Small-Scale Soil Database of Jilin Province, China

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Abstract. Choosing the example of Jilin province, the construction method of small scale soil database is discussed; the materials gather from the second soil survey projects are digitized; Jilin province 1:1000000 small scale soil database are established. Commonly, soil database includes the three parts of the spatial database, the attribute database and the metadata database. In the end of this paper, the application prospect of soil database is forecasted; the shortage of existing research results is discussed. The method would provide reference for the construction of small scale soil database in other provinces and regions.

Keywords: small scale, soil, database

1 Introduction

The study of soil resource database has been performing abroad since 1960s. In 1966, US soil protection division (SCS) established a new, comprehensive national soil information system NASIS. Later, in 1971, Canada developed CanSIS which starting from 1963. Then United Kingdom, Australia and other developed countries established their individual soil database.

Although launch researching soil database relatively late in China, it develops rapidly in recent years. Soil workers began to attempt the construction of soil database from the mid-1980s. In 1986, soil erosion information system was developed by remote Sensing Center of Peking University, which firstly completing the construction of regional soil erosion information database in domestic. Besides this, under the aid of Chinese Academy of Sciences *Tenth Five-Year Plan*, Nanjing Soil Research Institute built China soil database and established China soil information system SISChina[1-2].

In this paper taking Jilin small scale soil database as an example, the construction method is introduced, the building process of soil database is explored, and the problems existed are analyzed. Expect providing reference for relevant departments and fields while using soil database.

2 Overview of research area

Jilin province lies in the central part of northeasten China, is located in the east longit-

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ude 122-131, 41-46 degrees north latitude. Jilin province consists of eight prefecture-level cities(including Changchun, Jilin, Siping, Songyuan, Baicheng, Tonghua, Baishan, Liaoyuan) and one autonomous prefecture(Yanbian). It has a total area of 190,000km^2. In which, agricultural land accounted for 21.1%, forestry land accounted for 48.6%, animal husbandry land accounted for 8.1%, fisheries land accounted for 3.4%, and other land accounted for 18.8%. And has a total population of 27.3 million, agricultural population occupies 50.34% above, 13.49 million.

Jilin has the temperate monsoon climate and the obvious continental nature. Southeast is high, northwest is low and the Midwest is broad plain. The terrain is tilted from southeast to northwest, is characterized by obvious southeast and low northwest.

The total of province is divided into two first grade landform areas, the west is the subsidence based Songliao plain depression area, the eastern part of the uplift and erosion based Laoyeling Changbai Mountain uplift zone including medium mountains, low mountains, hills, platform and plain 5 kinds of landforms. In 1979 the second soil survey, the interim plan was formulated, and the total soil was classified into 19 soil categories, 59 sub categories [3].

3 Soil data analysis

The soil database is composed of spatial database, attribute database and metadata database, which concerns a variety of data. These can be divided into spatial data, attributes data and metadata by type [4], also can be divided into the census data and research data by source. There are the second Jilin province soil survey *soil Zhi* 55 copies(city, county), small scale maps and Jilin province second soil survey thematic research bulletin that China science and technology press in 1991.

3.1 Spatial data

From the table 1, it is clear that spatial data includes 1:500000 scale geological maps, 1:500000 scale topographic map and small scale other thematic maps of the second soil survey. This covers special soil type, parent material, nutrient index, trace element, and modified partition [5].

Table 1. Spatial data

Name	Scale	Create Time	Source	Format
Jilin geological map	1:500000	1989	Jilin Bureau of Surveying and Mapping	Paper
Jilin topographic map	1:500000	1989	Jilin Department of Geology and Mineral	Paper
City/Country soil maps	1:500000	1983-1985	City or country soil survey office	paper

3.2 Attribute data

Refer to *Jilin Soil* and other 55 soil books(province, city, district and county), with the final classification system of the second Jilin soil survey as the standard, original

census classification and code name are retained in database, and the national standard of soil classification is added(Table 2). Moreover, the topography, geology and other types of small and medium scale spatial database has been completed in China. In order to avoid data duplication of collection we should pay attention to priority on using of digital products.

Table 2. Attribute data

Name	Scale	Create Time	Source	Format
Jilin soil map	1:1000000	1991	Soil and Fertilizer Station of Jilin Province	Paper

3.3 Spatial metadata

It describes the contents, quality, representation, spatial reference and management of data, and achieves the dual purpose of effective management and reasonable sharing via providing geospatial information. For data producers, on the one hand, could release the geographic spatial data efficiently, maximize play the value of existing geospatial information, and facilitate understanding of the relevant information. On the other hand, according to the contents of the spatial metadata could effectively manage and maintain the existing geospatial data, so as to prevent the influence caused by staff changing and improve the data availability. For the data exchange center at all levels, realizing the fast searching and accurate positioning of the geospatial information based on the spatial metadata that data producer provided, and achieving data sharing last[6].

Metadata carries maximum convenience for data users querying and retrieving effective geospatial data, understanding the existing geospatial data, choosing the appropriate geospatial data, and promoting the reuse of geospatial data. Spatial metadata refers to national geographic information metadata standard.

4 Construction of soil database

Establish soil spatial database, property database and metadata database with ArcGIS 10 under the condition of soil data acquisition. Connect property data and metadata data with the key fields, and finally form soil database.

4.1 Construction of spatial database

Choose ArcGIS 10 as the database and spatial information processing platform. Image maps are vectored after scanning with the built-in ArcScan and edited with ArcMap, and metadata is processed(inputting and editing) by ArcCatalog, spatial data was finally stored in Geodatabase format.

4.1.1 Map pretreatment and scanning

Choose well preserved paper maps, if there is deformation, to preprocess the paper maps prior to scanning. It depends on the clean condition of the surface, remove the

stains, clean the elements of the map, paint, which all to reduce the error of the later processing and avoid rework or repeat construction[6]. Select appropriate scanning methods and parameters on map medium and map element while scanning, province, city, county, district, a total of 55 soil diagram sequentially scanned into the computer. While scanning must pay attention to keep supply level of paper angle, maps and a horizontal line angle does not exceed 0.2 degrees, the scanning resolution shall not be less than 300 dpi, image scanning should be clearly and correctly reflect the design elements, the deformation is larger amplitude block scanning, unqualified image should be re scanned.

4.1.2 Map mosaic registration

Mosaic and register maps using ArcGIS after scanning, formed soil maps have the unified parameters. Subsequently, open the soil maps and see the loading image content, register images using georeferencing function of ArcMap and add control points. Increase the number of control points when the deformation errors exceed the limit, Then click the Auto adjust button to correct the images, and click the save button to save the control points to the file, and load the control point from the file. Finally save and generate the sampling data, click the rectify toolbar to correct and raster to generate a new raster file.

4.1.3 Element vector

According to the contents and characteristics of soil type map, the various factors are divided into point thematic elements, linear thematic elements and areal thematic elements(Table 3). The elements are vector based on the layers with the interactive method. Vector elements in the process of constructing the spatial database, soil map digitalization is tedious, time-consuming, and is also the most important, mainly including the extraction of soil boundary, soil type note notes and profile position coordinates information. In order to meet the requirement of precision, errors are corrected by the automatic generation of standard frame theory module on ArcGIS, also are eliminated in spatial data acquisition and record.

Table 3. Vector

Type	Content
Point thematic elements	Section point, height point
Linear thematic elements	Soil classification wiring, highway, railway, river
Areal thematic elements	Soil type maps, reservoirs, lakes, and residential areas

4.1.4 Data check

In order to guarantee the quality of database, the vector results must be checked. Data checking is divided into two parts, routine checking and topological checking. Routine checking is mainly checking the vectorization results and scanning the original maps. And checking wrong painting automatic digitization brought, screen vectorization leakage phenomenon, confirm the original fuzzy elements, and fine correction of picture mosaic, correct figure line missing, note record does not match the other errors, added an important feature information and each element attribute

values are evaluated to confirm whether the error. Topology check is to check and revise several of topological errors of vector data, and finish related face shape element topology construction, and check the consistency of pattern spot attributes, at last forms Jilin province's small scale soil spatial database.

4.2 Construction of attribute database

Soil attribute data mainly from the soil records of counties and districts and reference to the soil data in the provinces, the municipal soil annals and other documents. The attribute data is stored in two ways of the pattern spot attribute and attribute table. Each map layer corresponds to a particular two-dimensional attribute table for the storage of spatial and non spatial attribute information of this layer entity. As to the information that map surface difficult to express, such as layered soil, bulk density, texture and mechanical components. These information all obtained from the soil records and other related materials. Attribute data table is established[7-8].

4.2.1 Soil attributes data

Soil attribute data are supposedly based on the second soil survey of Jilin province, mainly including soil profile data (soil profile of traits), nutrients (soil and fertilizer) data, background data (in the study area over the years of agricultural production, study area in recent 20 years meteorological data and society, depending upon the type of economic, demographic information). It will be seen that the basic mapping units are soil properties and soil species on Jilin 1:100000 soil maps, soil properties and soil analysis data are classified which refer to Jilin province local records and regional soil records. Preserving the original census classification name and coding, and increasing the national standard soil classification in database. Considering the possibility of errors in soil annals and soil map, attribute data must be tested first.

4.2.2 Attribute data coding

In order to achieve the efficient management of data information, the soil type name and other information must be coded while establishing the soil database. Attribute data can provide three kinds of classification query, that is, the county census classification, the provincial classification and the national standard classification, so as to establish the traceability relationship of different soil classification system. The coding of profile attributes is composed of two parts, that is, the coding of the section sample points and the information coding of the physical and chemical properties of the profile. Other statistical information is coded according to relevant national requirements.

4.2.3Construction of attribute database

According to the types and features of attribute data, design field name, field type, build attribute table structure, and organize prepared attribute data into tables.

Build attribute data's E-R model according to connections and restricted conditions between various entities and their attributes on the attribute data while building the attribute database, design the organizational structure of tables for each entity, include field names, field type, field length, etc. Reduce data redundancy as possible, maintaining the consistency of data in database usage and maintenance. The

organization of soil attribute data is of the same importance as the soil map digitization. Because of the attribute of the section and the data entry is more complicated, which easily bring out errors while inputting data. Therefore checking process is very important. The soil attribute data entry includes the profile data and the data in table. Among them, the typical profile is mainly from the county and the district soil.

4.3 Construction of metadata database

Metadata is the data describes data, mainly for describing data, data quality, data source, spatial reference, access and access mode, etc. Soil database metadata can be for data producers to provide the appropriate data, to facilitate understanding of the relevant information, so as to effectively save, management and maintenance of the data and prevent the influence caused by the change of data production staff, improve the data availability; on the other hand, soil metadata is conducive to user data correctly and quickly to query the data retrieval, better understanding of the data content, promote soil data sharing and exchange. In the construction of small scale soil database, the spatial database and attribute metadata database completed by referring to national geographic information metadata standard.

4.4 Construction of soil database

Establishment of soil database, spatial database and attribute database are indispensable. Without attribute data, the soil database established can only show soil types in the province's spatial distribution, and each physical and chemical properties of soil type not are stored in soil database.

Regional differences and complexity of data type leads to various kinds of corresponding relations between soil mapping unit and attribute data, which bring new difficulties realizing the connection according to a key field. With the increase of the scale, soil patches number also showed orders of magnitude increase.

Metadata database, adopt a "county (city, district) + soil type + digital" approach to spatial association pattern and attribute data.

First, analysis the layer metadata, obtain area ranges and properties field, classify mapping unit and property data via field searching according to the county (city or district). Then search corresponding map spot number and attribute table respectively in the spatial database and attribute database according to the soil type, and record the corresponding relations, so as to realize the one-to-one correspondence of the attribute list attribute record and spatial pattern unit. The tables of Jilin soil database includes surface tillage bedding characters statistics, typical profiles of attribute tables, statistical profile attribute data table, table query classification, distribution of soil, and taxonomic classification of reference.

5 Conclusions

The data might be out of date since the second soil survey carried out more than thirty years ago and great changes have taken place in the current land use and soil quality.

In addition, the errors on paper diagram under the influence of drawing level and preservation methods are unavoidable, for example, pattern line deletion, pattern note omission, different drawing boundaries dislocation and other.

The errors on paper soil map were corrected in process of building database, the quality of digital map compared to the original soil maps have greatly improved. Meanwhile, supplementary terrain, geology, land use and other information also makes database practicality has been enhanced. However, in the current database and the results of the application level, there are still some problems worthy of discussion and analysis. Soil database as a basic achievement, its application prospect is broad and related to agricultural, forestry, ecology and other disciplines and fields have a greater demand [9-11]. It is necessary that carry out the new soil survey and update soil patches and attribute data, both based on the new soil database, and refer to the second land survey and the cultivated land fertility survey results.

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