct the database. Based on the features of "One Map" database and the needs of its platform construction, the Oracle database of version 10.2.0.4 is utilized. Spatial vector data are stored and managed in the Oracle Spatial mode while grid data are stored and managed in the Oracle GeoRaster mode [17]. Database server is IBM3850, connected to the independent storage system through fiber exchange. Large amount of data or highly increasing data employ the Oracle partition technology, and independent table space is utilized separately. For historic data with low frequency of change, the read-only table space is utilized to improve the efficiency of data utilization and search. View mechanism is used to logically separate the data storage from data application, so as to further guarantee the safety and application efficiency of data.

All kinds of land resources data are scattered in multiple sectors, business systems and supporting databases and are featured by different formats, coordinate systems and sources, etc. Taking Chengdu City as an example, the "One Map" database contains vector data, DOM data, DEM data, Meta data, 3D model data, text data, worksheet data and multimedia information, etc. Among them, vector data consist of such heterogeneous data sources as Oracle Spatial, VCT, MapInfo, Autocad, Microstation, GeoMedia Access and MapGIS, etc. Moreover, different data may have different mathematical bases, mainly including Beijing 54, Xi'an 80, Chengdu independent coordinate system and WGS84, etc. After these were completely sorted based on the organizational model for "One Map" land resources data proposed in this paper and put into operation in 2011, the "One Map" database and its update management system had realized 51 items of land resources data in 13 categories [1], and formed 4 categories of basic data regarding basic geography, remote sensing image, rural land survey and urban land survey and 9 categories of specific data regarding land utilization planning, urban planning, farmland acquisition, land supply, land utilization, cultivated land protection, land law enforcement, geographical environment and mineral resources. In addition, more than 160 key elements and 90 million records as well as more than 3,300 properties and up to 3TB data have been covered by the database and are still expanding at the annual growth rate of 20% ~ 30%. In the implementation process of data update, any data that is not updated in the real-time manner should be updated in free time at night to avoid busy hours and improve the efficiency and reliability of update. Meanwhile, it is necessary to dynamically monitor the operation indexes and performance of database, in order to timely adjust for perfection. The scientific and reasonable index fields are determined to periodically optimize the index. As proven in practice, the "One Map" organizational model for land resources data used in supervision and service can satisfy the current demand for big data management of land and resources and provide the powerful data support and information service for the analysis and decision in the management of land and resources and the supervision of resources, *etc.* as shown in Table **2**.

4. CONCLUSION

Land resources data form a typical heterogeneous data warehouse containing vectors, grids, multimedia and other information. All data are scattered in multiple sectors, business systems and supporting databases and featured by different formats, coordinate systems and sources. After analyzing the features of land resources data, this paper put forward

the "One Map" organizational model for land resources data used in supervision and managed in four principles, that is, comprehensiveness, integrity, sharing and timeliness, and utilized the ETL and data update management technologies to realize the initial construction and update management of "One Map" database. In this way, this paper constructed the "One Map" comprehensive database with the full coverage of space, business and sector, so as to provide the powerful data support and information service for the analysis and decision of the management of land and resources and their supervision, etc. As proven in practice, this research put forward the organizational model for the "One Map" data based on supervision and services, which satisfies the demand of the current administration for land and resources for constructing and managing the database, while reserving and improving the ability to apply the existing data and provide services. This will not only maximally protect the existing results of informatization, but also enhance the service level of data management and application of land and resources. Database possesses a very high economic and social value and is the core achievement of informatization. Thus, data mining and the optimization and improvement of dynamic data update mechanism and method, *etc.,* should be constantly explored and studied and full use should be made of the achievements of "One Map" database to achieve the delicate management of land and resources.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

The authors wish to thank Tao Chen, XiaoLin Li for their comments, which was helpful to improve the paper. This Work was supported in part by a grant from The Study on Dynamic Change Technology of Land Information Based on the Results of Second Land Resource Surver (project NO: 201111013-06) in the Special Fund Program of Scientific Research in Pubic Welfare Industry of Ministry of Land and Resources.

REFERENCES

[1] C. Fang, "*Study and Application of the Technology System for Land and Resources Supervision Supported by the Information Technology*", Ph.D. thesis, ChengDu University of Technology, Cheng Du, 2013.

[2] A. Verdoodt, E. Van Ranst, "Environmental assessment tools for multi-scale land resources information systems: A case study of Rwanda," *Agriculture, Ecosystems & Environment*, vol. 6, no. 2-4, pp.170-184, 2006.

[3] J. Zhang, "Preliminary exploration on of geographic metadata resources with a map," *Land and Resources Information*, vol. 6, pp. 48-53, 2012.

[4] L. Guo, "Preliminary Research on Collaborative Creation of the Platform in Relation to Public Services of Geographic Information with Establishment of a "Map" in the Service of land Resources", *Land and Resources Information*, vol. 1, pp. 49-52, 2014.

[5] X. Qu, G. Zhao, "About state land and resources on "a map" construction," *Land and Resources Information*, vol. 4, pp. 12-15, 2013.

[6] H. Li, J. Ma, N. Wang, "Research review on scientific data organization and management at home and abroad," *Library and Information Service*, vol. 57, no.23, pp.130-136, 2013.

[7] Y. Liao, B. Li, X. Lv, C. Cheng, "Method of multi-type disaster data organization and management based on GeoSOT," *Geography and Geo-Information Science*, vol. 29, no. 5, pp. 36-40, 2013.

[8] B. C. Pijanowski, A. Tayyebi, J. Doucette, B. K. Pekin, D. Braun, J. Plourde "A big data urban growth simulation at a national scale: Configuring the GIS and neural network based Land Transformation Model to run in a High Performance Computing (HPC) environment," *Environmental Modelling & Software*, vol. 51, pp. 250-268, 2014.

[9] P. Yin, G. Li, X. Cai, "Study on data organization model and management in the business of land management," *Land and Resources Information*, vol. 1, pp. 61-66, 2014.

[10] C. Fang, X. Chen, T. Chen, W. Yang, "A dynamic monitoring system for land and resources based on 3G and 3S technology," *Computer Applications and Software*, vol. 30, no. 5, pp. 22-24, 2013.

[11] J. Li, W. Wen, L. Tian, J. Nong, "Data organization method of object-oriented spatio-temporal data model based on process," *Science of Surveying and Mapping*, vol. 38, no. 5, pp.100-102, 2013.

[12] D. Zhao, Q. Zhao. "The fundamental GIS spatial data organization mode of digital shenyang," *Geomatics & Spatial Information Technology*, vol. 36, no. 6, 2013.

[13] J. Cheng, J. Turkstra, M. Peng, N. Du, P. Ho, "Urban land administration and planning in China: Opportunities and constraints of spatial data models," *Land Use Policy*, vol. 23, no. 4, pp. 604-616, 2006.

[14] F. Wen. "Research on data quality estimate in the course of data organization," *Software Guide*, vol. 12, no. 11, pp.132-134, 2012.

[15] C. Shen, J. Niu, Fang, "Quantifying the effects of data integration algorithms on the outcomes of a subsurface–land surface processes model," *Environmental Modelling & Software*, vol. 59, pp.146-161, 2014.

[16] M. Yang, G. Guo, N. Sun, "Research and comparison on the changes capture of heterogeneous database & its dynamic synchronization strategy," *Office Informatization*, vol. 176, pp. 35-37, 2010.

[17] M. Tian, X. Lu, Y. Zhang, J. Ma, "Realization of basic geography spatial database on cyber-city based on oracle," *Science of Surveying and Mapping*, vol. 30, no. 3, pp. 80-82, 2005.

Received: September 16, 2014 Revised: December 23, 2014 Accepted: December 31, 2014