Design and Building of the New Countryside Construction Database Based on ArcSDE and SQL Server

Hongji ZHANG[1*], Xuping LI[2], Yong LUO[1], Lianze TENG[1], Aiqun DAI[1]

1. Sichuan Academy of Natural Resource Sciences, Chengdu 610015, China; 2. Geological Environmental Monitoring Station of Chengdu, Chengdu 610015, China

Abstract Building the new countryside construction database plays an important role in improving the construction efficiency, and enhancing the level of major project management. On the basis of detailed analysis of features of the new countryside construction data, we give an overview of the database design based on ArcSDE and SQL Server, and elaborate the association between data classification organization, database conceptual design, logical design, spatial data, and thematic attribute data. Finally, taking the provincial new countryside demonstration zone in Yanjiang District of Sichuan Province for example, we build the new countryside construction database.

Key words New countryside, ArcSDE, SQL Server, Spatial data

Building a new socialist countryside is a long-term arduous task involving a wide range of aspects, and great investment intensity. The planning, implementation and monitoring of the new countryside construction involve vast amounts of data, and the traditional management mode of paper-based information or general chart is difficult to meet the needs of new countryside construction for information management[1]. As information technology continues to evolve, building the new countryside construction database to manage information is of great significance to the scientific planning of construction, effective project management, and coordination of implementation. The majority of the data concerning the new countryside construction are the spatial data related to geographic location, so it is difficult for the general database management system to effectively manage it[2]. In this paper, we use the spatial data engine ArcSDE and relational database management system SQL Server to effectively correlate the spatial data with attribute data, and take the provincial new countryside demonstration zone in Yanjiang District for example to achieve database building.

1 The ArcSDE + SQL Server data management technology

ArcSDE (Spatial Database Engine) is a server-software sub-system (produced and marketed by Esri) that aims to enable the usage of Relational Database Management Systems for spatial data. The spatial data may then be used as part of a geodatabase. ArcSDE grew to meet the need of users of geographic data for robust multi-user editing, storage and access of extremely large geospatial databases. It integrates the spatial data and attribute data[3], thereby enabling the seamless connection between spatial data and attribute data. Microsoft SQL Server is a relational database management system developed by Microsoft. As a database, it is a software product whose primary function is to store and retrieve data as requested by other software applications, which is widely used[3]. There are at least a dozen different editions of Microsoft SQL Server aimed at different audiences and for different workloads (ranging from small applications that store and retrieve data on the same computer, to millions of users and computers that access huge amounts of data from the Internet at the same time).

Its primary query languages are T-sQL and ANSI SQL. ArcSDE adds the spatial data types to SQL Server, and does not change and affect the database and its applications; it only adds the graphics data items (Shape column) to the existing data tables, for the users to manage and access the associated spatial data[4-6]. The ArcSDE + SQL Server architecture diagram is shown in Fig. 1.

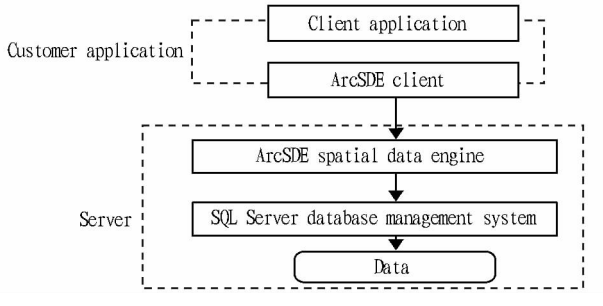

Fig. 1 The ArcSDE + SQL Server architecture diagram

The spatial data and spatial indexes are placed in different data tables, and they are linked by key items. When accessing the spatial data, the users do not need to know the actual organization form of data in the database, but simply to provide the parameters and identification information of target data needed by the spatial database connection, to complete a call for library data[7]. Therefore, on the server side, after connecting ArcSDE with SQL Server, we can load the spatial data with shp format by the wizards provided

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* Corresponding author. E-mail: 20154008@qq.com

by the functional module ArcCatalog in ArccGIS Desktop.

2 Classification and organization of data

The new countryside construction involves multifarious data, and the data structure is complex, including not only the spatial data on industrial layout, village layout and infrastructure layout, but also the attribute data on population, economy and project implementation content in each year. It covers not only the ordinary text and table data, but also the vector and raster data of maps and remote sensing images.

According to the data content and features, the data are divided into three categories: basic geographic information data, rural status data, and thematic data of construction planning. In order to facilitate data management, the three major categories are divided into several sub-categories. We classify and organize these massive data and design the corresponding storage format for the same categories of data in accordance with uniform standards. Table 1 shows the classification, organization of data and detailed instruction.

Table 1 Classification and organization of data and description

Main class	Sub-class	Data format	Description
Basic geographic information data	Space frame data	Vector format	Administrative division, transportation, river net, settlements
	Image data	Raster format	The remote sensing images with different resolution
	DEM data	Raster format	The digital elevation model with different scale
	……	……	……
Rural status data	Industry status data	Vector, normal form	The distribution of major industries and related attribute data
	Infrastructure data	Vector, normal form	Roads, water conservancy and land consolidation data
	Economic statistics	Normal form	County, township and village economic statistics
	……	……	……
Thematic data of construction project	Village construction data	Vector, normal form	Village planning and construction data
	Industry development data	Vector, normal form	Industrial development planning and construction data
	Social undertaking data	Vector, normal form	Social undertaking development planning and construction data
	……	……	……

2.1 Basic geographic information data The basic geographic data is the background data of database and positioning framework of space, with an aim to determine the positioning of other spatial data and accurate superimposition of related layers. It includes maps of different scales to meet the needs for different precise mapping. The data mainly include the administrative division, transportation networks, river net, settlements, digital elevation model (DEM), remote sensing images and soil maps.

2.2 Rural status data Rural status data is the basic background data for the new countryside construction, including demographic data, per capita income and other economic statistics, land use data, the main industry status data, village construction status data, and infrastructure status data.

2.3 Thematic data of construction project The new countryside construction covers a range of important special topics, involving many departments such as agriculture, water and technology. These thematic data are the core content of the new countryside construction database, mainly including industry development data, new countryside construction data, infrastructure building data, and social undertaking building data.

3 Database design

3.1 Database framework design Based on the ArcSDE + SQL Server spatial data management technology, according to data analysis and classification, the database framework is designed, as is shown in Fig. 2. By ArcSDE spatial data engine, data administrators and users make ArcSDE closely linked up with SQL Server, thereby realizing effective and rapid access of data.

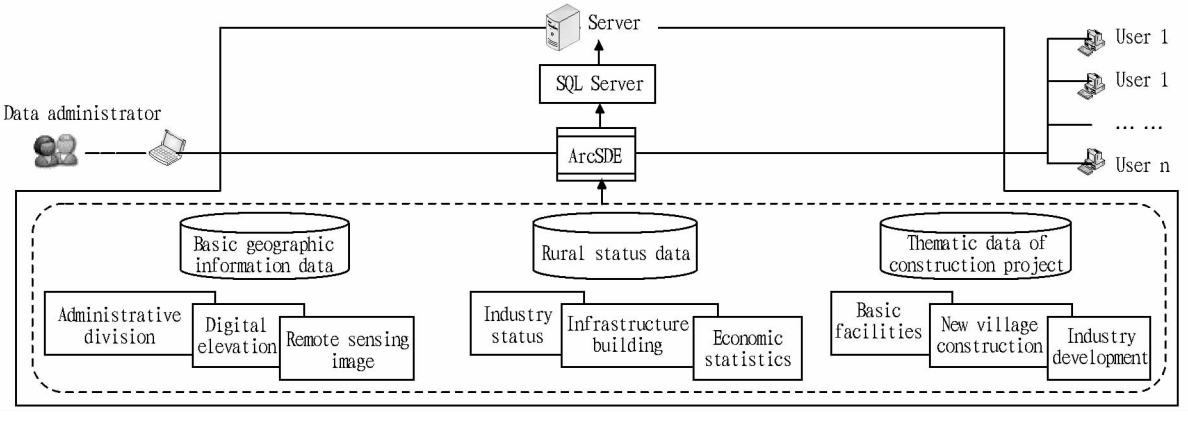


Fig. 2 Database framework

3.2 The conceptual design of database The conceptual design of database is to abstract the data into the conceptual model understood by users. Through the abstraction of the real world, finally we get the ER diagram of system[8-9]. The design of conceptual model often has four methods: top-down, bottom-up, gradual expansion and mixed strategy. We use the bottom-up method, namely first building the local conceptual model and then merging the local conceptual model to get the overall conceptual model of database. Fig. 3 is ER diagram of the new countryside construction project.

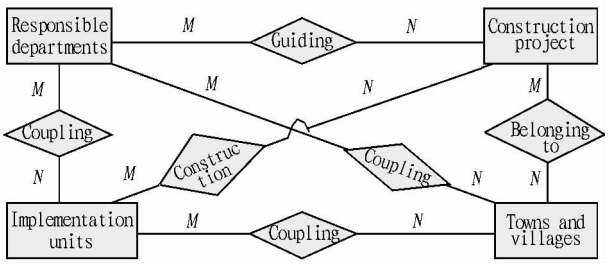


Fig. 3 ER diagram of the new countryside construction project

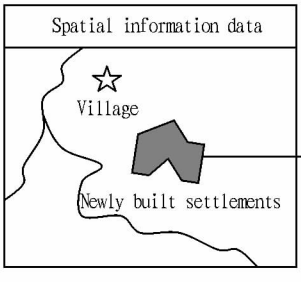
3.3 Logical design of database The new countryside construction database covers different types of massive data, and there is interrelated logic relationship between these data. For the spatial data associated with location, we use vector and raster ways for storage. For non-spatial data, we put the information closely related to the spatial elements (such as village name and size) as the extended attribute items of spatial elements; other general data are stored as the separate attribute data table, and the interoperability is achieved through the association.

3.3.1 Logical design of spatial data. In the new countryside construction database, the basic geographic information and thematic information of construction projects are mostly the vector graphics data, and these data are managed in the form of partitioning. According to different data classifications (such as roads, river net, land use, *etc.*) and different geometric expression forms (points, lines, polygons), we create different layers and unify the geo-referenced coordinates between different objects to achieve the association between spatial data.

Meanwhile, the spatial elements are uniquely encoded, to be associated with the corresponding thematic attribute data. Raster data is mainly the remote sensing image. Given that the image database needs to be constantly updated, we use the way of raster catalog to organize[10], catalogue the image data into a raster dataset, and store it in the same spatial database for query, browse, and updates.

3.3.2 Correlation between spatial data and thematic attribute data. Most of data elements of the new countryside construction projects, are related to the spatial location, and at the same time correspond to the unique thematic attribute data, such as the new countryside construction project corresponding to the data of new village construction subsidy to farmer. The relationship classes between the spatial and non-spatial elements are established to correlate spatial data and attribute data[11-12].

First, we establish the primary key in the spatial database layer and conduct unique coding on each spatial element according to certain criteria; the professional project attribute data are also regarded as the foreign key of data table through corresponding encoding. The primary key and foreign key have the same data type, and convey the same type of information. Taking the spatial data origin class and thematic attribute data as destination class, the relationship classes between them are established, to correlate the spatial entity in the layer and the attribute information corresponding to the entity. Fig. 4 takes the new countryside construction project and the corresponding new village construction subsidy to farmer for example, to illustrate the association between spatial data and attribute data.



The spatial data and attribute table of the new countryside construction project

FID	Shape	Project ID	Project type	Responsible units	……
0	Polygon	100101	Science and technology park	Technology Bureau	……
1	Polygon	100102	Industrial park	Agricultural Bureau	……
2	Polygon	100203	New village construction	Construction Bureau	……
3	Polygon	232004	New village construction	Construction Bureau	……

Relationship class

The spatial data and attribute table of the new countryside construction project

ID	Project ID	Name of head of household	Family size	Nature of construction	Construction area	Subsidy standard	Standard unit	……
1	100203	A	3	Concentrated construction	120	10000	Yuan // household	……
2	100203	B	4	Concentrated transformation	120	3000	Yuan // household	……
3	100203	C	3	Concentrated transformation	120	3000	Yuan // household	……
4	100203	D	5	Concentrated construction	150	10000	Yuan // household	……

Fig. 4 Correlation between spatial data and thematic attribute data

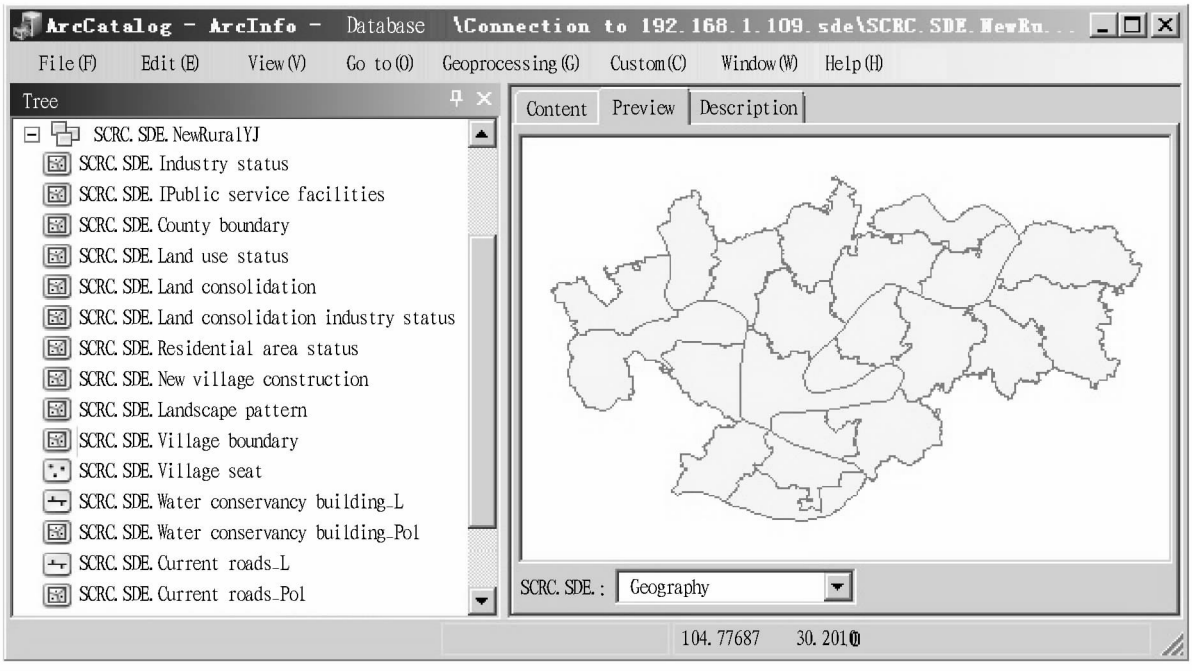


Fig. 5 The database construction of provincial new countryside demonstration zone in Yanjiang District

4 Application analysis

Based on the above analysis of the building of new countryside construction database, we use the following method to establish the database of provincial new countryside demonstration zone in Yanjiang District, Sichuan Province, and the database is shown in Fig. 5. The data are collected through local relevant departments, and some spatial data of key projects are supplemented, improved and updated through field survey. The data are classified and preprocessed in accordance with the classification criteria. The spatial data use WGS84 coordinate system. We scan the paper map, and conduct spatial matching based on the coordinate system. Using the geographic information software, the framing of basic geographic information data is completed according to standard, and the thematic data are vectorized based on the administrative region framing.

The topological relations are established after completing the vectorization of framing of layers, and then the maps are spliced. In accordance with different data classifications and geometric expression forms, different layers are created, to form each complete layer within the framework of region. The non-spatial data include professional attribute data and general form. For the attribute data, the unique code is set in the corresponding spatial data processing, and the spatial entity and attribute records are correlated using space link tools; the general forms are processed using Excel. The data are imported using ArcCatalog in the ArcGIS Desktop.

5 Conclusions

The building of the new countryside construction database not only provides a scientific basis for the authorities to optimize the spatial layout of major new countryside construction projects and implement process supervision, but also serves the fine management of the future work and provides a common platform for the relevant departments involved in the planning, implementation, and management process. Meanwhile, the database can also be extended to the application and regional resource management of other relevant departments.

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bile phone directly, and it is so considerate and convenient to use, saving me much trouble."

5.2 "Meteorology for agricultural condition" is a good help to farmers "My mobile phone have received messages of 'meteorology for agricultural condition' sent from Meteorological Bureau at different time since last May, this kind of short message service costs less with much advantages, and is well targeted, so we can have a correct knowledge of agricultural condition and farming, and engage in agriculture production. It is a good helper to farmers. And the Meteorological Bureau really has done good deeds to farmers."

5.3 Eel raising is inseparable from the "meteorology for agricultural condition" Liantan Village in Xiantao City, the trial area to build new rural areas of Xianhong, takes raising eels as its main farming way, and the whole raising area reaches 1350 acres. Weihua Lu the secretary of party branch in the village told us, "Meteorology is one of the main reasons influencing raising eels, and in July each year when is releasing eel breeding in the field, any change in climate will directly affect the eel's survival rate." At the early stage of releasing fishes, meteorological technical personnel are sent stationing in Liantan Village by Xiantao Meteorological Bureau to provide on-spot guidance to help farmers arrange producing, as well as providing scientific and efficient meteorological services to the raising farmers by short messages of "meteorology for agricultural condition".

5.4 "Meteorology for agricultural condition" boosts the greenhouse vegetable production In Wuhan City where is an important base for greenhouse vegetable production, short message of "Meteorology for agricultural condition" conducts farmers to control climate in the green house, and take preventive measures before disasters to reduce losses and improve efficiency. According to the advantages and disadvantages provided by "Meteorology for agricultural condition" in the freezing rain and snow disaster in 2008, the vegetable growers produce vegetables increasing by 7% -10%, as well as the output value increased by 5% -7%, and created a miracle that there is no disaster in year with major calamity.

5.5 "Meteorology for agricultural condition" conducted farmers to save themselves and fight against drought Hubei Province was hit by the most severe drought since 62 years from the birth of the People's Republic from the autumn in 2010 to the summer in 2011, and the "Meteorology for agricultural condition" message service has tracked the drought and provided farmers with services. It sent the latest drought and weather information, some information to fight against drought, helped the farmers to understand the weather change trends, conducted them to save themselves and fight against drought. It constantly sent weather warning information to more than 13 million households in severely drought-stricken areas, just between the beginning of May and middle of July the most severe month, and provided farmers with timely and effective service to fight against drought.

6 Conclusions

To some extent, the wide use of "Meteorology for agricultural condition" has changed the history of "harvest depending on the weather". "Meteorology for agricultural condition" is just like a green umbrella and brought some hope and warmth to the broad farmers. In current construction of agricultural meteorology service systems and the agricultural meteorology defending system against disasters pushed vigorously by our country, there is much work to do about providing meteorology services targeted at agriculture, rural places and farmers, but we believe that with the strong support of all-level government and the efforts of relevant departments, the meteorological service work will definitely play a much more important part in reducing disasters and increasing farmers' income such important issue that leaders of the Central Party Committee and the State Council have paid great attention to.

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