The research on regional conservation planning of urban historical and cultural areas based on GIS

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Abstract. With the rapid economic development and the growth of population happening in the urban historical and cultural areas, heritage and historical buildings along with their natural and artificial surrounding environments are suffering constructive destruction. Due to the lack of precise partition of protection region and construction control region in the local cultural relics protection law, traditional regional conservation planning cannot engaged with the urban controllability detailed planning very well. According to the several protection regulations about heritage and historical buildings from latest laws, we choose Baxian Temple area to study on the improvements of traditional regional conservation planning. The technical methods of this study mainly rely on GIS, which can complete the fundamental work of each stage. With the analytic hierarchy process(AHP), the comprehensive architectural value assessments can be calculated according to the investigation results. Based on the calculation results and visual corridor analysis, the precise range of protection region and construction control region can be decided and the specific protection measures can be formulated.

1 Introduction
As one of the state-listed famous historical and cultural city, Xi’an is the birthplace of Qing, Han and Tang dynasties. The urban form, road network and space constitution of this city still retain chessboard structure, which inherited from Ming and Qing dynasties. The unique historical and cultural landscape of Xi’an, such as Bell tower, Xingshan Temple and Dayan Pagoda, has brought opportunities and challenges to this city and make contributions to the urban development. These historical and cultural landscape draw world’s attentions and should be treated carefully and properly from the government.

The" Regulations On Protection Of Historical And Cultural City Of Xi’an", which enacted in 2002, made a precise definition of historical and cultural areas, which must reflect the obvious characteristics of cultural landscape in specific historical period and was constituted by the cultural relics. These areas do not contain the ancient ruins and the ancient city wall, the partition as shown below (see Figure 1). Temple of Eight Immortals (referred to Baxian Temple) area, where exist historical cultural features and located in the center of the city, is one of these area. We choose this area to study on the regional conservation planning of urban historical and cultural areas.
2 The application of GIS in the planning

Geographic Information System (GIS), which are used to input, store, query, analysis and display batch data in computer, is a brand new system combined with geography and cartography. The main function of this system is to processing batch secondary data operation and establishing database. This system has been applied into urban or regional planning flexibly and properly nowadays.

The fundamental work of regional conservation planning is to collecting and dealing with batches of investigation data. The efficient data in this research can be divided into two parts: physical environment informations, such as the height and width of each building, and historical environment informations, such as the the built time and architectural style of each building. The traditional method of collecting and processing investigation data has some defects. On the one hand, due to the lack of database management system ,large amount of variety investigation data cannot be classified and updated timely and properly; on the other hand, because of most data needs to be secondary processed by experts for further usage, the mistakes hardly can be avoided and the difficulty of establishing database managment system are increased. The lack of database management system lead the regional conservation planning reflects only the minorities subjective wishs and lack the rational analysis of historical and heritage buildings’ natural and artificial surrounding environments. Therefore, traditional regional conservation planning lack of logical and rational concern and cannot engaged with the upper-level urban planning very well.

3 Architectural information database of GIS

3.1 Regional basic information

Baxian Temple area locates in the east of Ancient City Wall and is surrounded by many famous ancient ruins such as Daming Palace ruins and Tang Eastern Market ruins. The location of this area has very convenient public traffic system and the total area of this region is 1.26 km² ,the specific
location of this area are as follows (see Figure 2). Because of three religions: Taoism, Buddhism and Christianity have co-existed in this area for hundreds of years, lots of believers and tourists coming to this area on weekends and on the temple fair, which leading the prosperity of antique business, incense business, even the funeral business in this area. The cultural and economical value that the religion brought to this area is immeasurable and should be protected properly.

Within the range of Tang Xingqing Palace ruins, there existing many historical and heritage buildings in this area (see Figure 3). As one of the most complete and famous Taoist temple in Xi’an, Baxian Temple, which was given named by the "Dragon Lady" Empress Dowager Cixi, firstly built in Song dynasty and renovated in Ming and Qing dynasties, is still in use. Wangji Temple, one of the Jodo Buddhism temples in this area, was first built in Tang dynasty by emperor Zhongzong. After reconstruction in Ming dynasty and three times of major repairment in Qing dynasty for thirty years with lots of devoutly religious, this temple is still in use nowadays. Dongxin Christian Chapel was built in 1901 by German missionaries and is the only Latin Cross Chapel in Xi’an. This church is still in use and holding Christian interaction prayer activities regularly. Laomu Temple, recorded to be the emperor Xuanzong’s ornamental pavilion site, was built in Qing dynasty and is abandoned now. These heritage buildings are all municipal historic relics protection units except Temple of Eight Immortals, which is the provincial historic relics protection unit, according to the list of the sixth batch of cultural relics protection units in Shaanxi. In addition, amounts of historical residential buildings, which was built in republican times in 1932 and was lived by the missionaries, are still unregistered and destructed by tenant’s improper use. These buildings can provide valuable historical informations and should be protected more properly.

![Figure 3: Historic building distribution, Source: Drawing by author](image)

### 3.2 Establishment of Architectural GIS database

In order to prepare for the establishment of GIS database, we use Landsat 8 OLI-TRIS image to geo-calibrated the original vector map in GIS. The point, line and surface information can be automatically picked up from the vector map. Importing both the surface information, which can be used as building plan, line information, which can be used as street network, and no offset vector map to GIS and coincide them, save the file as a basic model of this research. The basic data preparation work has been completed.

According to the "Regulations On Protection Of Historical And Cultural City Of Xi’an", we select several evaluation factors and classified them into two parts: physical influencing factor, which including architectural height, construction quality, and historical influencing factors, which including built time, architectural style, historical correlation and heritage classification. In the manual investigation, all the assessments of the current building was evaluated by the unified evaluation criteria and was photographed by the researchers. The ultimate evaluation result can be verified and modified by the photo.

### 3.3 Evaluation factor analysis
The establishment of regional GIS database mainly focused on buildings. With the help of regional vector map and manual investigation, we use the ARC MAP software to collect and classified 2271 buildings’ evaluation results and establish its database. The evaluation results are as follows.

Architectural height: Low-rise building (building floors are less than three); Multistory building (building floors are more than three, less than seven); High-rise building (building floors are more than seven).

Construction quality: Excellent quality (structural integrity, regular maintenance, complete public facilities); High quality (structural integrity, cooperatively complete public facilities); Ordinary quality (the structure is comparatively less integral without regular maintenance); Poor quality (Incomplete structure with safety hazard).

Built time: Qing dynasty (Baxian Temple, Wangji Temple and Laomu Temple); 1950s (Dongxin Christ Chapel and historic residential courtyards); 1970s (Shanty towns); 1990s (Multi-storey residential buildings); 2010s (High-rise residential and commercial buildings).

Architectural style: Excellent exterior (Historic religious temple and chapel); Harmonious exterior (historic residential courtyards); Ordinary exterior (multi-storey residential building and Shanty towns); Conflicting exterior (High-rise residential and commercial buildings).

Historical correlation: Strong (the buildings can fully reflect the contractual ages and historical, cultural and religious value); Close (the buildings can reflect the regional features, parts of buildings conserve comparatively integral and can reflect historical value); General (the buildings cannot reflect contractual and regional features, have life tracks and have less historical value); Weak (modern residential and commercial buildings, cannot reflect any contractual and regional features).

Heritage classification: Provincial historic relics (Baxian Temple); Municipal historic relics (Wangji Temple, Laomu Temple, Dongxin Christ Chapel); Unregistered buildings (all buildings other than the above).
4 Comprehensive value assessments

4.1 Weights of factors
Analytic Hierarchy Process (AHP) is an effective multi-target decision making method combined with qualitative analysis and quantitative analysis. Before conducting an expert survey questionnaire, we should establish a hierarchy of AHP decision-making model to determine the target layer elements and indicators layer elements. (see Figure 6)

Issuing questionnaires to 21 experts from different fields, which including architecture design, urban planning, archeology, and selecting 18 of them whose consistent results less than 0.1. The comprehensive result of every factor’s weight has been shown below (see Tab.1).
Table 1: Impact factors heavy weight, Source: Drawing by author

| Target                              | Intermediate         | Indicator              | Weight  |
|-------------------------------------|----------------------|------------------------|---------|
| Comprehensive architectural value   | Physical             | Architectural height   | 0.0366  |
| assessments                          | impact factors       | Construction Quality   | 0.0683  |
|                                     | Historical           | Built time             | 0.3116  |
|                                     | impact factors       | Architectural style    | 0.1182  |
|                                     |                      | Historical correlation | 0.3206  |
|                                     |                      | Heritage classification| 0.1445  |

4.2 Heavy weight raster calculation

Using the raster calculation in ARC GIS and entering the following formula to process the comprehensive architectural value assessments (see Figure 7).

\[
\text{Comprehensive architectural value assessments} = \text{Architectural height} \times 0.0366 + \text{Construction Quality} \times 0.0683 + \text{Built time} \times 0.3116 \\
+ \text{Architectural style} \times 0.1182 + \text{Historical correlation} \times 0.3206 + \text{Heritage classification} \times 0.1445
\]

Figure 6: Raster calculation formula, Source: Drawing by author

The threshold of total score is from 1.15 to 7.30. The comprehensive value of each building can be divided into four level referring to the “Regulations on the Protection of Historical and Cultural Areas in Shanghai”. The range from 5.04 to 7.30 will be defined as excellent value, which mostly are heritage buildings. The range from 3.32 to 5.04 will be defined as high value, which mostly are historical building. The range from 1.90 to 3.32 will be defined as medium value, which mostly are multi-story residential building. The range from 1.15 to 1.90 will be defined as poor value. The distribution of each level are shown below (see Figure 8).

Figure 7: Comprehensive architectural value assessments, Source: Drawing by author

5 Protection planning of Baxian Temple area

5.1 Reducing regional building density

According to the regional comprehensive architectural value assessments, dismantling the buildings of poor value (score ≤ 1.5), which mostly were temporary build, to reduce regional building density and giving back public space to residents. Depending on the family size, personal income level and communication range in this area, decentralized small-scale public space, such as landscape, playground and pavilion, will be more appropriate than the centralized large-scale public space, such as park, plaza and golf course. Giving back public space not only improving neighborhood relationship, but also increasing the visibility of historic buildings. (see Figure 9)
5.2 Improving road system
Current traffic system in this area have several unavoidable defects. Temporary shantytowns have a serious influence on the road accessibility and the road density is too low to afford the huge traffic flow on the rush hour. Besides, the vehicle-pedestrians reduce the efficiency of the road, increasing the accident occurrence probability. In order to clear the current road system, the blocked buildings must be dismantled referring to the comprehensive architectural value assessments. Dredging blocked road and opening more district level roads to this area can decompress the huge traffic flow on the rush hour. Dimensional-dividing of vehicles and pedestrian is a good way to improve the road efficiency and avoid the accident occurrence. (see Figure 10)

5.3 Historic building protection zone
According to the “National Cultural Heritage Protection Planning Requirements”, historical building protection zone should be divided into protection region and construction control region. Depending on the protection distance and intensity, appropriate protection zone can avoid historical and cultural area becoming isolated or confounded from the surroundings. According to the comprehensive architectural value assessments and the functional relation between the heritage building and historical buildings, the protection zone in this area should be divided into four layers: key protection region, general protection region, key construction control region and general construction control region. The distribution of each region are as followed. (see Figure 11)
5.4 Protection regulations

Key protection region: In the key protection region, including the most excellent valued and the most vulnerable buildings (score=7.3), any construction activities are forbidden in this area by the government, except the heritage and architecture repairment. The structure of each building should be inspected and reinforced regularly and the repaired portion should be recognizable from the whole building. In order to maintain the integrity of the heritage building, traditional landscape and religious activities should also be protected. Any changes in this region must be registered and recorded to the government.

General protection region: According to the comprehensive architectural value assessments, all the historical residential buildings (score=5.04) were built in this region. Renovation should be encouraged in this region. Small-scale mosaic repairmen is an appropriate way to fix exterior damaged building elements such as roofs, windows and decorations. Interior decoration and renovation will make these historical buildings more suitable to modern life. In order to prevent local residents leaving, redesigned the historic courtyard’s landscape and rent some of the rooms to tourists to increase their income. The most complete historical residential buildings and courtyards should be registered and protected by the government. This region is an important buffer zone between the urban city and the historical area and should be well protected and developed.

Key construction control region: Lots of medium valued architecture (score=3.32) built in this region. These buildings mostly are multi-storey residential building and were built several decades ago. Although the historical and cultural value in these buildings cannot be compared to the heritage or historical buildings, their architectural style and building height corresponding with the urban texture and reflecting some local construction characteristics. From this point, these buildings should be reserved if they didn’t blocked any road or visual corridor. In order to increase the visibility of historical buildings, the new construction project in this region should adhere to building height limitation, which can create a visual corridor for the heritage and historic buildings, and match to the traditional architectural style.

General construction control region: In this region, most buildings are newly built and the construction of these buildings were solid. However, the building’s height seriously blocked the visual corridor for the heritage and historical building. In the short term, these high-rise buildings can’t be dismantled by the government. Landscape design is an efficient way to reduce the visual impact caused by the high-rise buildings. In the long term, these high-rise buildings must be dismantled and the new construction project in this region should be comply with the building height limitation and improving the visibility of heritage and historical buildings.

6 Summarize
By using the efficient data management system, automatic batch operation and technical raster calculation in GIS, urban planners can make more logical and objective regional conservation protection planning for historical and cultural area. The completion of this study has a positive effect on promoting other regional conservation planning and the implementation of this conservation planning needs more application and research in GIS.

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