Acta Technica 61, No. 4B/2016, 271–280

A study on the construction of spatial database and its application on regional agricultural planning[1]

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Abstract. The structure of spatial database is introduced. Through an actual case of agricultural planning, the spatial database is constructed by SuperMap. In the end, the application of spatial database on regional agricultural planning are systematically analyzed. Our objective is to provide technical support for multi-source data management and to make the work of regional agricultural planning more scientific, efficient and multi-functional.

Key words. Regional agricultural planning, SuperMap, spatial database, 3D modeling..

1. Introduction

Regional agricultural planning plays an important role in the development of regional economics and beneficial to the improvement of the living standard of local farmers (Fan & Zhu [1], Liu [2]). Traditional planning methods are mostly artificial, paper-based, unilateral and inefficient. Over the past years, a number of innovative approaches were applied in regional agricultural planning, such as the GIS techniques (Petrisor [3], Wu et al. [4], Liu et al. [5]), computer database (Chen et al. [6], Liu et al. [7]) and 3D modeling techniques (Tang et al. [8], Kumar & Kushwaha [9]). Spatial database, by the way of relational database management, can realize the seamless connection, storage, query, management and analysis application of spatial data and attribute data (Song et al. [10], Hu et al. [11]). Therefore, the construction of spatial database of regional agricultural planning can realize the

[1]This work was financially supported by the Guangdong Science and Technology Innovation and Entrepreneurial Talent Service Project (No. 2015A020224013), the Soft Science project of Guangdong Province (No. 2016A070705039), and the President fund of Guangdong Academy of Agricultural Sciences (No. 201533).

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uniform management of data based on uniform projection coordinates on maps, and make the comprehensive analysis on agricultural situation, spatial feasibility, spatial layout and ecological environment much easier (Zhou et al. [12], Liu et al. [13]), and provide multi-disciplinary, multi-level, multi-target services and decision assistant for planning compilation, spatial layout and evaluation of implementation management (Guan et al. [14]). In this paper, we took an agricultural park planning as an example, elaborate in detail the process of spatial data acquisition, database construction and its application on the platform of SuperMap. Our research may provide technical support for multi-source data management and to make the work of regional agricultural planning time-saving, efficient and multi-functional.

2. Overview of spatial database

A spatial database refers to the collection of geospatial data in a certain area by the means of scanners, keyboards and other input devices and usually organized and stored according to GIS format (Wang & Gong [15]). It is the foundation and core of GIS spatial analysis, decision-making assisting and system development. The integrity and accuracy of database construction has direct impacts on the realization of GIS analyses and management functions (Peled & Gilichinsky [16]).

Spatial database of regional agricultural planning includes spatial data and attribute data, which usually requires regional topographic maps, remote sensing images, economic and social statistical data, soil data, climate data, and other multi-source data. By using the map editing and property management functions of GIS, multi-source data can be classified and processed to realize the seamless connection of maps and attribute data. Figure 1 shows the flow diagram of spatial database construction. In this paper, we took "Master Plan of Rongjiang County (Guizhou province) Modern Agricultural Demonstration Park (2010–2020)" as an example to elaborate the process of spatial database and attribute database construction and their application on regional agricultural planning.

3. Spatial database construction

3.1. Data acquisition and storage

3.1.1. Data acquisition. Data of spatial database usually includes spatial data and attribute data. While spatial data are often acquired by scanning vectorization, field measurements, aerial survey and remote sensing images etc., attribute data are obtained through field surveys, statistics and historical data etc. In this study, spatial and attribute data were acquired by site surveys, remote sensing images, statistical data and historical data of Rongjiang County (Guizhou Province) modern agricultural demonstration park.

1. Remote sensing images (RGB, resolution: 1 m), December 28, 2015, JPG.

2. Park topographic map (1:1000), March 2015, AutoCAD.

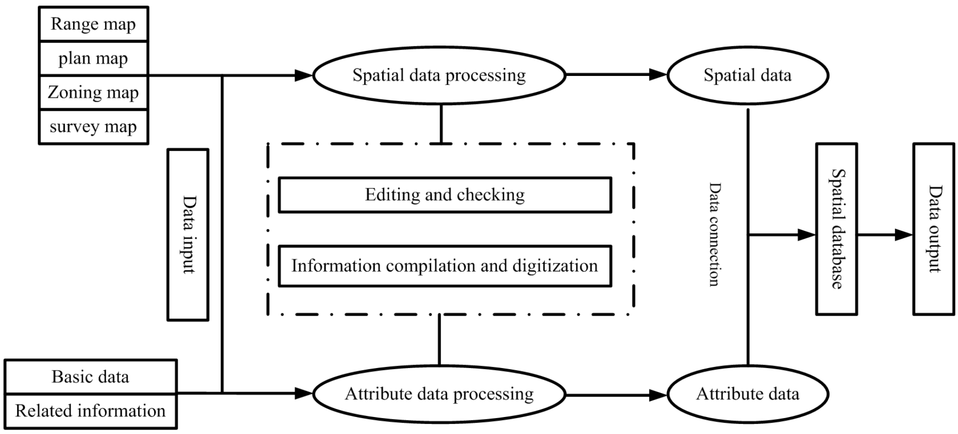

Fig. 1. Process of spatial database construction

3. Land use status of Rongjiang County, Guizhou province, Y2010, paper version.
4. Land use planning map of Rongjiang County, Y2010–2020, Guizhou province (1:10000), paper version.
5. Administrative map of Guizhou Province (1:760000), Y2013, paper version.
6. Statistical Yearbook of Rongjiang County (2010–2015).
7. Related materials on agricultural development situation of Rongjiang County, Y2010–2015.

3.1.2. Data storage. There are two methods for non-electronic spatial data storage: hand tracking digital technology (with digitizer) and scan technology (with scanner) (Zhu et al. [17]), the former is becoming more and more popular. Generally, maps are scanned with accuracy of 200–300 DPI. The obtained image primitives are then vectorized with GIS software. Electronic format spatial data are directly imported to GIS platform for processing and analysis.

In this paper, the GIS spatial databases were constructed by importing digitized maps to SuperMap Deskpro 6R platform. Remote sensing images and topographic map (CAD format) were directly imported while land use maps, land use planning maps, administrative maps were imported in JPG format by 300DPI precision scanning.

3.2. Data classification and coding

3.2.1. Principles of classification and coding. The principles of classification and coding need to be established so that the spatial data and attribute data can be recognized and fast processed by computer. Specific principles are (He et al. [18]) unicity, scalability, legibility, simplicity and integrity.

3.2.2. Data classification methods. There are three data classification methods: linear classification, faceted classification and mixed classification (Zhou et al. [19], Zhang et al. [20]). In this study, mixed classification was applied according to the characteristics of different maps.

3.2.3. Data classification and coding. Data classification and coding refers to establishing code symbol sets and setting the length and size of codes for spatial and attribute data. In present study, the vector and raster data were encoded, respectively. Vector data were classified and encoded based on point, polyline and polygon data, in which land data were classified and encoded in two levels based on "land use classification" (GBT21010–2007) (Table 1), other data were encoded according to the actual demand of the project based on the information nature of the maps. Raster data were represented by specific data that representing the actual value.

Table 1. Codes of land classes

Land class 1		Land class 2	
arable land	01	paddy field	011
		irrigated land	012
		dry land	013
garden land	02	orchard	021
wood land	03	forest land	031
		bush forest land	032
grazing land	04	natural grassland	041
residential land	07	rural homestead	072
traffic land	10	rural road	104
water and water facility land	11	river	111
		pond	114
		inland beach	116
		ditch	117
other land	12	agricultural facility land	122

4. Data processing and spatial database construction

4.1. Construction of attribute database structure

The attribute data were divided into current status data and planning data according to the planning phase of the park and stored in two packets. The current status data packet included elevation points, the park range, remote sensing images, DEM, land use status, elevation grade, slope classification, current roads etc. The planning data packet included industrial evaluation, field planning, pool planning, pumping stations planning, water monitoring points, water pipes, drains planning, road planning and pig farms planning etc.

For every map, an attributive structure table was established according to layer class and purpose. For every layer, a relational attribute table was established with the point, polyline and polygon data. Point layers, such as the elevation point layer, need to determine the elevation data, thus the "elevation points" field was added to default field in order to save the elevation data (Table 2). Polyline layers, such as the road layer was added to a "class" field in order to separate the roads of different class (Table 3). Polygon layers, such as the land use status, were added ("Code of land class I, Name of land class I, Code of land class II, Name of land class II, Area of land class II"), see Table 4.

Table 2. Attribute structure table of the elevation point layers

Field names	Alias	Field types	Field length
*SmID	SmID	32 bit integer	4
Elevation points	Elevation points	Single precision	4

Note:"*" means the default field of SuperMap, the same below.

Table 3. Attributive structure table of the road layers

Field names	Alias	Field types	Field length
*SmID	SmID	32 bit integer	4
*SmLength	SmLength	Double precision	8
*SmToPoError	SmToPoError	32 bit integer	4
Type	32 bit integer	Text type	12

Table 4. Attributive structure table of the land use status layers

Field names	Alias	Field types	Field length
*SmID	SmID	32 bit integer	4
*SmArea	SmArea	Double precision	8
*SmPerimeter	SmPerimeter	Double precision	8
Code of land class I	Code of land class I	Text type	3
Name of land class I	Name of land class I	Text type	50
Code of land class II	Code of land class II	16 bit integer	2
Name of land class II	Name of land class II	Text type	50
Area/Mu	Area	Single precision	4

4.2. Map editing and attribute data input

The map data were edited by the way of artificial description and automatic vectorization. Attribute data of each layer were inputted and edited according to its corresponding information. Take park status layer for example, the plotting CAD base map was used for automatically capture and editing. The attribute data were inputted according to GBT21010-2007 with the aid of remote sensing images for status classification and identification. The area data were calculated through SuperMap default field "SmArea". For scanned layers like the land use status and land use planning map, their attribute data were digitally scanned and inputted artificially. Similarly, for other layers, their maps data were edited and attribute data were inputted according to data features and actual research demand.

4.3. Mapping and visualization

According to different thematic needs and corresponding drawing specification, map layers can be selected, combined and displayed through human-computer interaction. Various spatial analysis process and results, such as the land use planning map (Fig. 2) and the slope classification map etc. (Fig. 3) can be displayed intuitively in a graphical view.

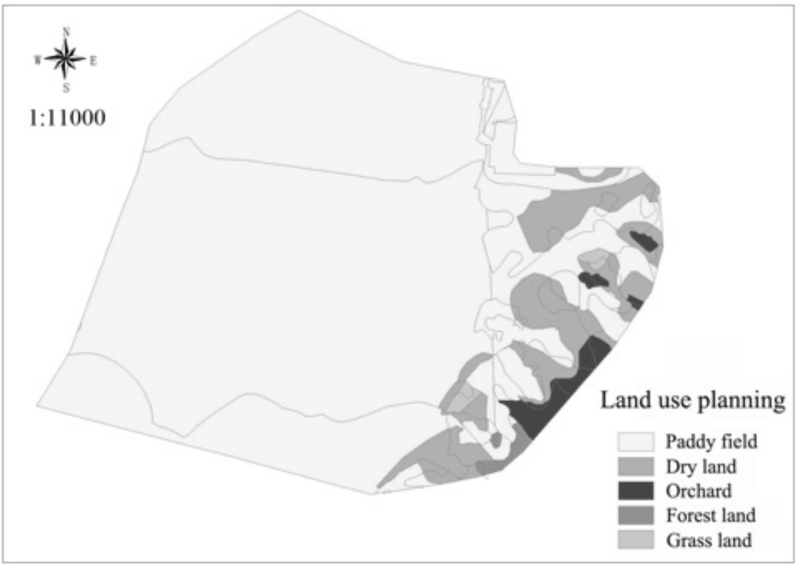

Fig. 2. Land use planning map of Rongjiang County

5. Application of spatial database

Through the combination of planning data, information and maps, the spatial database can provide scientific planning basis and management support for regional agricultural planning, strengthen the quantitative analysis of map data, further enhance the feasibility and implementation of regional agricultural planning to facilitate the analysis and planning of industrial layout, acquire more precise planning data and improve planning efficiency. The application of spatial database of regional

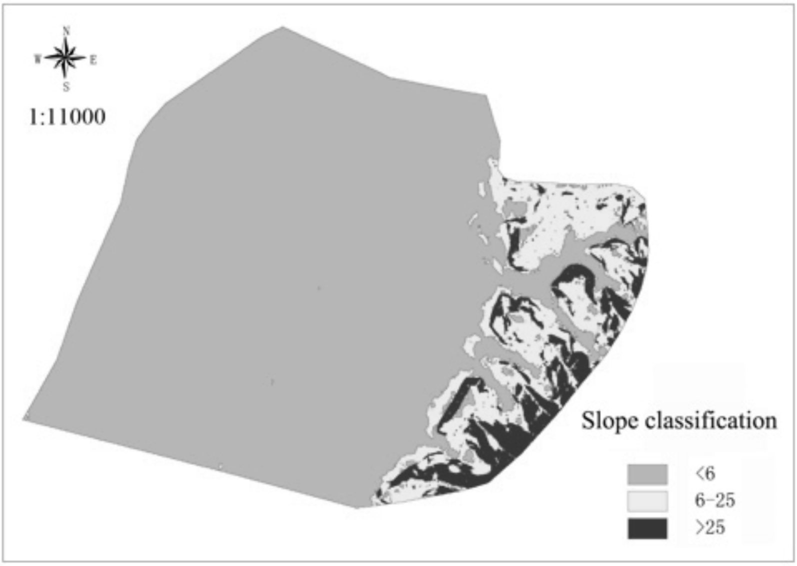

Fig. 3. Slope classification map of Rongjiang County

agricultural planning mainly includes the following four aspects:

Firstly, spatial database is the basis of comprehensive analysis of status data, objective and accurate evaluation of regional agricultural planning. With spatial database, the status data such as land, soil, hydrology, climate, transportation and location etc. are standardized and modeled, making it easy to analyze the advantages vs disadvantages of status production, processing and distribution of regional agricultural, and provide technical support for regional agricultural planning.

Secondly, with spatial database, it is convenient to analyze the favorable and unfavorable conditions of the upper planning and related planning in the project areas, thus to provide accurate information for spatial feasibility of planning. In addition, regional agricultural planning is often constrained and controlled by higher territorial planning, land use planning, town planning, transportation planning and other related planning. With the help of spatial database, it is possible to collect multi-sectoral spatial planning simultaneously and to provide some important information, such as the planning area, for regional agricultural planning.

Thirdly, based on spatial analysis of topography, water source, roads and farmland water conservancy facilities, we can accurately plan the layout of industrial land, set infrastructure layout to provide accurate data for the investment and help to guide the construction design (Dong, et al. [21]). Spatial database is a collection of multi-source data involved in agricultural planning, with it we can select agricultural industry through the establishment of different planning models, and provide support for objective analysis and evaluation of the implementation of agricultural planning.

Finally, based on GIS platform, some application systems can be developed and make the planning process and results integrated, thus to facilitate the implementation of planning. With the addition of some other modular such as the planning implementation modular and planning management modular, it is possible to realize the information management of the whole process, from preparation to implementation of regional agricultural planning.

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Received November 16, 2016