Application of Spatial Information Technology in Heritage Investigation and Protection Planning of the Grand Canal

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Abstract: With an overall length of 1,784 km, the Grand Canal from Beijing to Hangzhou is a giant, dynamic and line-typed cultural heritage. After 2500 years' evolution, it has gained a complicated heritage structure. Based on the characteristics of spatial information technology, together with the actual needs of applying for the world cultural heritage, this paper focuses on the problems in heritage investigation and protection program of the Grand Canal, probes into the application process of spatial information technology in heritage investigation and protection program, and designs the assistant programming system for the Grand Canal from Beijing to Hangzhou. Results show that: spatial information technology plays an important role in heritage investigation, value assessment and protection programming of the Grand Canal; meanwhile, it can increase the efficiency of the protection program and strengthen the scientificalness and practicality of the programming effect.

Key Words: Spatial information technology, the Grand Canal, Protection Planning

1 Introduction

As a feat of great daring for human beings to remodel nature, the Grand Canal from Beijing to Hangzhou is a main communication artery in Chinese history; it has played a magnificent role in unifying the country as well as in economy and cultural communication. The Grand Canal from Beijing to Hangzhou "is not only a large ancient water carriage and irrigation project, but also a special line-typed cultural heritage, and a large-scale cultural landscape heritage as well." [1] It is furthermore viewed as "a symbolic project of China's great ecological civilization" [2]. Till today, almost the 900-km-long channel segment to the south of Jinan has still been in used and plays an inestimable role, which is the characteristic, function and value that other cultural heritages cannot compare with. In 2006, the state bureau of cultural relics declared the Grand Canal to be the national key cultural unit, and included it into the ready list of world cultural heritage the same year. The east route of south-to-north water diversion project which is now under construction has used part of its river course. The Grand Canal from Beijing to Hangzhou is now facing a new opportunity for development. Figure 1 is the river course of the modern Grand Canal from Beijing to Hangzhou.

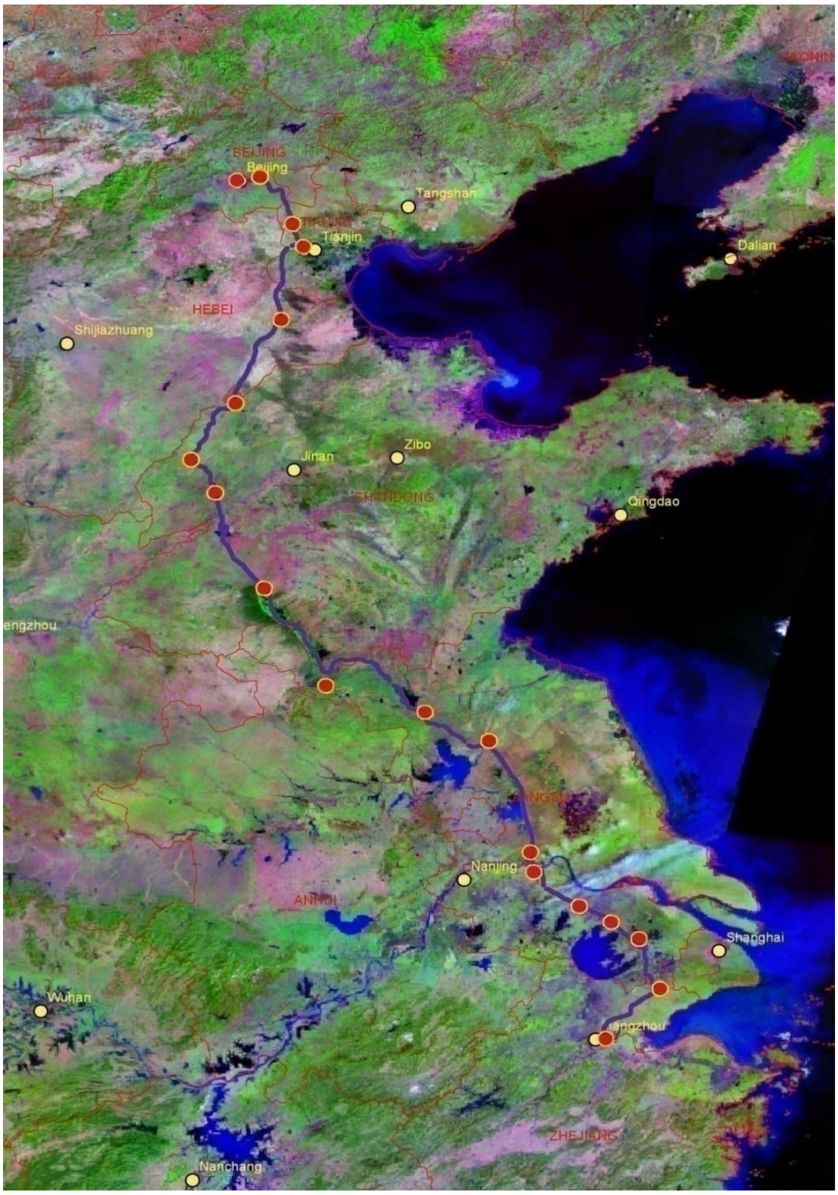

Figure 1: The Modern Grand Canal from Beijing to Hangzhou

However, the protection and utilization of the Grand Canal is facing a large number of complex problems. Although it is considered as a world-famous ancient construction wonder just like the Great Wall, there are no corresponding laws or regulations to protect its historical position and multiple values. As for the trunk of the river course and the cultural heritages along the canal, they haven't been investigated clearly and there is no complete protection scheme. Some parts haven't been maintained for a long period of time, and their realness and integrity have been losing under the attack of modern civilization and overexploitation. The main problems that the Grand Canal is facing can be categorized into the following aspects[3]: first, people disagree on how to regard the cultural heritages along the Grand Canal; second, there are contradictions between the protection of the Grand Canal and the social and economic development of the area; third, the integrity and safety of the Grand Canal are facing sever threats, for example, some channel segments have dried up; the water is polluted severely; the ecological system is deteriorating; the shipping function of the canal has changed; and the heights of the landscapes along the canal are becoming the same; forth, the management and operation system of the Grand Canal is not clear; fifth, the protection of the Grand Canal lacks effective scientific support.

Represented by 3S technology, spatial information technology has been widely used in the field of cultural heritage protection both at home and abroad. It is mainly used in heritage investigation, heritage data collection and management, heritage display, heritage dynamic monitoring and building heritage management system. It helps in the decision making process of realizing historical and cultural resources management and protection programming.

2. Heritage Constitution of the Grand Canal from Beijing to Hangzhou

The Grand Canal from Beijing to Hangzhou heritage refers to the water shipment system and historical remains and relics along the canal, which can reflect the canal's historical role and position on the national level, and can be proved by relevant archeological proofs, objects, scientific data and specific references. These historical remains and relics are directly related to the development of the canal and have outstanding values. The main body of the canal heritage is immovable material cultural heritage; therefore, its constitution is heritage groups that can embody the core value. The heritage of the Grand Canal consists of the following 5 categories:

（1）Irrigation project heritage of the Grand Canal

The irrigation project heritage of the Grand Canal is the most important material cultural heritage of the canal and also the main value embodiment of ancient irrigation technology, project implementation and management. It mainly contains river course, all kinds of ancient irrigation facilities and subsidiary facilities built to maintain normal shipping of the canal (floodgate, dam, weir, dyke, diversion culvert, etc), shipping facilities (navigation lock, bridge and dock, etc), ancient canal facilities and remains of the administrative organization (administrative organization, organization for water transport of grain and storehouses, etc) and ancient sacrifice relics related to the Grand Canal.

（2）Canal town and village

The settlement of the Grand Canal heritage can be categorized as follows:

Canal town, among which those approved historical and cultural cities can use the title of historical and cultural canal city (town); however, it is needed to analyze the history and current situation of all cities to determine the parts that need heritage protection.

Canal village, among which the approved historical and cultural cities can use the title of historical and cultural canal city; however, it is needed to analyze the history and current situation of all the villages to determine the parts that need heritage protection.

（3）Other canal material cultural heritages

According to the standards of the third national cultural relic survey, the other canal material cultural heritages of the Grand Canal can be classified into 6 categories: ancient ruins, historical buildings, ancient tombs, lithoglyph, historical sites or relics of modern times, and typical buildings and others. It also includes the industrial historical sites and relics of modern times and industrial heritages represented by buildings in the south region of Yangtze River, which developed and thrived because of the Grand Canal.

（4）The ecological and landscape environment of the Grand Canal

The ecological and landscape environment refers to the woodland, grassland, wetland and farmland that are connected to the Grand Canal closely and have important meanings to the ecological protection and landscape environment construction of the Grand Canal.

（5）Intangible cultural heritages related to the Grand Canal from Beijing to Hangzhou

The intangible cultural heritages refer to those which are closely connected to the Grand Canal and can reveal the value of the Grand Canal’s cultural variety. The Grand Canal culture they represent must be rooted in the canal itself or along the canal, widely transmitted by the canal and passed on from generation to generation. They have become distinctive marks along the canal and have been recognized and spread by the masses.

3. The Application of Spatial Information Technology in Heritage Investigation of the Grand Canal from Beijing to Hangzhou

Developing the cultural heritage resources investigation along the canal, finding out about the canal, fully understanding the living condition of the heritage itself and deeply digging up the historical, artistic and scientific values of the cultural heritages of the canal and areas along it is the foundation for canal protection and world cultural heritage application. GIS technology can help the cultural heritage protection unit integrate the historical and cultural resources data of the heritage site (area) and its background environment, and build up scientific and complete digital archives for the cultural heritage. Applied in the investigation, remote sensing technology can provide clues and help to orientate, and solve some problems which traditional methods can't solve. Apply remote sensing image to archeology, and the images provide abundant information and wide field of view. Use geographical information system to provide assistant decision making function and integrate all sorts of materials and information. Combining with the value assessment model, it can help make an objective assessment of the canal's heritage value.

The figure below is a mobile handheld system for the heritage investigation of the Grand Canal which is developed based on GIS technology:

Figure 2: Mobile system for data collection of the Grand Canal

4. The Application of Spatial Information Technology in Protection Program of the Grand Canal from Beijing to Hangzhou

After understanding the canal heritage clearly, developing special protection program, delimiting protection scope and construction control area and guaranteeing the safety of the cultural heritage of the canal and along its sides is the key to apply for world cultural heritage successfully.

Based on 3S technology, the assistant supporting system for the Grand Canal's protection program can provide professional analytical tool for the heritage protection program and guide to build buffer area around historical sites to protection the surrounding environment. For example, use distance analysis, we can determine whether there is enough distance between construction and ancient building, historic ruins and historical areas; use inter-visible analysis, we can evaluate whether the important skyline and landscape view line within the historical areas can protected or not; use overlay analysis, we can evaluate whether the utilization of the soil around the area is reasonable or not. Meanwhile, the efficient program result outputting function of the system can improve the work efficiency immensely. Figure 3 is the business process of the protection programming of the Grand Canal:

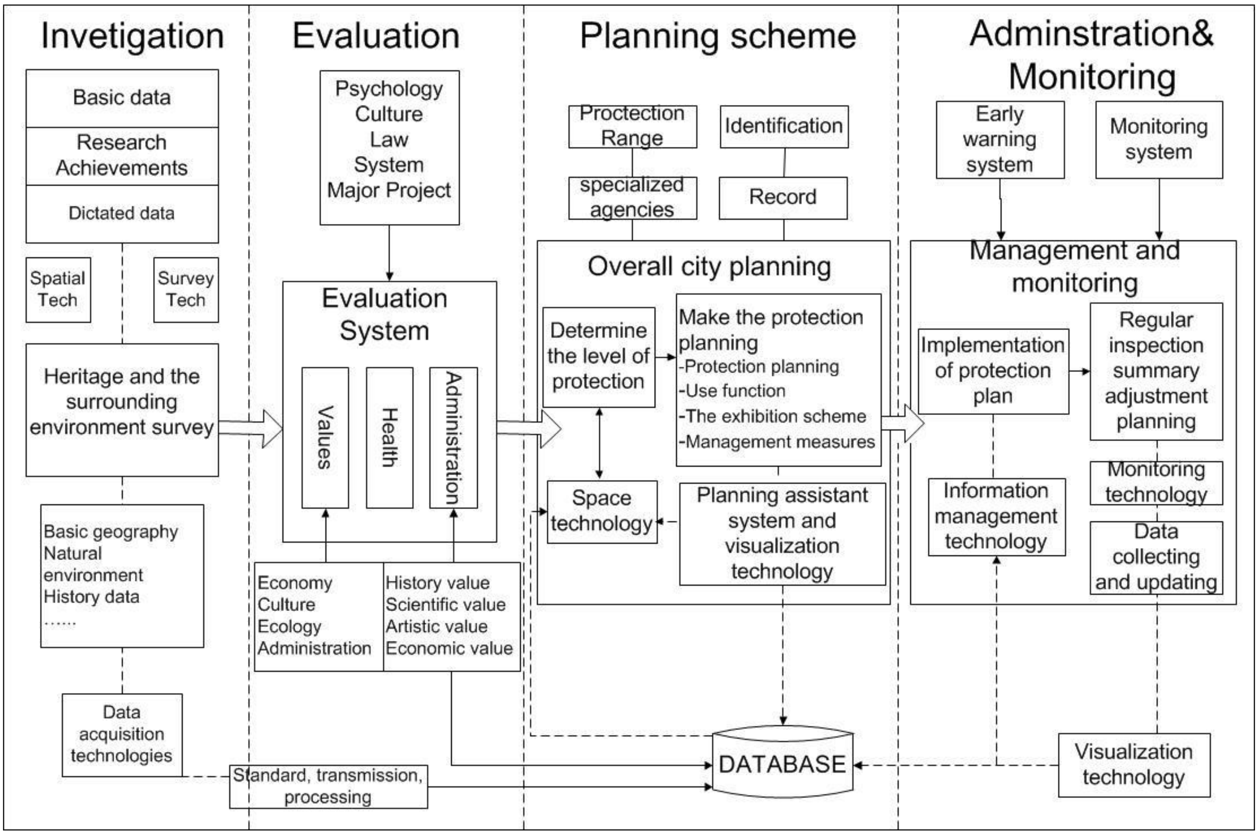

Figure 3: Business process diagram of the protection programming for the Grand Canal from Beijing to Hangzhou

5. The Assistant Supporting System for the Protection Program of the Grand Canal

5.1 Database for the protection program of the Grand Canal

The data base for the protection program of the Grand Canal should contain the metadata information that is used for data management and data declaration; therefore, the whole database should consist of 5 data sub-bases:

1） Metadata sub-base. Metadata is called data about data, which reflects the characteristic description function of the data corresponding to the metadata. Metadata sub-base mainly stores the basic information that describes all kinds of spatial data in the protection programming database and provides services for data update and application.

2） Basic geographical data sub-base. Basic geographical data sub-base is the foundation for protection programming. The data types in this database consist of three parts: digital elevation model (DEM), digital orthophoto map (DOM) and digital line graph (DLG). These data constitute the time-space frame of the whole protection programming database; they are they spatial positioning datum of other professional data (including historical and current data).

3） The canal in-itself and cultural relics sub-base. This one is the core database for protection programming establishment. It mainly stores data about the canal itself, the irrigation facilities along the canal and the cultural relics. Among these data, the canal data include data about the spatial form of all channel segments, navigation and water quality. Data about irrigation facilities include the facility information of floodgate, dam, bridge and dock. Data about cultural relics include the relic information of ancient buildings, historical tombs, ancient ruins, important historic sites and buildings of modern time, lithoglyph and other cultural relics.

4） Environment data sub-base. This database mainly includes the social and economic information along the canal, such as the populations of every region along the canal, economic development level, land utilization and ecological environment, etc. Apart from these, it also includes all kinds of programming information of every cities and towns along the canal. These data are the important basis of protection programming establishment.

5） Programming result sub-database. The protection programming establishment of the Grand Canal is a huge system project. A large number of programming results will be produced during the whole process. This database is to organize and manage these results reasonably and effectively for result display, comparison, analysis and utilization. Meanwhile, it provides support for the execution of the programming.

5.2 The assistant programming system of the Grand Canal from Beijing to Hangzhou

Adopting the 3-tiered architecture design, the assistant supporting system consists of 3 tiers: database tier, application system tier and customer-oriented terminals. Database tier mainly builds up programming information database on the basis of data standardization and collects relevant data into the programming information database. This system adopts ODBC (Open Database Connectivity) to connect Oracle database system. On the basis of ArcGIS commercial software platform, the application system tier realizes data dispatch, inquiry, statistics and access, and graph generation, edition, management through application program interface (API), or builds multiple application system combination through secondary development of the software platform, including data input and maintenance, inquiry and statistics, GIS spatial analysis, 3D modeling and display, comprehensive application or assistant decision-making, etc. This tier can be connected to the database using ODBC and the programming language can adopt VB or VC. Customer-oriented terminals use C/S structure or B/S structure, and have corresponding relations with customer object types (illustrated in the figure below).

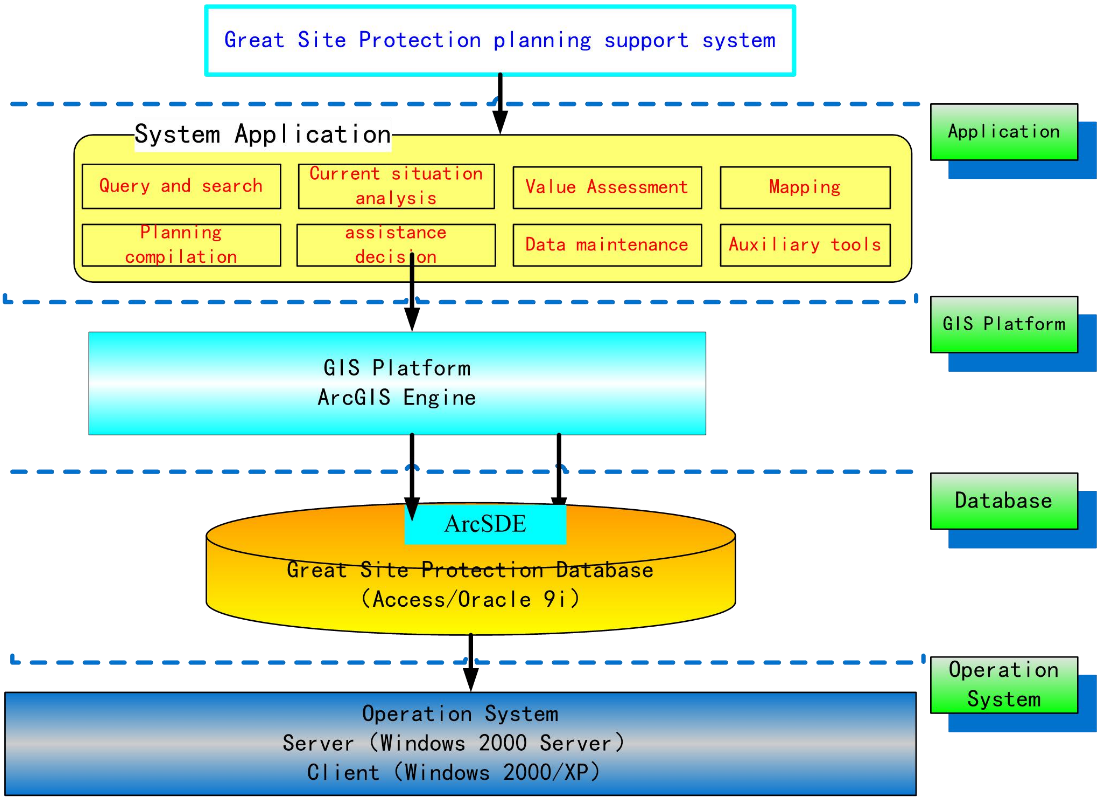

Figure 4: Structure diagram of the assistant supporting system for the protection programming of the Grand Canal

The assistant supporting system for the protection program of the Grand Canal realizes the whole business process of heritage investigation, heritage value assessment, protection programming establishment, management and monitoring; it provides decision-making supporting platform for the protection programming establishment, trans-department and trans-region management of the Grand Canal.

6.Conclusion

The protection of the Grand Canal faces complicated problems. Spatial information technology provides a comprehensive platform for the heritage investigation, assessment, programming, management, decision-making, monitoring and display; it also supplies very strong scientific support for continuous protection of the Grand Canal. The construction practice of the geographical information system for the protection of the Grand Canal also proves that spatial information technology can be comprehensively applied in cultural heritage protection. China is an ancient civilized nation with a vast territory and a long history; she is the only country in the world with a 5000-year uninterrupted history and numerous cultural heritages. It can be foreseen that as information technology further develops and the government puts more efforts in protecting historical and cultural heritages, the demand for spatial information technology will be increasing, and its application depth and scope will be largely expanded.

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