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Spatial Aided Decision-making System for E-Government

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1 Building background and application status of the system

1.1 basic concepts of Spatial Decision-making System

Geographical Information System (GIS) is a new subject which rose in the 1960s, and is combined with computer science and geographic information science, and is also a technology system, it analyzes and manages geographic data contains spatial information using system engineering and information science theory under the support of software and hardware, and meets the need of planning, management, decision-making and researches. Decision Support System (DSS) generated in the 1970s, it is added to model base and management system based on Management Information System (MIS), is a computer system aiming at doing decision-making, and it provides decision support environment of analysis, model construction, decision-making simulation, decision evaluation for managers. With the development of its support scientific theory, DSS not only absorbs expert systems, fuzzy logic, neural networks, genetic algorithms, rough set techniques, etc, but also uses method base and its management system, knowledge base and management system to support intelligent decision-making.

Spatial Aided Decision-making System consists of spatial decision support, a number of interdependence and interaction elements of spatial databases. It is an organic whole for spatial data processing, analysis and decision-making. It is a really new information system on the basis of the combination of conventional decision support system and geographic information system. It transforms spatial data, extracts facts and relations which hides in the spatial data and expresses these using forms of graphics, tables, character, provide scientific and reasonable decision-making support for all kinds of applications in the real-world finally.

In order to adapt to the needs of information technology and enhance the level of administrative efficiency and decision-making, then realize optimization restructuring for government organizational structure and workflow, establish the government and the public electronic interactive channels, at last to achieve the development of national economic and social information, the government manage administrative departments use modern information technology roundly which is a new mode of management and

organization providing quality services to the public, this is so-called e-government. The research and application of domestic and international e-government proved that more than eighty percent of integrated business management and decision support activities in e-government are associated with geo-spatial distribution. Therefore, the geo-spatial information and spatial support decision-making technologies have become an important content of e-government construction and applications, and its main functions are as follows:

(1) E-government is the basis of diverse government information relationship. Almost all government affairs are related to spatial location: in macro view, activates such as resources, environment, economic, social and military all take place in a certain area on Earth. In medium view, environmental protection, traffic, population, commerce, taxation, education, health care, sports, culture and heritage charged by government all have a specific location. In tiny view, social services also take place in specific locations, such as financial-commercial site, tour place, schools, hospitals and public transportation site. So it can be said that the majority of government affairs are related to locations, location is government information's integration basic.

(2) E-government is means of various types of government information visualization. Aiming at characteristics of management information targets, it can realize visualization of multi-dimensional spatial data processing and analysis process, multi-dimensional dynamic expression and process simulation of spatial phenomenon through spatial information visualization technology, which provides technical means for users to understand spatial information location features, the relations of composition and data quality.

(3) E-government is the platform associated with attribute information. By connecting a variety of professional information related to geographic information, comprehensive information applications can be formed through geo-coding technology. Similarly, collaborative information network of sharing data for that professional information based on relational database, which has no spatial orientation, can be also formed.

To sum up, the integration of spatial decision-making technology and e-government technology using GIS and DSS as the core can provide spatial quantitative analysis and scientific decision-making tools for government management.

1.2 Characteristics and key technologies of spatial aided decision-making system

Compared to general decision-making system, spatial aided decision-making system has five main differences:

(1) Different forms of data: spatial data refers to natural, social and cultural economic data which uses earth's surface spatial location as reference. they can have graphics, images, text, tables, and digital form with some attributes such as coordinates, location relationship and properties;

(2) Different ways of gaining information: spatial data have special access of gaining data, they are input to spatial information system through hardware devices such as digitizers, scanners, or image processing system and their corresponding input-driven software;

(3) Different decision-making models: there are many spatial models in Spatial Decision-making System, spatial models sometimes can be transformed into non-spatial

model to compute, and non-spatial model can be transformed into spatial model through implementing the model in each spatial unit.

(4) Different output results of decision-making: most of spatial decision-making system results are graphics, images, forms, etc.

(5) Different system structure: it is added to GIS spatial database and database management systems.

Due to these features, the construction process of spatial decision-making system will involve a number of high technology, such as computer technology, information technology, network communication technology and spatial information technology, in those technologies, new search engine, data mining technology, mass data management, comprehensive application technology of 3S (GIS, RS, GPS) and four-dimensional or three-dimensional virtual reality technology have developed very rapidly, the application foreground becomes explicit gradually.

Regarding to new search engine: collect and find information using a certain strategy in the Internet, understand, extract, organize and process the information, provide retrieval services for users, and realize the purpose of information navigation. New search engine contains the natural language understanding technology, XML extensible markup language and intelligent search engine technology; more accurate search technology is the core of intelligent search engine, which contains intelligent search, personalized search, structured search, vertical search, and localized search.

About Data Mining: With the development of computer and Internet technology, data resources are becoming richer and richer. However, the knowledge which is in data resources is not be fully excavated and used until now, the problem of "rich data but poor knowledge" is serious. The technology of data mining brought a ray of hope to solve the problem in recent years. It can reason the data and extract information from large amount of data to find some new interesting links; it is the extension of new knowledge discovery study in the database system.

In connection with massive data management: mass data storage and Internet are two important factors for database technology, it is already cannot meet the people's need using memory and external memory secondary storage of computer, so we need to use three-level data management. It should adopt different strategies for large database access and management, at the same time there is a big new problem to search and browse data in such a large database, so in some respects we must reconsider or abandon the intrinsic concepts and methods.

About integrated application technology of "3S": spatial information technology will come through a great development period in the next few years, satellites observes the Earth firing continuously provide up-to-date spatial data, and there is no need to translate the map to enter the GIS database, the commercialization of high-resolution satellite imagery will change the strategic position of vector map.

Regarding to technologies of three-dimensional, four-dimensional and virtual reality: from two-dimensional to three-dimensional and until virtual reality, from symbolic system to visualization, naturalizing landscape and even using natural language to interact, this kind of technology enable people to enjoy the results of modern IT technology with natural forms. Time dimension makes GIS change into four-dimensional spatial-time system.

About Decision support system: it finds necessary data from database and produces needed information systems for users applying mathematical models. It is mainly used to solve

problems, such as computer organization automatically, the operation of multi-model, so as to achieve a higher level of decision-making capacity.

1.3 Spatial aided decision-making systems pattern and operational mechanisms

The operational pattern of spatial aided decision-making systems and government management business processes are closely related with information flow, In essence, business processes pattern of government is the application and construction operating mode of spatial decision-making systems. In e-government environment, there are three actors which are related to the application and construction of spatial decision-making systems: government agencies, enterprises and the public. In fact, spatial aided decision-making system has four construction and application patterns, which are government-to-government, government-to-government public servants, government-to-business, and government to citizens.

(1) Government-to-government pattern, government-to-government pattern is the basic pattern of e-government, is mainly referring to e-government activities which happen inside the government, among the different levels in government and different regions, different functional departments. It has many expressional forms, such as internal government network office systems, electronic regulations and policies systems, electronic document systems, electronic financial management systems, vertical network management systems, horizontal coordination management systems, network evaluation system, city network management system.

(2) Government-to-government public servant pattern, which refers to e-government between government and government public servant, it is a important form for government agencies to use to achieve internal electronic management through network technology. It is also the basic of government-to-government, government-to-business and government to the public e-government pattern. The key of the pattern is to establish an effective administrative office and staff management system using Intranet to enhance government efficiency and the level of public servant management. The specific contents include daily management of the public service and electronic personnel management.

(3) Government-to- business pattern, which includes the Government e-procurement, e-tax system, the administration of e-business systems, electronic foreign trade management system, small and medium-sized e-services, integrated information service systems.

(4) Government to citizens' pattern, the core of which is the government provides services for citizens through electronic network system. These services include electronic authentication, electronic social security services, e-health services, e-employment services, and e-education and training services.

Diversity, complexity and state administration of E-government provide Chinese support decision-making mechanism possesses the following features:

(1) Government leads unified planning. The construction of spatial support decision-making system is a complex systematic project, involving many departments and subject fields, such as the choice of network platform, the establishment of standards, design and construction of integrated resource database, the building of hardware and software environment, the support of regulations system, the establishment of information-sharing mechanisms, the building of organizational and investment channels, and so on. All these problem need government heads make unified planning and deployment. Without government's unified

leadership, the construction of spatial support decision-making system must be in serious difficulties. In addition, we had better adopt the top-down building strategy considering the data infrastructure, standards, technology infrastructure and talent base, and economic strength and application needs of the actual situation. That is, from the construction and application of general office of the state council, general office of the province government and department of the state council, through a typical demonstration, can sum up experience, improve inadequate, and then extends to geotropism government agencies. This mode of construction and operation can save time and has fast results.

(2) Unified network platform building. Unified government affair network platform is one of the cores of e-government construction, and its quality and efficiency affect the e-government construction. The network platform of spatial aided decision-making support system and e-government is consistent. Considering China's national conditions, outside administrative network and inside administrative network constitute e-government network platform, implement physical isolation between outside administrative network and inside administrative network, and implement logic isolation between outside administrative network and internet; In addition, we should build central government unified network gradually, integrated online information resources and services, and make the public get government information and services quickly and expediently and propose advice to government in time, and achieve interactive exchange of information among government, companies(enterprise) and residents step by step.

(3) Uniform norms and standards. As a unified platform or cross-platform structure, spatial aided decision-making support system requires standardization of guideline. Norms and standards include: application technology standardization, administrative information and public information production standardization, administrative processes standardization, spatial decision-making system criterion, database standards, government public network name standards, and interfaces standardization.

(4) Coordinated service is the basic operation mechanism. Coordinated service is the basic operation mechanism of spatial decision-making system, the so-called coordinated service can realize maximum commutative information resources sharing and application inside government agencies, between central government and local governments, between government agencies and relevant government agencies, between government agencies and companies(enterprise), and between government agencies and the public under the support of unified network platform, unified standard, unified geo-spatial information basis framework and unified information security system, and give priority to provide information services for government leadership agencies.

1.4 Application results of China's spatial aided decision-making system

The construction of China's spatial aided decision-making system commences since 1990s, the main representative is the project of GIS implemented by Surveying and Mapping administration and general office Secretary department of the state council in February 1992. From now on, it has lasted more than 16 years. The project followed our country's construction objectives and development strategy, insist the combination of technology and business, applicant it and at the same time, develop it. The project makes GIS become the powerful tool that provides information service for government's macro-management and decision-making and have great application the results:

(1) Establish basic spatial databases aiming at government macro-management which can provide basic spatial information and orientation framework for government spatial aided decision-making system.

(2) Develop special GIS application platform whose name is"Geo-Windows" fully by self aiming at government spatial information, expand it to become e-government spatial decision-making support software platform according to the government operation and finally become spatial information service tool which is easy-to-use for government department.

(3) Establish special spatial database support government spatial decision-making application. Through data processing, integrate special spatial database from professional sector base on national spatial database. Data include comprehensive national conditions, natural disasters, resource ecological environment, government information resources, western region, and economic cooperation with foreign countries.

(4) Establish multi-sectored coordination services operating environment, form an effective multi-sectored coordination service and integrated spatial information application pattern.

(5) Establish application service system which services the general office of the state council and local government.

2. Spatial information integration and database construction

2.1 The characteristics of E-Government data

The contents of E-Government involve many-sided government affairs such as geographical environment, national economy, social development, disaster prevention and mitigation, resources, conditions, population, corporate body, international economy, diplomacy and etc. So E-Government data represent the following characteristics: the variety of data types, the complexity of relationships and the multi-level.

(1) The variety of data types. The E-Government data mainly include foundational spatial data and thematic data with various proportional scales, remote sensing images which have characteristic of multi-platform, multi-spectral and multi-temporal, various statistics, large surveying records and other data such as text, images and video information. After digital processing, the display type of all above data can be divided into vector data, image data, raster data, relational databases, multimedia data and etc.

(2) Multi-levels. Because the geographical information system needs to meet the people orderly and gradually understanding on the geographical phenomenon, systems usually are demanded to provide multi-level magnification ratio data to different users. But it's difficult to build a geographical information system, which can integrate information fully and automatically through modern technologies. However, a method, to build multi-scale database, can resolve this question and can be realized easily.

(3) Complex relationships. In addition to topological relations between spatial data and hierarchy network crossing relations of data itself, there exist pivotal relations, the spatial location matching between different types of graphics and images, in the comprehensive utilization of spatial data, especially the relations of multiple entities in the region established by breaking the map-sheet limit when spatial database are being queried.

(4) More data origin. The government management covers all aspects. So, production, maintenance and updating of data need different departments. These make data come from

different origins and difficultly maintain and update.

In response to these characteristics, the system needs an appropriate model on the data organization. With the popularity of spatial data, the system needs distributed maintenance for different data, particularly the non-spatial data, and requires the data separation and data integration between spatial data and non-spatial data.

2.2 Database design and construction

The latest trend of GIS technology is to use the relational database or the object-relational database to manage spatial data and to establish GIS data server. It can take full advantage of the data management of RDBMS, of the data operation of the SQL langue and, at the same time, of management on massive data, transaction processing, record locking, concurrency control, warehouse and so on. These can integrate spatial data and non-spatial data, and then realize the Client / Server and Browser / Server structure veritably. In this project, we use the large-scale relational database system to manage data so that ensure the integration of spatial and non-spatial data.

2.2 .1 Whole design of database

From the view of application, the system adopts the following method, described as Figure 1, which designs an open, easy to reconstruct and well-suited decision-making database through taking advantage of the features of the GIS and the DSS.

According to the storage feature, the system data can be divided into spatial data and non-spatial data including the national economic statistics, text, images and multimedia. According to the data life cycle, the spatial data and non-spatial data can be both separated into static data and dynamic data. Static data has long update cycle and is maintained and updated by the professional maintenance tool of the system. Dynamic data is updated automatically through the clearinghouse and load to the spatial database and non-spatial database according to the type of data.
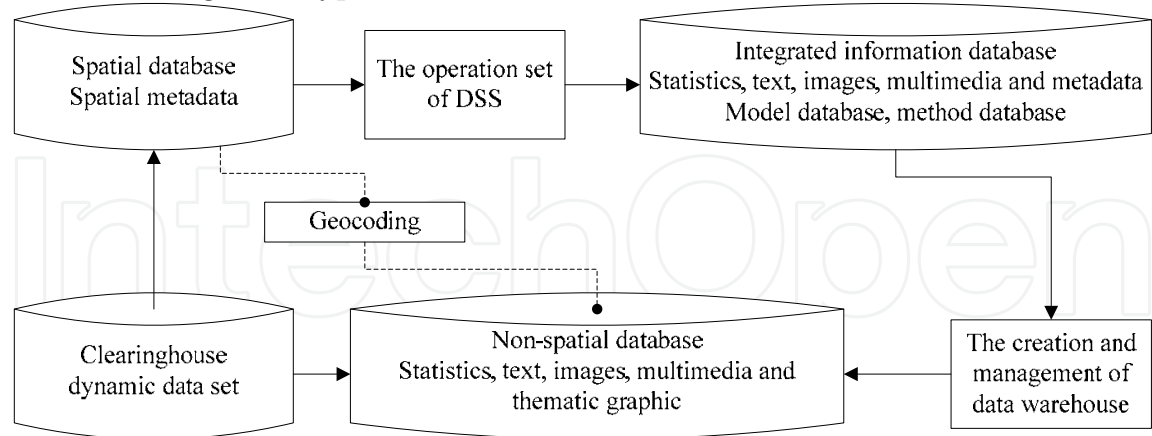

Fig. 1. The whole design of database

Spatial database stores the location-related data including vector graphics data, digital elevation model(DEM) data, thematic raster data, remote sensing image, spatial metadata and the basic attribute of spatial features. Non-spatial database store the original economic statistics, text, images, multimedia data and part of the non-spatial data contained geo-coding information, such as administrative divisions' codes and the road code. Based on

non-spatial database, model database and method database, the integrated information warehouse can be established to face decision-making services. The multi-level connectivity of spatial elements can be realized through the DSS set, geo-coding technology and information stored in integrated information database, such as information-level object, foundational data tables, intermediate results and display results. The whole database adopts a unified database management tools to manage.

2.2 .2 Logical design of spatial database

Based on large-scale mature commercialization management system, such as Oracle, the spatial database uses an entire relationship storage model, which supports the multi-scale, multi-type and seamless massive spatial data management in logic. The specific logic model is like the Figure 2.

Organizations of various types' spatial data are as follows. Map-sheet is the collective set of point, line, polygon and annotation features belonging to the same logic region. Vector features in one map-sheet may include polygon features, line features, point features, annotation features and combination features of above basic features. Entity is the integrated and continuous complexity object aggregated by simple features, such as line and polygon feature, and is not subject to the restriction of map-sheet. Layer is a set of map-sheets, which have the same reference system, the same logical content and continuous distribution of spatial location. Database is a set of various types' data not only including vector layers, raster layers and image layers but also attributes data and ancillary data corresponded the vector data, and without any internal structure. The maps of database, usually refers to all spatial information of a region, may use different projection type and data type.
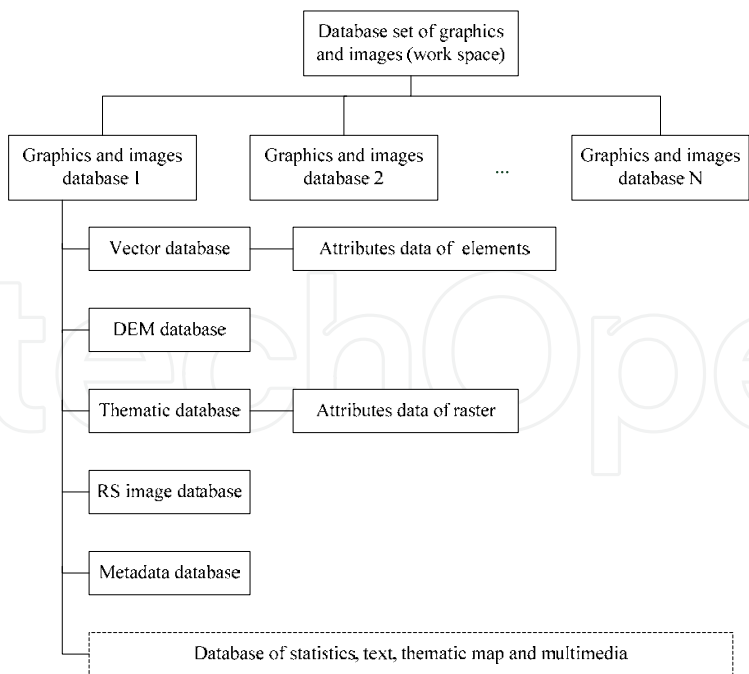

Fig. 2. The logic design of the spatial database

Spatial data are described by database sets, one work space, and are true of the geographic region which studied in one application. Database sets are composed of a series of graphics

and images database. In this design, database is regarded as logic cell and it has various types but the same or similar expression of spatial resolution and the same mathematical basis. Data set stored in spatial database has characteristics of geographic location and spatial relationship, and can be separated into different spatial blocks and layers according to space and features' attributes. Spatial features can interconnect with non-spatial data in the data warehouse, such as statistics, text, image and multimedia, through geo-coding.

2.2 .3 Logical design of non-spatial database

Non-spatial database includes social economic statistics, text, images, multimedia, thematic graphics and other professional databases, which provide the data source for integrated information warehouse. Non-spatial database uses physical relational table to store non-spatial data, establish the tree structure information index relying on the theme and supports the use of geo-coding.
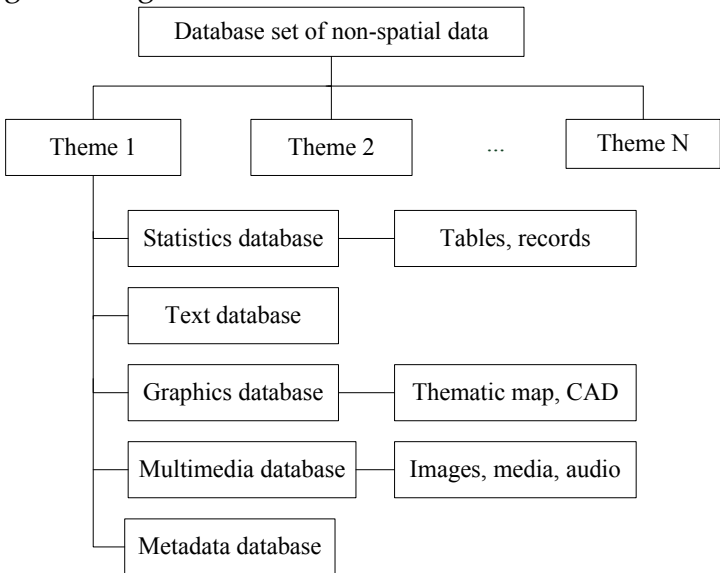
Fig. 3. The logic design of the non-spatial database

2.2 .4 Main flow of spatial database's establishment

The establishment of spatial database includes format conversion, projection transformation, data cropping, storage and symbolic expression. Each process has a batch tools to be completed quickly. Vector data supports the shape, E00 and SDE database format. Raster data supports the exchange format of ArcInfo grid and SDE database. Image data supports Geotiff, img, bmp, tiff and SDE database.

The establishment process of vector data includes projection conversion, format conversion, data storage, symbolic expression, annotation distillation and edition. The establishment process of raster data includes projection conversion, format conversion, data cropping, data storage, image creation and pyramid creation.
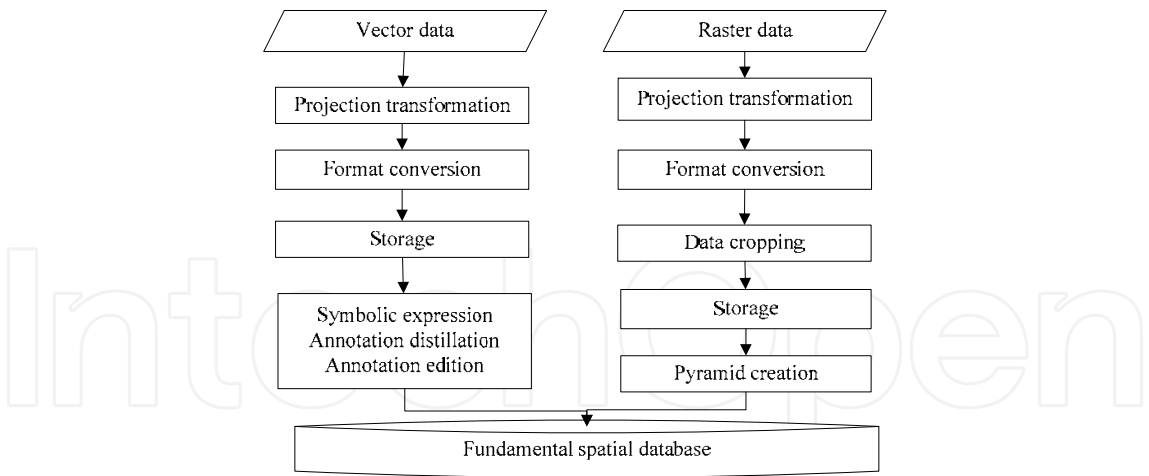
Fig. 4. The establishment process of spatial database

2.2 .5 Main flow of non-spatial database's establishment

Non-spatial data usually include a variety of tables, text, images and multimedia data. The core of non-spatial data management is the unified organization and storage of various discrete data, the logic relation between the different data based on its entity and the description information of data. So the system can provide standardized thematic dataset for applications. The steps of non-spatial database establishment include the following parts.
(1) Storage of various types' data
The system formats various types' data, such as tables, text and multimedia, into a unified relational database, uses alterable field to store its body paragraphs and creates entity code, type, storage time and other information for each non-spatial entity.
(2) Subject-oriented organization
In order to facilitate the data selection in the future, the system needs to establish a tree-view, and included subjection and parallel relations, using the entity geo-coding according to the theme.
(3) The establishment of logical relationship between spatial data and non-spatial data
The system defines a few of special field as the bridge to connect the no-spatial data with the spatial data.

2.3 The integration based on spatial framework for government information

2.3 .1 Integration technology of various types' data

Because administrative data have more sources and complex structure, there exist semantic differences and discontinuity between foundational spatial data and non-spatial data. It is difficult to integrate and share non-spatial data directly. The system uses geo-coding technology to realize the spatial data correlation and integration, uses geographical ontology technology to solve the semantic integration, uses dynamic projection to resolve rapid superposition of different projection data, uses data mining technology to achieve the integration of spatial data and text and uses the expression technology of economic statistics grid to integrate statistics and spatial data.
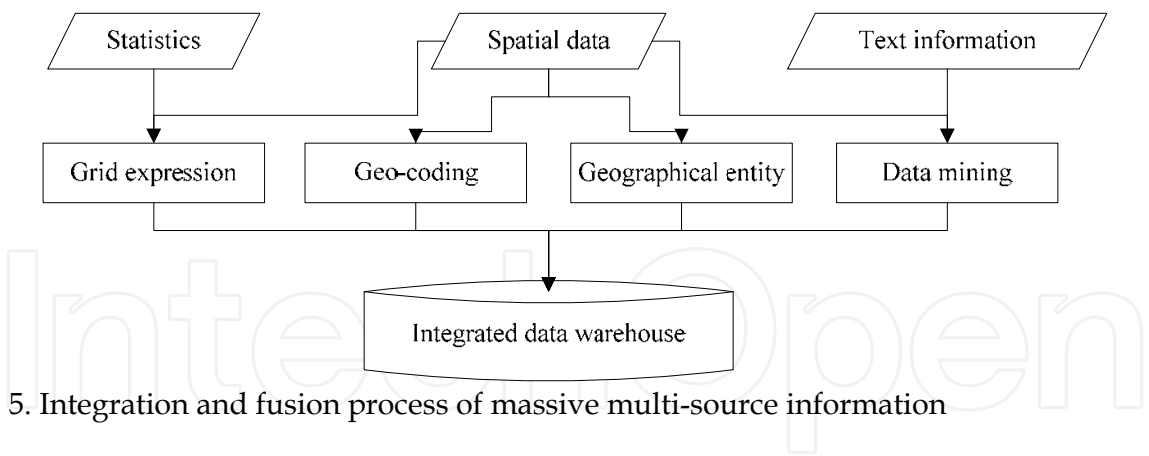
Fig. 5. Integration and fusion process of massive multi-source information

2.3 .2 Spatial data integration model

Administrative data involve civil affairs, land, water conservancy, agriculture, earthquake, environmental protection, marine, forestry, military and other departments. In order to ensure the integration services of the system and ensure that various types' spatial data can be displayed, queried and integrated analysis, the system must integrate the foundational spatial data and thematic data together. Department thematic spatial data involve various types' data, which can be divided into static and dynamic data. The static data are department data which have small change frequency, long change cycle and hugeness of data volume, whose management are off-line. The dynamic data are department data which have quick change frequency and very short change cycle, whose management are realized by real-time exchange and integration. Thematic data belong to different departments, most of which have established a respective classification indicator. For the departments with larger covers and more professional application, it is very difficult to provide a unified format for professional exchange in a short period of time. So those departments can provide a special data interface and resolve the question through a special conversion platform. Responding to changes in the thematic data, data integration can be completed in the foreground and background of the system to solve the integration of static data and dynamic data.
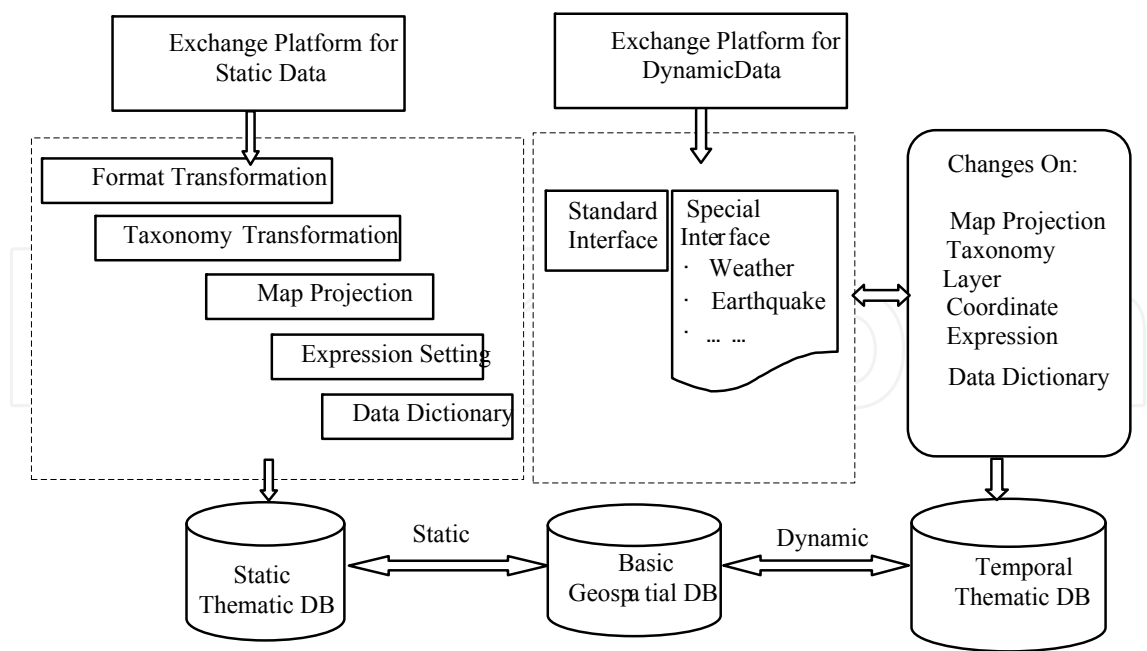
Fig. 6. Schema of data exchange and integration

3. Spatial aided decision-making software platform development

GIS is one of construction technology for E-government, and is also an aided tool to carry out management and macro analysis for all levels governments. It has an effect on national economy management, disaster prevention and governmental affairs management. But GIS and DSS usually independently work, the interactive relation between them is unsubstantial, so that application of e-government in GIS is inconvenient and inefficient.

Under the actual situation, we need to construct software platform of the spatial aided decision support system in the network environment, and to tightly integrate DSS technique with GIS technique, so that we can supply comprehensive information and decision-making service for the governments.

3.1 Design method of the platform based on GIS and DSS integration

3.1.1 The integration target of software platform

According to macro construction target of the e-government in China and system management requirement, the platform adopts uniform system structure design, database structure design, module and function design and component development, and takes the foundational spatial database as a framework to integrate a thematic spatial information, national economy statistics information, government affair information and multi-media information, and establishes spatial database with comprehensive information warehouse, and implements GIS, DSS and close integration and vivid function call according to the safe electron governmental affairs platform, and sets up an uniform spatial decision software platform for the E-government application.

The following principles are used in making the general design of the software platform: to meet the overall requirements of electronic government affairs and digital China

construction, to conform to the national standard and specification and principle of information share and multi-protocols, to apply the integrated application pattern of C/S and B/S systems, to support information management structure of multi-subjects and multi-levels standardization and personality application, to realize the distributed management and maintenance.

3.1.2. The uniform database design

The work points of the database design are to accomplish the following works:

（1）Confirm design principle. Based on large relational database characteristics, we establishes some principle of database design, and at the same time, gives attention to request of GIS and DSS integration, request of application function.

（2）Choose database contents. According to application and characteristics of the spatial system the data contents of the platform are chosen such as the thematic data, spatial data, attribute data, document and multimedia data , etc.

（3）Design database. The concept/logic design of the database, physical design of the database and setting up the demonstration test of the database will be carried out in prescriptive method.

3.1.3. Uniform data management and scheduling

The implement of uniform storage and management for spatial data and non-spatial data are different from pure relational data management, also is different from file management. The important point is to resolve management efficiency of spatial data within relational database and concretely involved technique is described as following:

(1) The establishment of spatial data query mechanism. The key of spatial data organization is index and the good or bad performance of the spatial data index directly influences the whole performance of spatial database and GIS platform.

(2) Data compression. Regular GIS manages amount of data, high or low system performance have very great relation to transmission speed of network. In order to reduce load on network, we consumedly lower the transmission network quantity using data compression of spatial data, so the performance of the system has got higher.

(3) Making use of large relational database technique. The query of the great capacity for spatial data may return to a very big result to gather and attain several 100, 000 even million records. So we can put the records to database buffer in server.

3.1.4. The uniform software development

In order to exert respective characteristics of GIS and DSS in the application, attain the close integration of their function, the platform adopts component to accomplish function integration of GIS and DSS. The component can define a general call method for software serve, it can cross over a link library, application program, system software even network, the component can still provide valid path to separate software block, each block provides respectively service, the developer can use an object-oriented method to design and develop program, simplified complicated system.

For implement method of the software function, because system includes spatial data and

relational data or statistic data, for the attribute data of spatial data adoption relational model are suitable and using SQL statement to carry out query is efficient. But object oriented method with abstraction, packaging, encapsulation; polymorphism is feasible to handle spatial data. Therefore, mixing object oriented with relational model is suitable for implement integral management of spatial data and attributes data.

3.2. The architecture of the platform

Application service structure of the platform adopts B/S, and the system maintenance adopts C/S structure, such as figure 7.

The software platform can be divided into three parts: application integration tools, application server and client module. The tools can deal with spatial data, such as input, processes, edit, and application theme integration/modify in server side. Application server runs in server side which receives and analyzes client's request, then, gets spatial and non-spatial data from database and send them to client. For complicated spatial operation, which could not be performed in client side, such as spatial analysis, the application server will call component in server side to perform the operation. Client side module is consisted of display and user interface.

Through uniform system structure design, database design, modularized function design and component development method we can implement close GIS and DSS integration and vivid function calling, set up uniform spatial decision software platform.
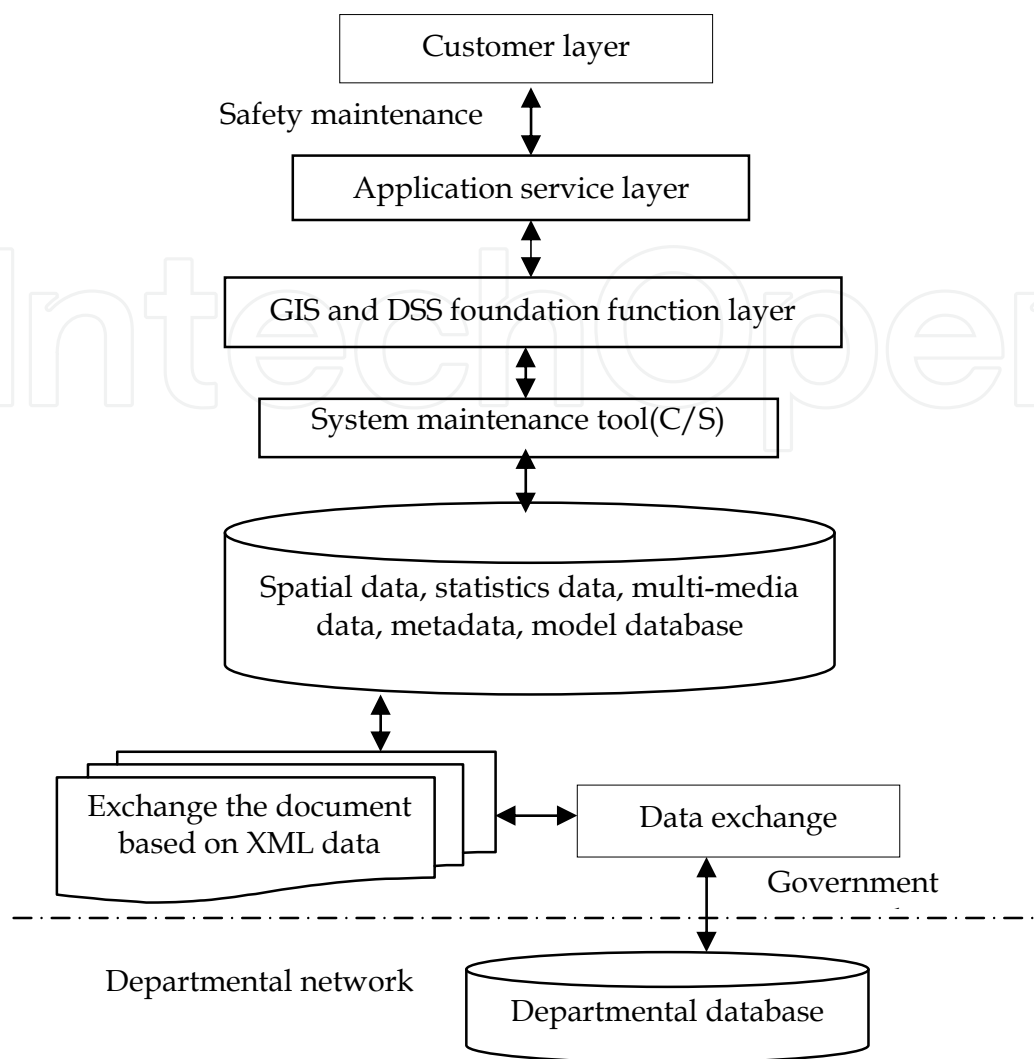
Fig. 7. Software platform architecture

3.3 The running software and hardware environment of the platform

Hardware environment: that includes high efficiency PC server, microcomputer client and wire network whose speed is above 2M.

Software environment: that includes the Windows operation system in server and client side, data management by Oracle 9i.

3.4 Integrated design and development of the software platform functions

To take GIS as a foundation framework and to use function calling to implement the close integration with DSS, the integration of their function are exhibited on three levels: data layer, maintenance layer and application service layer. Integration method is shown in figure 8.
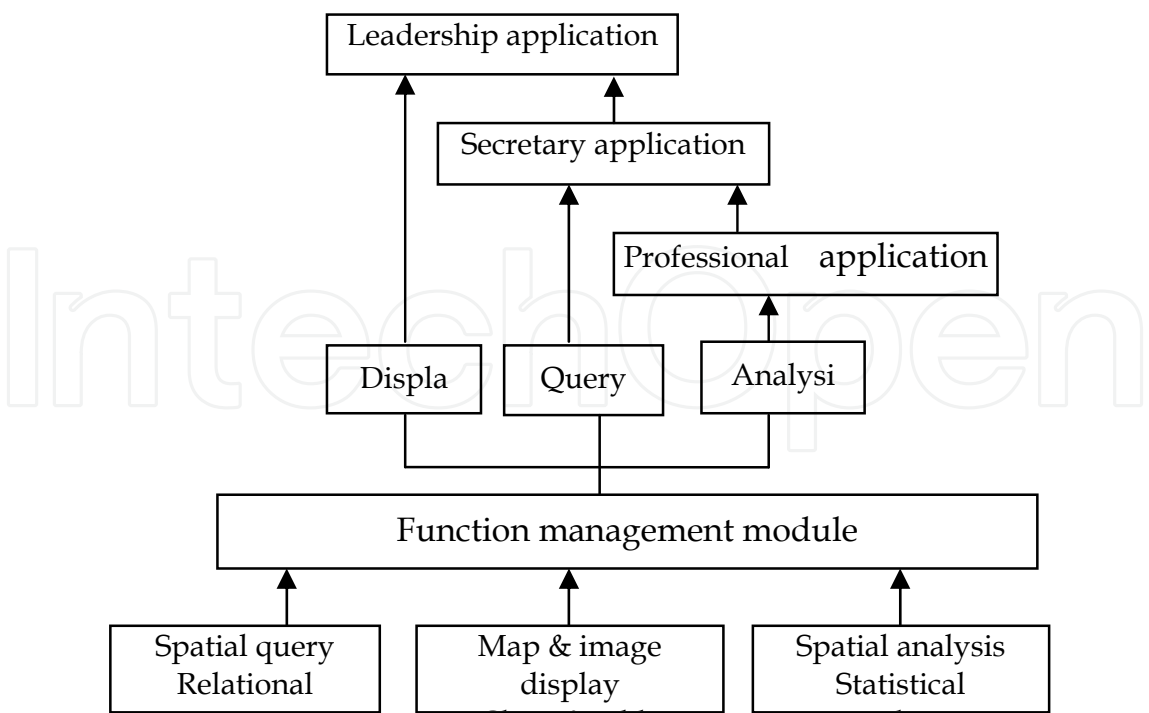
Fig. 8. GIS and DSS function integration

3.4.1 The integration function design of data maintenance layers

Using C/S system structure, the system administrator with professional GIS background can carry out management and support of the spatial database, comprehensive information database, operation process and the user interface.

(1) Geography spatial database support tools. It includes data import module, spatial database creation module, meta database maintenance module, database management module and data automatic exchange module.

(2) The non-spatial database support tools. It includes data import module, non-spatial data index creation module, database management module, data automatic exchange module.

(3) The comprehensive information data warehouse support tools. It includes relational database basic management component:, data interface component and data description metadata management component etc.

(4) The thematic database management tools. User interface consists of series of application thematic term and these themes are organized and spread by tree form. The system provides uniform maintenance tool of the thematic information to implement an user interface establishment and to make custom operation, on the thematic information tree each node can link with a series of spatial data, non-spatial data and correspond an operating command, create theme object entity, is used for description thematic spatial place, attribute information and operating command.

By providing uniform maintenance tool of the thematic information the system can complete a thematic tree creation, register, the increment, delete, copy, modify, operation for node, and at thematic tree node we can add spatial information (extent, entity), non-spatial information (table, text, thematic graphics, multimedia) and spatial query, spatial analysis and comprehensive information data warehouse analysis, etc.

3.4 .2 The function design and implementation of the application service layer

With adoption of uniform component standard method to integrate GIS and DSS function of being different hierarchy in serve, the application server takes GIS as a calling framework, GIS call the component function provided by DSS, and supports function of gentle assemble each other.

(1) Foundational function design. To complete the design of basic function of the system floor and corresponding correlation, reasonable grain dimension of the partitioning function, implement the united data access, data query, data operation.

Map display class: Show several data, vector map layer data, map library data, event.

The vector data query class: Provide map query, attribute query, metadata query, result conservancy.

The report prints class: Print the data (library, table, memory), record print and the sort print and the report make to order.

The vector quantity edits class: Edition setup, point, line, polygon and annotation edition, the map connecting side, metadata update.

The spatial analysis class: Overlaying analysis, buffer analysis, network analysis, the spatial statistic operation.

The terrain analyzes class: According to DEM, the system implements profile and factor creation output.

The spatial data processing class: Projection change, projection alteration, linear transformation, polynomial transformation, cut to slice, concatenation and attribute concatenation.

Statistics graphic class: Statistics cartographic model and statistics, the map decoration, thematic mapping, map keeping.

The intelligent graph component: To use artificial intelligence (AI) technique, applying rule knowledge processing thought, give the data information format according to the data list processing tool, national economy statistics information table and statistical charts automatically are expressed.

Combine time sequence model: Include model data processing component, the model creation component, settle information processing, model application analysis component.

The population simulation of spatial distribution model: Include model data processing component, the model creation component, settle information processing, the model application analysis component, census taking and spatial distribution analysis component etc.

(2) Application service function design. Through the function component of the assemble foundational function and custom development the system can provide more integrated information, text, multimedia and assistance the geography spatial information for application system.

Query function: Vector and raster data blending query, condition query, spatial relation query, Topology query, the spatial factor gather, sort and statistics, text data browsing, table data browsing, the intelligence make graph, information incident query etc.

The DSS function server can be run by the operation of defining command (usage operation coding start service) in advance, also query operation with GIS to combine an operation.

Analyze a function: The spatial topology overlay, buffering analysis, shortest path analysis, the best path analysis, resource allocation, DEM analysis, evaluation analytical, and region national economy decision analytical model.

Display function: Multi-dimensions map displays, remote sensing image the multistage show with roaming, data table, text, statistical charts.

The web serve. Provide a united user management, command request and respond to a function.

(3) User layer function design. Providing the system information service according to the WEB environment, the user can establish thematic information tree getting into an operation interface in advance.

Thematic tree: Show current theme name, we can click it to carry out a theme selecting.

Operate: Showing the information that includes current theme and its related operation is the main entry point of thematic tree.

3.4.3 Design of data layer integration and implementation methods

The spatial data and non-spatial data adopt large relational database such as Oracle to storage.

Provide uniform information framework to implement geographic spatial data, non-spatial data with comprehensive information warehouse based on the GIS platform.

Comprehensively adopt relational database to storage through geography code by making the spatial data linked with non-spatial data.

Implement the data integration of the exterior dynamic state through XML file from data switch center. In memory, GIS and DSS and use XML file as a medium to realize data exchange.

4. Spatial aided decision-making applications

With the development of the application of GIS and DSS facing Government management, it has been basically completed the application system of spatial aided decision-making services which support s the government management and decision-making. The mode of government services is from a single sector to multi-sector collaboration to support services. The application software is upgraded to the online version information systems from stand-alone version. The application fields from the simple electronic map to the information services whose business is associated closely. It has formed standardized services technical specifications and operating mechanism. Its application become more and more abroad.

4.1 Application fields

According to related statistics, more than 80% of the information that is supported to government agencies to carry out macroeconomic analysis and aided decision-making is related to spatial location information. Therefore, spatial decision-making system has a deep and broad application in government agencies. The main areas include:

(1) Integrated business management and macro-aided decision-making of the central government agencies

The spatial aided decision-making applications system, which is based on the organic integration of multi-scale, multi-temporal, multi-types geospatial data and a variety of non-spatial data, can provide comprehensive national information service to the leader,

including querying, tracking and understanding of the geographical environment throughout the country, economic and social development, disaster prevention and mitigation, emergency, infrastructure, and so on.

(2) Integrated business management and macro-aided decision-making of the government department

The application fields of spatial aided decision-making are broader in the government department, the example as follows:

i) Urban planning and management

ii) Land planning, management and use

iii) Population management

iv) Agriculture, forestry and meteorology

v) Environmental Protection

vi) Transportation

4.2 Work mode

Spatial aided decision-making system based on DSS and GIS mainly uses the mode of collaborative application of WAN and LAN as well as remote information service. It also uses construction methods of collaborative service based on the unified technology architecture and data standard and oriented the Chief of macro-and micro-level. It has completed collaborative work with many departments and can automatically load and integrate the related thematic information, such as meteorological, hydrological, remote sensing, disaster, and statistical information. The system achieves a continuous operation every day, and ultimately provides aided decision-making services of relevant information for the leaders.

Spatial decision-making services technology for e-government, based on functional synergy, adapts from the structure of E-Government which simplify the work of information services. Without changing the current computing environment of e-government, it accomplished the collaboration of a variety of spatial information between service and browser through a service agreement. It avoided the original spatial data transmission through the transmission to calculation results, so it improved the operating efficiency.

Spatial aided decision-making system based on DSS and GIS is a highly technical and complex project. It relates many aspects. Its effective application is not only dependent on technology, but also other factors, such as: data acquisition, data processing, data distribution, data sharing and so on. Under some conditions, the factors that affect the system success are not a lack of data or technical ability, but the practicality of the data. We have to be provided the most appropriate data to make the system work together.

4.3 Society benefit and roles

Now, spatial aided decision-making system has a considerable role and effectiveness in the social, economic, disaster prevention and mitigation, planning and construction of major projects and emergency. As follows:

(1) Providing decision-making services for leaders of government agents and improving efficiency and quality of government decision-making.

(2) Accelerating the development of domestic self-copyright software technology about

e-government, raising the level of application effectively, and promoting the development of e-government market.

(3) Through integration of e-government information resources database, it speeds up and promotes the process of the information sharing, integration and standardization and e-government development in China.

(4) It broadens the application field of geospatial data and promotes its application in government departments to a new level of the distributed network of government. Furthermore, because of the applications running in the government network, it provided services not only for the central departments and the four western provinces, but also for all the l local government and relevant departments. The application has a strong demonstration effect. This method may be popularized in building e-governance for government agencies.

4.4 Typical demonstration application

Under the support of the central and local government departments, Chinese Academy of Surveying and Mapping has developed spatial aided decision-making software platform based on DSS and GIS. It has used construction methods of collaborative service based on the unified technology architecture and data standard. It has built a series of application systems using business management and macro-spatial decision support, which include disaster prevention and mitigation, analysis of economic development, development of the western region and China electronic map. The system covers the applications of government comprehensive departments and professional departments in the government's macro-management, earthquake resistance and disaster relief, environmental protection and facilities planning. In addition, it has built e-government resource database including geography, economy, social development, disaster prevention and mitigation, resource and environment, conditions, population, corporate, international economic and foreign relations. The data is from the authority departments. The integration of spatial data and non-spatial statistical data, text data, multimedia data is achieved. It has established basically the update mechanism and technology system for thematic data.

4.4.1 Application systems running in the special network of the central government departments

(1) Information service subsystem of disaster prevention and mitigation

On the basis of geo-spatial data, through jointing the departments of State Council in charge of natural disasters and their command centers, and integration of the relevant important information, it provides the geographical location, socio-economic background, disaster live information and disaster-regional economic statistics and analysis when the disaster occurs. The main contents include the flood information, meteorological information, remote sensing information, earthquake disaster information, geological disaster information and so on. As shown in Figure 9 - Figure 12.
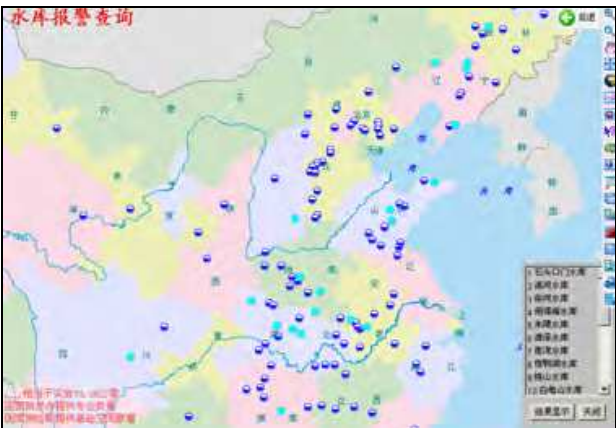
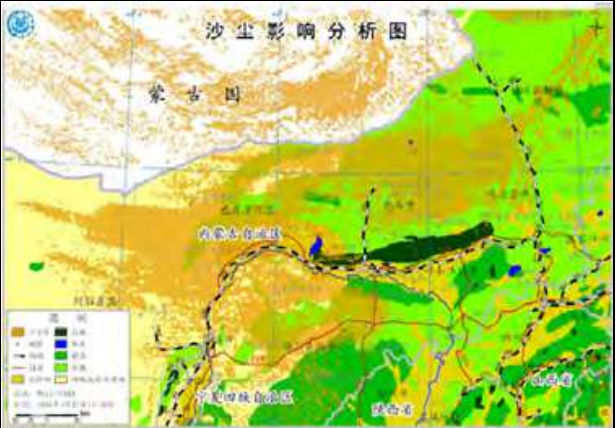Fig. 9. Reservoir alarm information

Fig. 10. Analysis information of the dust distribution and impact

Fig. 11. Distribution of geological disasters and statistical information

Fig. 12. Hailstorm disaster information

（2）Information service subsystem of the western region development

It provides the management information of western region's economic development strategy, including the latest reports of the western development strategy and planning which are published by relevant national authorities each year, the basic information with a large number of national information about western region and the comparison of Middle, East, West, as well as the condition of western infrastructure and key projects. The system can connect with the related application system of western provinces to integrate services. As shown in Figure 13.

（3）Economic development and analysis subsystem

Through the function integration of GIS and DSS, it provides economic statistics about the world and China's economic development trend and the latest research and statistical analysis results of national and international authorities. This subsystem includes: the world economy, international trade, international investment, regional integration arrangements, the main indicators of China's economy, the main indicators of the world economy. As shown in Figure 14.
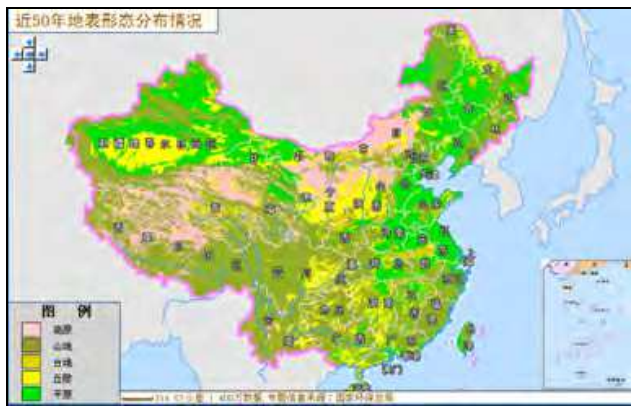
Fig.13 Distribution information of the surface morphology
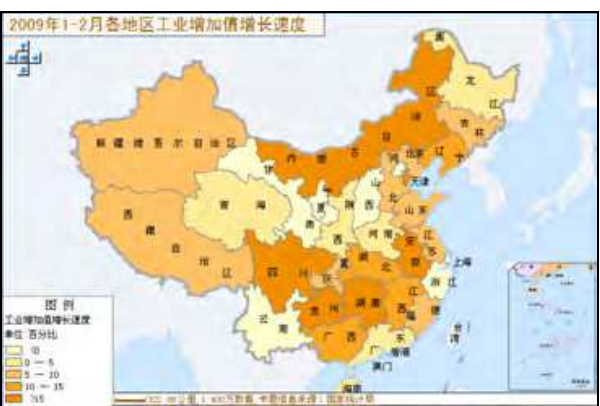
Fig.14 Economic development and statistical information

（4）National resources and environmental monitoring subsystem

China is a drought, water shortage and desertification-affected country and the development trend is more and more serious. The sub-system mainly makes government departments get the monitor and analyze information timely and provides decision-making support. It contains two topics on desertification and water resources. It integrates the monitoring and analysis information of national desertification since 2002 and the water resources of Beijing and its surrounding since 1999. As shown in Figure 15 and Figure 16.

Fig. 15. Change information of desert in Yulin City, 2002-06
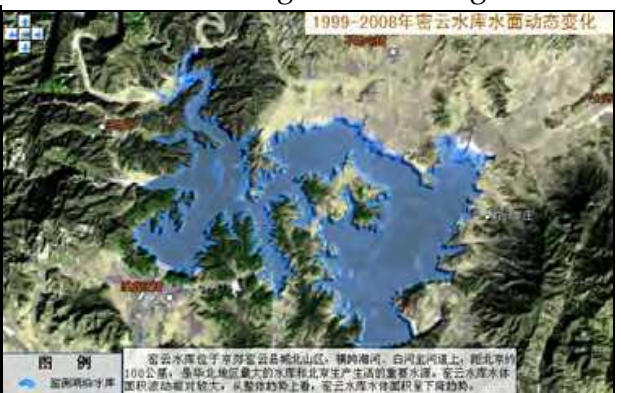
Fig. 16. Dynamic monitoring information on Miyun Reservoir

（5）Urban development and comparison subsystem on 30 years of reform and opening-up

Making Multi-spectral remote sensing data of "Beijing-1" satellite as the data source, combining with 70's US Land Satellite MSS data, it monitors the central built-up area expansion of 131 cities (including Lhasa) on China's mainland whose population is over 500,000. Combining with general classification system of national land use and using uniform standards and technical processes, it carries out research of resources and environment monitoring. As shown in Figure 17, Figure 18.
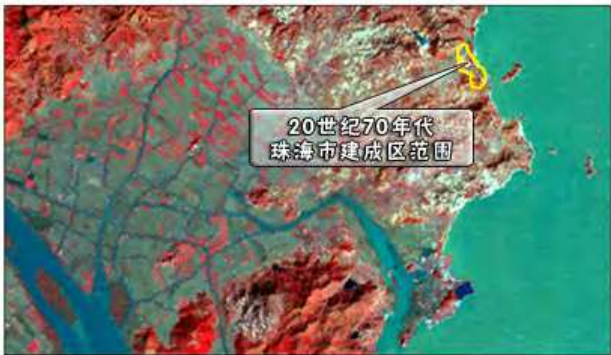
Fig. 17. Urban area of Zhuhai in 70's of the 20th Century

Fig. 18. Urban area of Zhuhai in 2007

（6）Major disaster service subsystem

The system integrates statistical analysis information and images of disaster of the Wenchuan earthquake and freezing disaster early in 2008 in more details, including the geographical location of the earthquake disaster, disaster information, as well as statistics and analysis of economic losses in disasters regional. It contains two topics: Wenchuan earthquake disaster and freezing disaster. As shown in Figure 19, Figure 20.
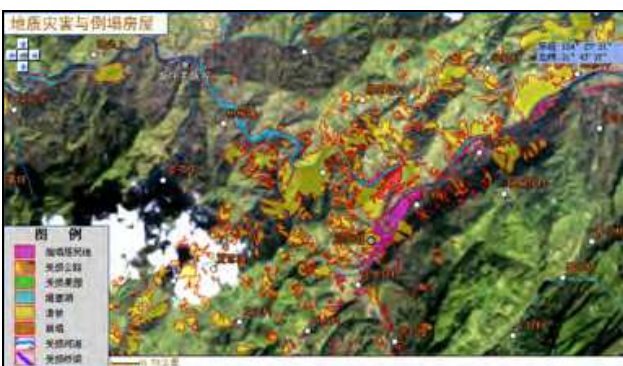
Fig.19 Distribution and statistics information of Wenchuan Earthquake

Fig.20 Freezing disaster in Hubei Province in 2008

（7）Strategic resource subsystem

It mainly provides the statistical and analytical information of the strategic resources from domestic and international authority, such as geographical distribution, supply and demand, production of the world's energy, forest resource and important mineral resource. As shown in figure 21.
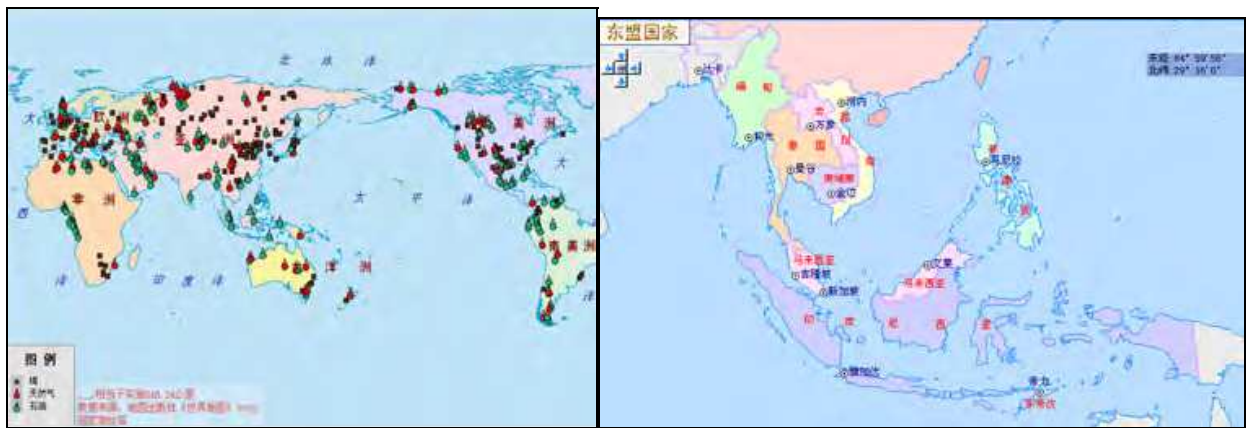
Fig. 21. Distribution of global energy   Fig. 22. Distribution of ASEAN countries

（8）Integration arrangements subsystem

It mainly provides the information of regional economic cooperation and economic globalization. It focuses on the basic situation, run profiles, macro-policy options and statistics and analysis of economic and trade. They involve China-ASEAN Free Trade Area, Association of Southeast Asian Nations, the European Union, North American Free Trade Area. As shown in Figure 22.

（9）China electronic map subsystem

The system is mainly to facilitate the function of "mobile office" for leaders. According to affiliation of the national administrative divisions, it combines the basic geo-spatial data and attribute information to provide the latest national information of the county administrative. The national electronic map is multi-scales, rich and powerful. As shown in Figure 23.

Fig. 23. The basic information of a county

4.4.2 Application systems of the provincial government agencies

In addition to the central departments, the application of spatial aided decision-making system also set Chongqing, Guizhou, Gansu, Yunnan, Henan, Xinjiang, and other provincial government departments as models, which are being widely used and founded corresponding application systems. As described below.

Chongqing City Economic and Social Development Aided Decision-making System

The system integrates population database, corporation database and basic spatial database

to establish the Chongqing Municipality level of urbanization evaluation model. And by using government network and software platform provided by e-government spatial aided decision-making demonstration projects, it builds e-government spatial aided decision-making system, which consists of spatial data center, attribute data center and government information and resources service platform. It forms the working mechanism of coordinate services. As shown in Figure 24.

Guizhou Province Resource and Environment Application System

It builts the resources and environment database, which integrates provincial and county levels basic geographic data and resources, ecology, environmental data. And it establishes Zunyi County and Guizhou Province resources and environment information systems to provide information services for leader. It integrates many results of Land and Resources Office about land, resources, environment, ecology and accomplishes the information integration of the resources, ecology, environment. As shown in figure 25.

Gansu Province Returning Farmland to Forest and Grassland Application System

The system is established based on Zhuanglang County as an experimental unit according to the demands of 'detailed to the village to monitor the land, corresponds to the farmers'. Remote sensing monitoring images contrast in the latest and before returning can be made to monitor the effectiveness of farmland in the interior departments to complete check and acceptance work in the manner of combining with the traditional method. As shown in Figure 26.

Yunnan - ASEAN Free Trade Area Application System

The system has finished the construction work of macro-scale geo-spatial data framework in Yunnan Province and ASEAN. This system can integrate social, economic information resources based on B/S structure and reflect the geographical distribution of ASEAN countries, Yunnan's regional advantages in China-ASEAN Free Trade Area as well as construction information of international channels to connect Southeast Asia. As shown in Figure 27.

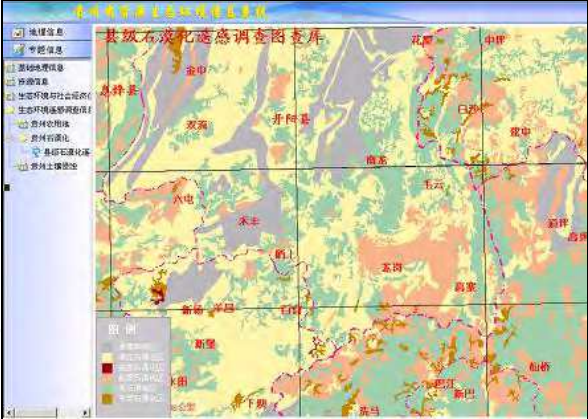Fig. 24. Chongqing City Aided Decision-making Application System

Fig. 25. Guizhou Province Aided Decision-making Application

Fig. 26. Yunnan Province Aided Decision-making Application System

Fig. 27. Gansu Province Aided Decision-making Application System

(5) Spatial Information Service System of Xinjiang E-Government

The system builds the three-level topics architecture and database of autonomous regions, autonomous prefectures (regions, cities), counties (cities). And it establishes thematic information of national economic development, tourism, mining, transportation and so on. It reflects the development of the autonomous region and provides decision-making information for the leaders. As shown in figure 28.

(6) Spatial Information Service System of Henan E-Government

On the basis of "Central China city groups", it can load and integrate e-government information of different industries and sectors in e-government aided decision-making platform. The system can provide information, such as province's economic, social development and urbanization development, to provide aided decision-making for related departments. As shown in Figure 29.

Fig. 28. Xinjiang Aided Decision-making Application System
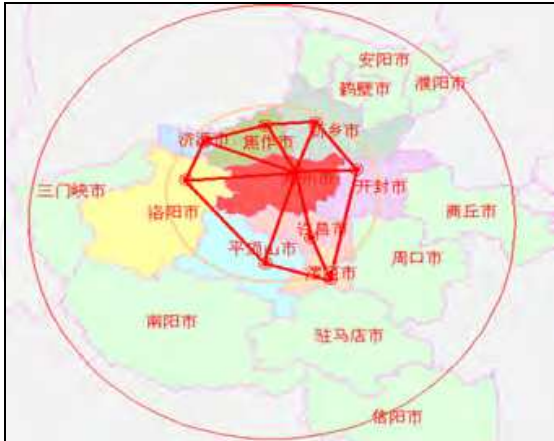
Fig. 29. Henan Province Aided Decision-making Application System

4.5 Development trends of application

With the rapid development of modern science and technology, GIS and DSS technology are being improved continuously. At the same time, with a series of e-government approach, regulations and policies being put forward, applications of e-government spatial aided decision-making system have new trends under the new situation.

(1) The end-user of e-government spatial aided decision-making system should not be limited to government departments. Information resources with no secret or being relatively low can open to the public after taking some safety measures.

(2) E-government spatial aided decision-making system becomes more and more demand-driven, application-oriented and data-centric.

(3) E-government spatial aided decision-making system takes more and more characteristics of human nature and makes the public as the core.

5. References

Guo Zhendan. (2007). Humanity t is the essence of e-governmen.http://www.chinabyte
.com

Liu Yankai. (2004). Relying on GIS to achieve the integration of basic data, Informatization
Construction

Liu Jiping. (2005). Application of spatial information technology in management and
decision-making of government agencies.   E-government spatial aided
decision-making system report

Liu Jiping. etc. (2005). Study and Application of Comprehensive Data management for
Spatial Decision-Making for E-government, Science of Surveying and Mapping,
Beijing China

Li Bin, etc. (2005). Analysis and applications of e-government spatial aided decision-making
system based on GIS and DSS.   Geomatics World

Li Bin, etc. (2006). The practice of disaster management system based on GIS and RS. Survey
and Mapping Sciences

Wang Liang, etc. (2005). Design and Development of Software Platform of Spatial Aided
Decision-Making Based on GIS and DSS. Science of Surveying and Mapping,
Beijing China

Wang Liang. (2008). GIS as a management tool for government. Computer World

Zhang Qingpu, Liu Jiping. (2003). Government Geographic Information System, Science
Publisher, Beijing China

E-learning Experiences and Future

Edited by Safeeullah Soomro

This book is consisting of 24 chapters which are focusing on the basic and applied research regarding e-learning systems. Authors made efforts to provide theoretical as well as practical approaches to solve open problems through their elite research work. This book increases knowledge in the following topics such as e-learning, e-Government, Data mining in e-learning based systems, LMS systems, security in e-learning based systems, surveys regarding teachers to use e-learning systems, analysis of intelligent agents using e-learning, assessment methods for e-learning and barriers to use of effective e-learning systems in education. Basically this book is an open platform for creative discussion for future e-learning based systems which are essential to understand for the students, researchers, academic personals and industry related people to enhance their capabilities to capture new ideas and provides valuable solution to an international community.

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