Research on the Design and Application of Earthen Sites Information Modeling Under the Background of GIS Practical Course in Shanxi

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Abstract. To enrich the practical content of the course of GIS, this paper introduces the design and application of earthen sites information modeling from the perspectives of information collection, database designing, information input and processing, information analysis, information display, etc. in Shanxi. It has been proved that students have learned how to establish a complete information management platform and have applied the information data in the platform for relevant analysis, which has achieved good results and has been suitable for further promotion in the later stage.

Keywords: Earthen Sites · Information Modeling · GIS · Practical Course · Design and Application

1 Introduction

The course of *Geographic Information System (GIS)* is a basic practical course for students majoring in architecture and urban and rural planning in Taiyuan University of Technology. It is a professional elective course designed to enhance students' practical application ability and improve their comprehensive cognition in their professional fields. It has been taught in English or bilingual [1] for many years. It has the advantages of tight rhythm, high-quality undergraduate teaching tasks, and international exchange in GIS technology.

By summing up the existing teaching problems, the phenomena are found as follows: Chinese students do not like to discuss in class in English. When teachers threw out problems in English, it was often in a cold field phenomenon. Different from the foreign students' elective system, domestic students took more elective courses each semester and spent less time after class. It's unrealistic to require them to complete all practical content after class. In the context of quality education, it is a general trend to reduce class hours. How to improve students' participation in the classroom and let students complete the teaching content with high quality has become an urgent problem for the teaching team.

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This course focuses on the training of students' practical operation and cultivation of their academic innovation ability and practical innovation ability. In the early learning process, students had a certain theoretical understanding of GIS, but they had few practical links. To solve above problem, referring to the teaching reform research of many colleges and universities [2–4], the team has purposely added a multi-step, complete course practice link in the second half of the course, starting from information collection, database designing, information input and processing, information analysis, information display, etc. to instruct students how to establish a complete information management platform and apply the information data in the platform for relevant analysis. A relatively mature case is selected for brief introduction.

2 Information Modelling Construction

Different from the planning idea of traditional cultural relic, the current special protection plan for cultural relic needs to strengthen the management of spatial data, most of which are the integration of historical and cultural heritage spatial information into the territorial space basic information platform. In other words, the management of cultural relic resources has shifted from classified management to the spatial management stage of building heritage information models.

By comparing and analyzing the development history of BIM, CIM [5], LIM [6] and HIM, we can see that the information modeling of earthen sites belongs to a special study of HIM. It can digitally express the traditional paper materials and relevant spatial information in the platform of HIM, managing all information by levels, recording the whole life cycle process and recording the research contents of scholars and providing a complete professional collaborative management platform for a series of life-cycle management work. After the built model, scholars in different fields can query, insert, update and modify on the platform. This model can strengthen the mutual cooperation among various disciplines and achieve the goal of collaborative work.

At present, the research work of national key cultural relic protection units (including Great Wall of Ming Dynasty) in Shanxi is less developed, and there is no accurate geospatial data information as a reference, which makes the research mostly stay in the qualitative analysis stage. This paper uses GIS software to complete the basic data model construction of famous historical and cultural cities, towns and villages, national key cultural relic protection units (including Great Wall of Ming Dynasty) and Shahukou, including: information collection, database designing, information input and processing, information analysis, information display, etc.

The GIS model construction process (Fig. 1) is as follows: to query the geographic coordinate system by using Baidu Map plug-in and import data into Baidu coordinate module of GIS database; to convert data from Baidu coordinate system into GPS coordinate system by self-developed data conversion software; to attribute information through a variety of information processing methods to complete additional information recording; to use GIS self-developed module to complete information analysis.

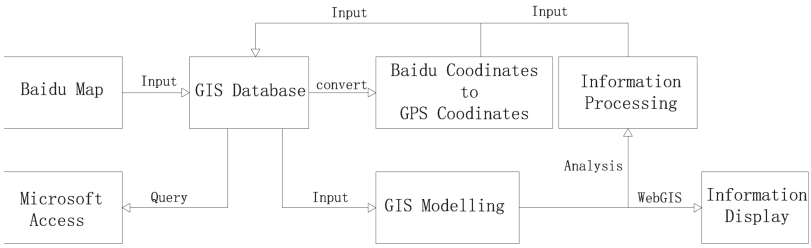

Fig. 1. Figure with GIS modelling construction process.

3 Building up Information Modelling

3.1 Information Collection

Information collection needs to record the preservation status, damage factors, damage degree and causes of cultural relic and buildings. It needs to sort out the existing information and understand the research object, and its purpose is to provide basic data and technical parameters for the later study of the disease development mechanism of Shanxi earthen sites. Here we take vector data as an example to demonstrate information collection.

The existing vector data include provincial, municipal and county zoning maps, river distribution maps, etc. The three popular data based on cultural relic are not open to the public, so it is necessary to focus on the geographical location data of key national cultural relic protection units (including Great Wall of Ming Dynasty).

1) **Coordinate acquisition**

The coordinate picking system in this paper selects Baidu picking coordinate system, and the obtained Baidu coordinates need to be converted into GPS coordinates. The picking method is application query (Fig. 2).

2) **Baidu coordinates to GPS coordinates**

a) *Reverse GPS data*

At present, the geographic information data we have obtained is Baidu Coordinates. At this time, we need to process the data and convert it into GPS coordinate data.

b) *Programming Language Design*

After verifying the accuracy of the above methods, C# language can be used to make application applets. The purpose is to use the Data Change application (Fig. 3) to automatically convert the coordinate data imported into Microsoft Access Database to reduce the workload of manual operation.

Through the above methods, this book has obtained complete GPS geographic information coordinates of famous historical and cultural cities, towns, villages and national key cultural relic protection units (including Great Wall of Ming Dynasty), providing a complete geographic coordinate data support for the later heritage protection research.

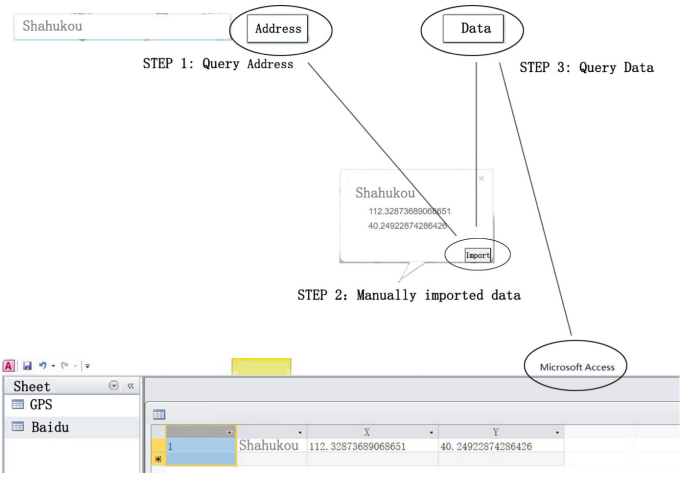

Fig. 2. Figure with coordinate acquisition system application program.

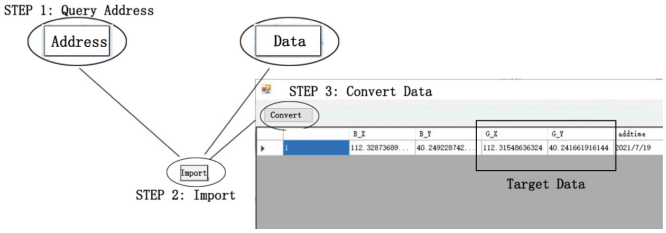

Fig. 3. Figure with coordinate conversion system application program.

3.2 Earthen Sites Database Designing

1) **Geographic database creation**

To create file geodatabase in ArcCatalog. At present, the database of this book uses file geodatabase that comes with ArcGIS to organize data. Each file geodatabase can store data up to 1 terabyte. Data can be stored and sorted through multiple databases. When the amount of data increases gradually in the later period, ArcSDE Geodatabase based on SQL Server without storage limit can be considered as the data storage medium to store data and complete the centralized management of geographic data.

2) **Element dataset creation**

GIS includes two kinds of geographic coordinate systems. In the selection of geographical coordinates for feature datasets, vector data coordinates are often used as the Earth coordinate system, and they need to be converted into projection coordinates for

backup. In this book, the earth coordinate system is set as WGS_ 1984, the projection coordinate system is set to Xian_ 1980_ 3_ Degree_ GK_ CM_ 114E.

3) **Spatial data storage**

Import the existing data into the feature dataset. The data here includes all vector data and raster data of famous historical and cultural cities, towns and villages and national key cultural relic protection units (including Great Wall of Ming Dynasty). Vector data includes regional data of provinces, cities and counties in China, linear data of national roads and rivers, accurate geographic spatial point data, etc. Grid data includes relevant satellite images.

4) **Attribute Data Storage**

The attribute data of the database is qualitative or quantitative data describing the ontology attributes of cultural relic, which is non-spatial data. It includes Tabular Data and Text Data. Table data is typical attribute data, and text data is a supplement to table data, which can be recorded through dBase, Info, Text, Microsoft Excel, etc. Based on the comprehensive performance of data information processing, this paper selects Microsoft Excel as the storage method of data records to complete the research on cultural relic, cultural relic value, environmental conditions and major diseases.

5) **Data association**

The association between a spatial database and an attribute database is encoded by a unique object identifier (Object ID). In the association process, you can use the Joining button in the Attribute Table of ArcGIS data to link and attach data.

6) **Database coding**

The serial number of National Historical and Cultural Cities, Towns or Villages is marked with 9 digits. Wherein, the 1st numerical value represents the type number, 1 for famous cities, 2 for famous towns and 3 for famous villages. The 2nd numerical value represents the published batch code, 1 for the first batch, 2 for the second batch, 3 for the third batch and 4 for the later added list. The 3rd to 6th numerical values represent the year of publication. The 7th to 9th numerical values represent the order of the batch.

The serial number of National Priority Cultural Relic Protection Sites is numbered with 9 digits. Among them, the 1st numerical value represents the batch code published by the national key cultural relic protection units. The 2nd to 5th numerical values are the sorting code of each batch unit. The 6th numerical value is the type number of the cultural relic protection unit, 1 for ancient sites, 2 for ancient tombs, 3 for ancient buildings and historical memorial buildings, 4 for grotto temples and stone carvings, 5 for important historical sites and representative buildings in modern times, and 6 for others. The 7th to 9th numerical values are the sequence number of each type of Chinese property protection unit.

The serial number of the Great Wall in Ming Dynasty is marked with 5 numerical values. Among them, the 1st numerical value represents the town number, 1 for the number of Gansu Zhen, 2 for Guyuan Zhen, 3 for Ningxia Zhen, 4 for Yulin Zhen, 5 for Shanxi Zhen, 6 for Datong Zhen, 7 for Xuanfu Zhen, 8 for Jizhou Zhen, and 9 for Liaodong Zhen. The 2nd to 4th numerical values represent the order of the towns. The

5th numerical value represents that the building belongs to the town road station, 0 for a town, 1 for a road, 2 for an acropolis, 3 for a city, and 4 for a fort.

3.3 Information Input and Processing

The process of information input can also be called the process of model building. GIS model information input is to input the collected geospatial location information and attribute information into the GIS information management platform (Fig. 4).

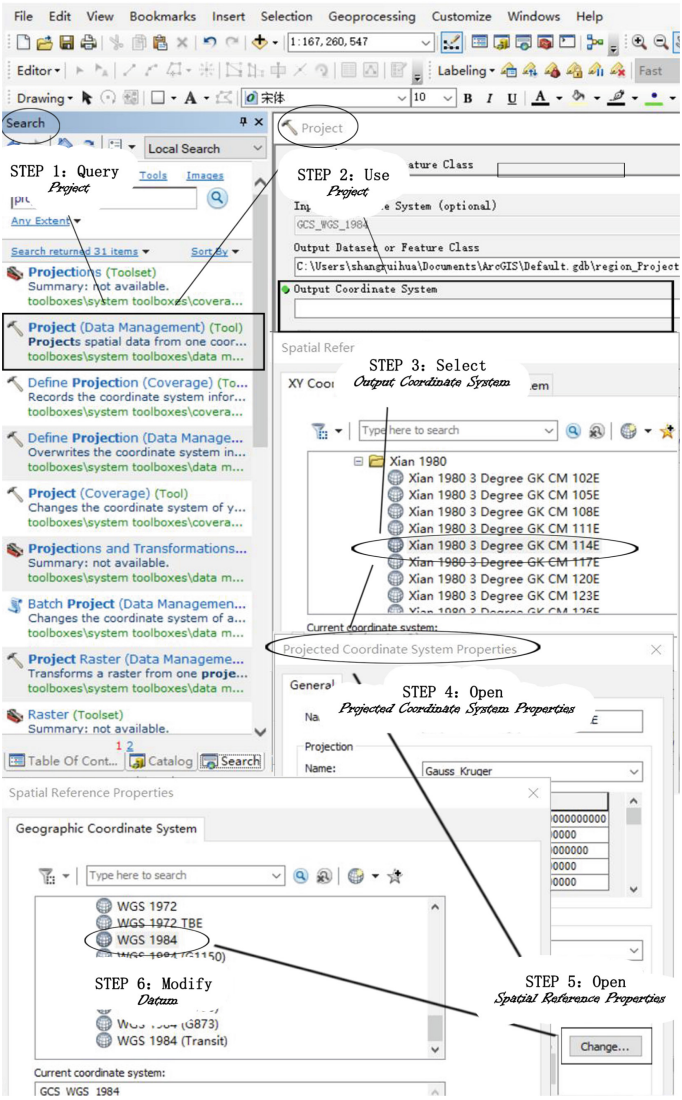

Fig. 4. Figure with steps from geographic coordinates to projected coordinates.

Information processing refers to the orderly classification and hierarchical division of the entered information for later information analysis. The classification and grading principles are as follows:

1) **Top ranking of important information**

The information that directly affects the model construction is more advanced in the classification. The higher the classification is, the more important the data information is, and the less easily the data information is ignored.

2) **The information hierarchy is just right**

Too detailed parameter settings will lead to the need to raise the level of information in the later stage to meet the requirements and increase the workload of data analysis in the later stage. Too rough parameter setting will lead to a large amount of data collection and supplement work in the later stage to solve the problem, and may also affect the information docking with other related software. Therefore, the information hierarchy should be properly divided.

3.4 Information Analysis

The information model of earthen sites is a special study of heritage information model. This paper selects GIS software as the comprehensive information management platform of earthen sites, studies the temporal and spatial distribution characteristics of earthen sites(Fig. 5–7), designs the information model construction process for different software, completes the information collection, database design, information input, information processing and information analysis of earthen sites information model, and puts forward effective suggestions for future model display and application.

The conclusions are as follows. There are 127 National Historical and Cultural Cities, 312 National Historical and Cultural Towns, 454 National Historical and Cultural Villages and 10 National Historical and Cultural Blocks in China. There are 4 National Historical and Cultural Cities, 15 National Historical and Cultural Towns, 96 National Historical and Cultural Villages and 2 National Historical and Cultural Blocks in Shanxi. There are 5058 National Priority Cultural Relic Protection Sites in Shanxi, including 1188 ancient sites and 420 ancient tombs. Great Wall is announced in 1st, 3rd and 4th

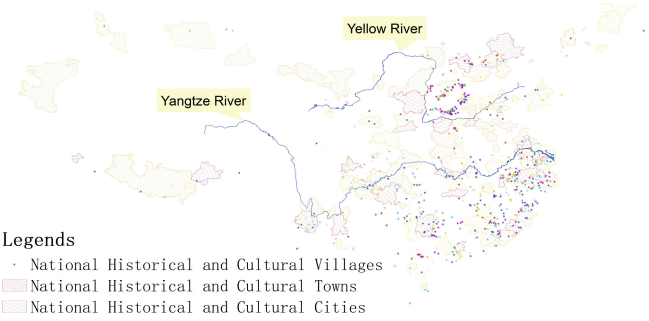

Fig. 5. Figure with National Historical and Cultural Cities, Towns or Villages.

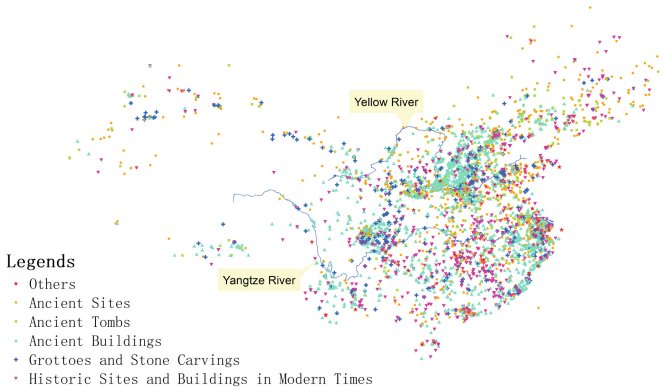

Fig. 6. Figure with Priority Cultural Relic Protection Sites.

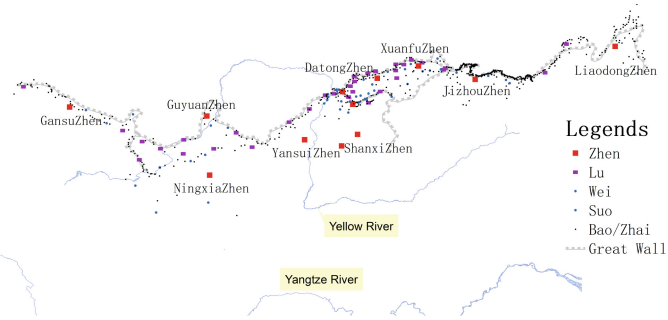

Fig. 7. Figure with military defense system in Ming Dynasty.

batch and 6th and 7th batches of Great Wall are supplemented in 5th batch in National Priority Cultural Relic Protection Sites.

4 Conclusions

After years of practical experience, the bilingual course of *Geographic Information Technology (GIS)* in Taiyuan University of Technology has become increasingly perfect and formed its own unique teaching characteristics. It has been proved that students have learned how to establish a complete information management platform and have applied the information data in the platform for relevant analysis, which has achieved good results and has been suitable for further promotion in the later stage.

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