Research Article

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Research on the conservation and sustainable development strategies of modern historical heritage in the Dabie Mountains based on GIS

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Abstract: With the advancement of China's economy and the acceleration of urbanization, the conservation and sustainable development of historical architectural heritage has become the focus of the current and future society. However, there are still many deficiencies in the conservation and development of modern architectural cultural heritage. Due to the scattered distribution of heritage space and the lack of overall planning in the process of conservation and development, there are some problems, such as uneven development in various regions, insufficient integration of resources, serious destruction of cultural heritage, and so on. This article takes the modern historical and cultural heritage of the Dabie Mountains as the research object and integrates its resources according to different types with the Geographical Information System platform to establish the historical heritage basic database. Data attributes are analyzed through dot density, traffic accessibility, and other spatial elements, whose results are used to evaluate the conservation and utilization status of the regional historical heritage. On that basis, combined with the distribution characteristics of historical resources, this article puts forward the conservation planning scheme based on the level and focus, and the sustainable development structure of group development and linkage development, so as to realize the transformation from section conservation to sustainable development. It also presents new ideas and technical methods for historical heritage conservation and sustainable development of the Dabie Mountains.

Keywords: GIS, modern historical heritage, conservation, sustainable development, Dabie Mountains

1 Introduction

In recent years, with the acceleration of China's modernization process, great changes have taken place in cultural ecology. The architectural cultural heritage and its living environment have been seriously threatened, and many modern historical sites and buildings have been destroyed. At the same time, the conservation and utilization of Chinese cultural heritage has transferred from "ancient relics" to the "twentieth-century heritage" [1] and "modern historical heritage" [2]. In this article, the domestic and foreign conservation methods and sustainable development strategies of historical buildings are summarized as follows:

- (1) The development of foreign urban heritage: (1) before the eighteenth century, reconstruction; (2) in the eighteenth century, the beginning of the renovation of the monuments; (3) in the nineteenth century, the historic century, from the restoration of buildings to the conservation of those, legislation started to conserve the historical buildings; (4) in the first half of the twentieth century, from the conservation of individual buildings and monuments to the adaptive reuse of historical buildings; (5) after 1980s, extensive practice and exploration of conservation and development were carried out [3–6]. In conclusion, the research on the foreign urban heritage has developed from the early attack on urban renewal and the research on the noumenon value of historical buildings to the research on the intangible part of urban life, which boosted a lot of analysis and research results of the past reuse practice. Urban heritage cannot be disassociated from urban planning any more than from human society and culture, economic, and ecological considerations [7–11].

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- (2) The development of Chinese urban heritage: (1) before the twentieth century, reconstruction [12]; (2) from 1920 to 1960s, conservation of individual buildings; (3) from 1970 to early 1980s, urban renovation and partial reconstruction; (4) from 1980 to 1990s, the practice of conservation and reuse of historic cities [13]; (5) in the twenty-first century, the diversified development of conservation methods [14–17].

Through an in-depth review of the related achievements of Chinese urban heritage, it is found that domestic research on the sustainable development of modern heritage is in its infancy, and there is extremely scarce research on sustainable utilization planning for the Dabie Mountains, which is in the middle territory of China and rich in modern architectural heritage [18]. Therefore, this article adopts the Geographical Information System (GIS) technology to review, sort out, evaluate, and analyze the historical heritage of the Dabie Mountains, explores the long-term conservation and utilization mechanism of the heritage, and proposes improvements and optimization suggestions and development strategies to fill the research blank of the sustainable development of the Dabie Mountains historical heritage.

The research object of this article is the historical heritage of the Dabie Mountains, which is located at the

junction of the three provinces of Anhui, Hubei, and Henan (between latitude 30°10' and 32°30' north, longitude 112°40' and 117°10' east), including 57 districts and counties of the 12 cities of those three provinces, covering an area of about 70,000 km² (Figure 1). The Dabie Mountains are in the watershed between the Yangtze River and the Huai River system. The water from the southern foot flows into the Yangtze River and that from the north foot flows into the Huai River. It has typical mountain climate characteristics, with a mild climate and plentiful rainfall. The altitude ranges from 400 to 1,700 m, and the vegetation changes significantly, forming a colorful forest landscape. The unique natural and geographical conditions have created a significant position in the historical heritage wave of modern China in the Dabie Mountains, which has abundant cultural heritage and historical resources [19].

This article adopts GIS technology to sort out the heritage types of the Dabie Mountains, initially establishes the basic information database of the Dabie Mountains heritage, and launches further analysis and research (Figure 2). Based on the objective evaluation of the architectural heritage, combined with the current state of preservation of cultural relics, it is considered that some problems exist in the modern heritage of this place, such as poor preservation of the building itself, inadequate display and utilization, and weak accessibility of the traffic in

Figure 1: Location of the Dabie Mountains.

Figure 2: The general layout of the historical heritage in the Dabie Mountains.

large regions. Then, it puts forward targeted conservation and development ideas with levels and priorities and implements them into the conservation and sustainable development planning framework of cross-region, overall development, and coordinated development.

2 Method description

2.1 The applicability of GIS technology in the conservation of historical heritage

GIS is a technology on the basis of computer science and technology, which integrates multiple disciplines such as surveying, information, and remote sensing. It can collect and describe related geographically distributed data, edit operations, and manage queries, and it has powerful data storage and analysis capabilities [20].

Since the 1990s, GIS and RS and other high-techs have been applied by UNESCO in cultural heritage conservation planning, management, and utilization [21], which has gradually been promoted to provide powerful assistance for increasingly complex urban planning and heritage conservation work. Many practical problems have been solved by them, while they are rarely used in the conservation and planning practice of Chinese modern historical and cultural heritage. This article applies GIS technology to the architectural heritage of the Dabie Mountains, which has the following applicability: (1) according to

the information platform attributes of GIS, cultural relics with a wide range of distribution, diverse types, and different degrees of conservation are concentrated under a unified framework for analysis and evaluation, which overcomes the obstacles caused by the cumbersome amount of information; (2) according to the convenience of information storage of GIS, a customized protection file is established for each heritage ontology, and the time, method, and funds of each maintenance are accurately recorded. The damage rate of historical buildings is analyzed on the basis of existing historical data, so as to accurately infer the next restoration time and funds. (3) With the help of GIS technology, cross-section conservation of the past transforms into sustainable development. The evolutionary law of the ontology's full life cycle is analyzed through recording the diachronic evolution process of architectural heritage, which provides a scientific basis for the precise investment of architecture conservation funds and also provides technical support for the sustainable development of the heritage.

2.2 General idea

This planning strategy uses GIS and takes the Dabie Mountains as the research area; establishes the database of its modern and contemporary cultural heritage period, type, characteristics, preservation status, and other basic attributes; analyzes the relevant spatial density and traffic accessibility; and finally carries out a comprehensive

Figure 3: Types and distribution of historical heritage sites in the Dabie Mountains.

resource evaluation. According to the evaluation results, this article puts forward a systematic conservation and planning scheme and provides a scientific and complete strategy basis for the sustainable development of the Dabie Mountains.

3 Evaluation of modern architectural heritage resources in the Dabie Mountains based on GIS

3.1 Overview of the historical heritage and the construction of the database

There are 1,123 historical and cultural heritages distributed on the vast land of 70,000 km² in the Dabie Mountains. The study collects and summarizes the following information data: preservation status, display and utilization status, conservation types, conservation levels, periods, and other attribute information, which are input into Excel. Then, the Excel file and attribute data are processed and input into GIS to construct the attribute database of the Dabie Mountains cultural relics (Figures 3 and 4).

3.1.1 Conservation types of cultural relics

In terms of categories, the historical relics in the Dabie Mountains mainly include the sites of vital institutions in modern times, the former residences and activity places of important figures, and the former sites of key events, among which the number of vital institutions' sites is especially large (Figure 6). They can be divided into the following six categories: (1) historic-site buildings (506 sites), (2) former residences of celebrities (176 sites), (3) tombs (243 sites), (4) key event sites (103 sites), (5) stone carvings (16 sites), and (6) others (79 sites).

Among all forms of modern historical heritage in the Dabie Mountains, historic-site buildings and former residences of celebrities take up the most (Figures 5 and 6). The former offered venues for some historically significant events over the turbulent years toward the founding of P. R. China and are mainly distributed in Jinzhai County, Xin County, Yuexi County, and Qianshan County, while the latter are residences of country leaders or prominent figures in history, such as former residences of Wu Guanghao and Li Xiannian, and are mainly found in Hong'an County and Macheng City. Most of these two types of buildings are dry-stacked constructions, with clay-made bricks piled up and the surface smoothed by lime; and rubble of tiles and bricks are sometimes used in the clay to reinforce the structure (Table 1). Meanwhile, the orientation of the doors and windows of

Figure 4: The spatial distribution of cultural relics at different levels in the Dabie Mountains.

the buildings are arranged as per geomantic rules (or fengshui). Evaluation of these two types of heritage reveals the following findings. First, their architectural styles agree with the natural environment and the social custom of the villages; second, the location of these buildings and the orientation of doors serve geomantic purposes; and third, inheritance of traditional construction techniques that could be dated back to a century ago manifests the long history of buildings in this region.

Table 2 shows the conclusions reached through analysis of the current conditions of historic-site buildings and former residences of celebrities in this region.

3.1.2 The conservation level

According to the national evaluation standard of immovable cultural relics [22], the conservation level could be

Figure 5: Historic-site buildings.

Figure 6: Former residences of celebrities.

divided into three categories: national level, provincial level, city level, and county level (Figure 7).

3.1.3 Preservation integrity and utilization

Selective investigation on the historical heritage buildings in the Dabie Mountains revealed that bricks in walls of these old buildings were removed or shredded (caused

by human damages during demolition); the masonry mortar in some walls cracked or reduced to powder; the timber frames and beams cracked and were subject to erosion and deformation under the impact of weathering. According to the current state, the preservation status of cultural relics in the Dabie Mountains can be divided into four categories: good, general, poor, and none. Therefore, leveled antiseismic and reinforcement measures should be taken as per the degree of damages to the buildings [23–26].

Table 1: Overview of the historic-site buildings and former residences of celebrities

Components	Materials	Colors	Environment
Roof	Tiles		Local materials, integration with the environment
Wall	Selection of rubble stones Adobe or black brick walls		
Detail	Timber components		

Table 2: Damages to historic-site buildings and former residences of celebrities and the spatial layout of the village

Individual buildings	<p>1. Natural damages: the vagarious climate and frequent rainstorms in the Dabie Mountains have been a big threat to the safety of cultural heritage. The poorly constructed traditional buildings, worn off by rains and storms, suffer from deformation, with wooden structures and carvings being worst damaged. Moreover, for some old buildings, the surroundings do not agree with the overall environment, undermining the cultural or historic value of the buildings.</p> <p>2. Human damages: most buildings of cultural heritage are deserted, demolished, or reconstructed. Many old buildings are privately owned and no longer serve their original functions; some of these buildings are used as storerooms without appropriate maintenance, thereby effacing their cultural or social significance. Worse still, some property owners of these buildings change the original structures of the buildings at their discretion without an approval from the cultural heritage protection administration, which reduces the original charm of the cultural relics.</p>
Spatial layout of cultural heritage in the villages	<p>As the living standard improves, most residents demolish the old buildings, giving way to new buildings, which leads to damages to the spatial layout of cultural heritage in the villages. On one hand, the demolition of old buildings, especially those within a well-preserved and representative cluster of traditional buildings, changes the original architectural layout. On the other hand, newly constructed buildings often fail to blend in the heritage-intensive zone. In most cases, the architectural volume, shape, façade, height, texture, and color scheme of the new buildings do not agree with those of the old ones, which also leads to damage to the original spatial layout of cultural heritage.</p>

Figure 7: The number of cultural relics at different levels in the Dabie Mountains.

Major problems in the exhibition and utilization of historical heritage include the following. The first one is the lack of diversity in the theme and form of the exhibition. Historical heritage in this region is exhibited in a static form, and most of the time, by images of historical events, former residences of celebrities, and museums. The second problem is the extensive development. The presentation methods are backward and fail to meet the market needs. The third is the unvarying development modes. Natural beauty and cultural heritage are not integrated, and other resources are not made full use of. According to the exhibition of the utilization, it can be

divided into three categories: the displayed, the qualified, and the unqualified.

3.2 Analysis of GIS data of the Dabie Mountains heritage

3.2.1 Analysis of spatial density

Based on the data attributes of GIS database, according to the distribution of cultural relics with different attributes,

Figure 8: The spatial density distribution of the cultural heritage in the Dabie Mountains.

the spatial dot density of cultural relics in the Dabie Mountains is analyzed (Figure 8).

The spatial distribution of the cultural relics in the Dabie Mountains can be divided into four levels: (1) Xin County, Hong'an County, and Macheng City are the most concentrated regions, which rank at the first level. (2) Huangmei County and Jinzhai County rank at the second level, which has less number of culture relics (Figure 9). (3) Some cultural relics are concentrated in Tanghe County, Tongbai County, Tuanfeng County, Yuexi County, and Huaining County, which rank at the third level. (4) A small number of cultural relics are scattered in other counties and cities, which rank at the fourth level.

3.2.2 Traffic analysis

From the perspective of the traffic environment, the Dabie Mountains are located in the triangle region formed by Wuhan, Zhengzhou, and Hefei. It is the junction zone of Wuhan city circle, Central Plains Economic Region, Wanjiang city belt, and Poyang Lake ecological economic region. There are Beijing Guangzhou, Beijing Kowloon, and Nanjing Chongqing railway lines passing through the region, and high-speed railway stations are set up in Xinyang City, Hong'an County, Macheng City, Jinzhai County, and Shou County. However, limited by geographical conditions, the road network structure of internal and external connections has not been fully formed. The lack of transportation capacity and the high logistics cost have restricted the development of the old area.

Comprehensively considering the terrain, obstruction of the river system, highway, expressway, railway, and other factors, this article analyzes the traffic accessibility of cultural relic sites in the Dabie Mountains [27]. It can be found that although the terrain is complex, the traffic conditions around the cultural relic sites are relatively convenient, and most of them are within 30 min of traffic accessibility (Figure 10).

3.2.3 Analysis of poverty attribute

In recent years, the Dabie Mountains had a rapid development in the social economy. Since 2006, the GDP of this region has maintained an average annual growth rate of more than 10%. The income of urban and rural residents increased by 1.5 times from 2006 to 2014. The new industrialization, urbanization, and agricultural modernization have been accelerated, and the economic strength has increased significantly (Table 3). However, due to the weak foundation, the overall development is still lagging (Figure 11 and Table 4). In recent years, the per capita GDP is only half of the national level [28].

The attribute table of each county in the Dabie Mountains is supplemented and input into GIS database. After analysis, it could be found that the Dabie Mountains in those provinces are concentrated contiguous poverty-stricken regions. There are many national poverty-stricken counties, and the task of poverty alleviation is arduous (Figure 12). Among them, the Dabie Mountains' cultural relic sites involve 55 counties and cities, including 25

Figure 9: Two-level circle structure of the core group.

Figure 10: Traffic accessibility analysis of the core region.

national poverty-stricken counties and 8 provincial-level poverty-stricken counties [29].

3.3 Evaluation of heritage resources of the Dabie Mountains

According to the framework for assessing cultural heritage values and the basic information database of the Dabie Mountains heritage (Table 5), spatial visualization statistics and analysis are carried out. It is presented that the historical resources of the Dabie Mountains mainly have the following characteristics:

(1) Rich resource types, numerous quantity, and distinct theme

The Dabie Mountains are rich in historical value, sentimental value, and environmental value, especially in modern times. The resource types, such as

relics of socioeconomic and cultural activities, residence and community, and single activity venues, all of which have representative landscapes, reflecting the historical process of different periods.

(2) Rational structure and level of resources

There is a rational structure of resource quality level in the Dabie Mountains, which has many national-level, provincial-level, municipal-level, and county-level heritage and cultural resources. Some counties and cities, such as Hong'an, Xin, and Macheng, are the concentration points of the cultural relics, which are distributed in groups in large space, forming the key areas of the study. It provides favorable conditions for the centralized development of resources, the driving of key areas, and the integrated development with other tourism resources. Within the group, cultural relics are scattered in rural, mountainous, and residential areas, showing the characteristics of large agglomeration and small dispersion.

(3) Wide distribution and difficult integration

The heritage resources in the Dabie Mountains are widely distributed, covering almost all districts and counties in this region, which is subordinated to Hubei, Henan, and Anhui provinces. Due to the administrative division, the free flow of production factors is hindered, and the degree of industrial cooperation and development remains at a low level. It constitutes the administrative barrier for the development of cultural industry in this region. The division also causes rigid constraints on the regional

Table 3: Total GDP comparison between the Dabie Mountains and Guangdong Province in recent 5 years (unit: 100 million yuan)

Area	Anhui Province	Henan Province	Hubei Province	Guangdong Province
2015	22,006	37,002	29,550	72,813
2016	24,408	40,472	32,665	80,855
2017	27,519	44,988	36,523	89,879
2018	30,007	48,056	39,367	97,278
2019	37,114	54,259	45,828	107,671

Figure 11: Comparison of the urbanization rate between the three provinces and the national situation in recent 5 years.

Table 4: Comparison of urbanization rates among the three provinces in recent 5 years

Area	Anhui Province (%)	Henan Province (%)	Hubei Province (%)	China (%)
2015	50.50	46.85	56.85	56.1
2016	51.99	48.50	58.10	57.35
2017	53.5	50	59.3	58.52
2018	54.69	51.71	60.3	59.58
2019	55.81	53.21	61	60.6

economic development and produces the phenomenon of administrative region economy contrary to the regional economic integration [30]. The utilization value of heritage needs to be improved.

- (4) Characteristics of traffic accessibility nearby and weak accessibility at long distance

The Dabie Mountains are located in the center of six provinces in central China, connecting Shanxi Province, Hunan Province, and Jiangxi Province. Through GIS traffic accessibility analysis, the conclusions are as follows: (1) most cultural relics conservation units can arrive in a short time. The road network is dense and the accessibility of small-scale traffic is relatively high. (2) From the regional level, due to the limitation of natural conditions, the accessibility of regional transportation in the Dabie Mountains is weak, especially in Xin County and Hong'an County where cultural relics are most concentrated. In the future, it is necessary to improve the road network structure and coordinate resources to improve the overall regional traffic accessibility and develop with

the surrounding provinces and cities [31]. The utilization value of heritage needs to be improved.

- (5) Low utilization and poor preservation of the heritage ontology

After sorting out and evaluating the basic census information of the heritage, it is found that the preservation quality of the architectures in the Dabie Mountains area is uneven. Most of the national and provincial vital architectural heritages have been well maintained and conserved. However, the cultural relics conservation units scattered in the countryside and mountain regions are faced with the problems of difficult restoration and high-cost preservation, and they need more conservation. To the well-preserved architectures, there are also many problems, such as insufficient display and utilization, complex property rights, inadequate maintenance funds, and so on. The utilization value and artistic value of heritage need to be improved. Through GIS, we can further screen the cultural relics conservation units that need to be renovated and invested to provide a scientific basis for the next step of cultural relics conservation and fund expenditure.

4 Strategy of heritage conservation and sustainable development based on GIS

As globalization and modernization gain momentum, China is seeing tectonic changes in its cultural ecosystem

Figure 12: The distribution of poverty-stricken counties in the Dabie Mountains.

and great challenges in preserving cultural heritage. One case in point is that the historical heritage, including old-site buildings, former residences of celebrities, and mausoleums, in the Dabie Mountains has been damaged in different degrees. Against this backdrop, the government issued a range of policies to improve protection of cultural heritage in this region. In 2017, the National Cultural Heritage Administration of China released the 13th 5-Year

Plan for Cultural Heritage Conservation of China, which demanded to strengthen protection of modern historical heritage represented by that in the Dabie Mountains, make detailed plans for conservation and use of cultural heritage, take precautions against damages to the heritage, create a catalogue and big data databases for resources of cultural heritage to protect heritage of historical significance, and rescue cultural relics that are prone to

Table 5: Framework for assessing cultural heritage values in the Dabie Mountains

Comprehensive value	Multidimensional value	Value indicators
Value of modern historical heritage in the Dabie Mountains	Historical value	Relevant events and figures in history; integrity of preserved historical information; uniqueness of preserved historical information; importance of the historical information; authenticity of the buildings
	Artistic value	Representativeness of the architectural art; preservation of the appearance of buildings; integrity of the artistic features; reflection of regional characteristics; referential value for contemporary architectural design; artistic value of urban cultural heritage
	Sentimental value	Memorial site; psychological recognition of the site; users of the heritage; the role of the heritage as spiritual symbols
	Environmental value	Authenticity of the environment of heritage; connection between the heritage and the natural setting; coordination with the architectural cluster; the role as local landmarks; the role as the city's name card; reflection of cultural characteristics
	Utilization value	Safety of architectural structures; completeness of support facilities; practical use of heritage; location; economic efficiency of regeneration; rationality of current use of heritage; integrity of spatial layout

Figure 13: The planning of the core region in the Dabie Mountains.

damages and disappearance. Meanwhile, as the central government invests more to boost tourism, the regional governments in the Dabie Mountains began to turn the cultural heritage into tourist resources and thus relieve poverty in the region through tourism. In these years, thanks to the collaboration between governmental departments at all levels, the historical heritage of the Dabie Mountains has been protected and developed into tourist products of local characteristics, and corresponding strategies and goals for protection and development of the cultural heritage have been identified.

Despite the government's efforts mentioned earlier, the conservation of cultural heritage in the Dabie Mountains has just got started and is facing many challenges. First, plagued by the widespread poverty, the Dabie Mountains have a hard time to fit into the country's strategic plan to boost the economy along the Yangtze River and catch up with other regions in central China in economic growth. The second challenge is the poor foundation of infrastructure and an underdeveloped market: a road network that improves traffic accessibility of this region is yet to be constructed, the traffic infrastructure is not enough, and an elaborate market system that integrates finance, technology, and information is not in place. The third challenge is the lack of public services and shortage of public facilities, and the fourth is the insufficient support of economic factors.

To tackle these challenges, we have designed the following strategies for heritage conservation and sustainable development.

4.1 Ideas of conservation and development

Considering the conservation level, distribution density, and other factors, the sustainable development planning is divided into three levels: macro level, medium level, and micro level.

Macro level: The planning scope spans parts of the three provinces of Hubei, Henan, and Anhui, which form the whole Dabie Mountains region. This article puts forward the overall planning goal, sustainable development strategy, the space system of conservation and utilization, the overall framework structure, the division of regional theme units, and the interpretation of key boutique display routes.

Medium level: The scope is narrowed to key regions, with Xin County, Hong'an County, and Macheng City as the core (Figures 13 and 14), supplemented by several surrounding concentration areas of cultural relics. From the center to the northeast through Guangshan, Luoshan until Tongbai, and to the southwest through Yuexi, Taihu Lake until Huangmei, this belt region is the core of the distribution of relics in the Dabie Mountains. The number of relics accounts for about 65% of the total number in the Dabie Mountains. Hong'an County, Macheng City, and Xin County are located in the center of the core region, whose number of cultural relics accounts for about 35% of the total relics in the Dabie Mountains.

Micro level: The core region, namely, Xin County, has the largest number and the highest level of cultural relics. Taking Xin County as an example, this article puts

Figure 14: The location of two counties and one city in the core region of the Dabie Mountains.

forward the specific developmental goal orientation and planning strategy.

4.2 Conservation and reuse system

4.2.1 Ontology conservation and sustainable development plan based on current preservation status

This conservation and sustainable development plan adheres to the first principle of preserving the current state of cultural relics and maintaining the original appearance of history. It is forbidden to adopt modern construction methods to repair historical relics locally or in a large area, so as to maintain the original construction form of architectural heritage in the region to the maximum extent. According to the analysis results of GIS on the current state of preservation, this article puts forward the ontology conservation plan and the repair suggestions for different cultural relics [32].

4.2.2 Improvement of infrastructures

The infrastructures around and inside the cultural relics that affect the style and feature of cultural relics should be reconstructed. The main measures include underground burying of power, telecommunication, water supply and drainage lines, and concealed treatment of environmental

sanitation facilities, such as garbage stations. It also includes water supply and drainage engineering, road traffic engineering, electrical engineering, parking lot, and service facilities engineering. Among them, the water supply and drainage engineering is applicable to the cultural relic buildings, which are still used as houses or open places. The road traffic engineering and electrical engineering mainly aim at open cultural relics and scenic spots.

4.2.3 Conservation of the surrounding environment

The plan aims to optimize the traffic system around the cultural relics site, renovate the surrounding architectures, and carry out the greening of surrounding areas and efficient use of natural water in combination with the needs of sustainable development.

4.2.4 Construction of development plan based on value theme and ontology characteristics

On the basis of the conservation of historical relics, historical values should be made full use of, and the display route should be broadened. On the premise of protecting the main body of cultural relics from being affected, around the theme of the historical education, the basic functions of architectures are used to create a number of folk-custom homestay experience projects to increase economic benefits.

Figure 15: The spatial layout structure of one core, one belt, two axes, and three groups.

4.3 Planning framework of sustainable development

4.3.1 Group and tandem development – macro level

Through the integration of cultural relics, traffic conditions, resource distribution, etc., this article proposes and promotes a model of hierarchical group conservation and development, which combines the development of regional central cities such as Nanyang, Wuhan, and Hefei around the project base. The overall structure of the spatial layout is “one core, one belt, two axes, and three groups.” According to different themes of the cultural relics, different theme regions are divided. On this basis, a key boutique display route is created to connect these regions (Figure 15).

One core refers to the core region of the Dabie mountains cultural relics. To which, the number is large, the range is wide, the level is high and the conservation degree is complete. The region mainly includes Xin County in Henan Province, Hong’an and Macheng in Hubei Province, and Jinzhai in Anhui Province, including but not limited to the aforementioned counties and cities.

The belt refers to the continuous area of the Dabie Mountains cultural relics, which extends to Yuexi, Taihu Lake, and other places in Anhui Province in the East, to Tanghe and Tongbai counties in the south of Henan Province in the west. It contains more than 1,000 essential cultural relics in modern times, which is conducive to integrated development and utilization.

Two axes refer to the cultural relics axis connecting Hefei and Wuhan metropolitan areas, respectively, whose passenger flow is attracted to the Dabie Mountains. This will create conditions for the centralized development and utilization of cultural relics and also prompt to realize the interconnection of the main infrastructure and the co-governance and sharing of ecological management.

Three groups refer to the east group, the central group, and the west group, according to the regional boundaries. The central group is located at the junction of the three provinces in the central Dabie Mountains, including seven counties and one city: Hong’an County, Xin County, Macheng City, Guangshan County, Luoshan County, Dawu County, Shangcheng County, and Jinzhai County. It contains cultural relics of various periods, with diverse historical values and numerous poverty-stricken counties. The east group is located at the junction of Hubei Province and Anhui Province in the southeast of the Dabie Mountains, including Huangmei County, Yingshan County, Yuexi County, and Taihu County. The west group is located in Henan Province in the northwest of the Dabie Mountains, including Tanghe County, Tongbai County, Fangcheng County, and Sheqi County.

4.3.2 Medium level

According to the GIS analysis data, the dot density of cultural relics is the largest at the junction of Xin

County, Hong'an County, and Macheng City. Within this region, the regional resources of the three areas are coordinated, the linkage effect is exerted, and the demonstration area regional cooperation is formed. In addition, these three are all national poverty-stricken places, which belong to the concentrated poverty-stricken region of the Dabie Mountains. In this region, the plan can promote the deep integration of cultural tourism industry and poverty alleviation [33] and create a cultural zone of heritage.

4.3.3 Micro level

At the micro level, Xin County, as the core of modern cultural heritage conservation in the Dabie Mountains, has a high level and vital status. It can be positioned as the core region of the Dabie Mountains in culture and patriotic education (Figures 16 and 17).

To the conservation and restoration of the architectural heritage in Xin County, the general ideas are as follows:

- (1) The relevant national laws and policies should be strictly implemented for conservation and utilization.
- (2) On the premise of conservation, reasonable development and renewal are suggested to carry out. Its value and connotation will be excavated on the basis of the maximum protection of the overall historical features and information of Xin County.

- (3) The inheritance and protection of traditional crafts and technologies should be persisted, which is a prerequisite for the preservation and restoration of cultural relics. The conservation of the Dabie Mountains cultural relics includes not only the buildings but also traditional materials and technologies. The application of new materials, new processes, and new technologies is to better preserve more raw materials and structures rather than replace them. Traditional materials and their processing will be used and restored. It is suggested to keep long-term training of professional personnel for the conservation and restoration of historical buildings.

To the historical building group in Xin County, the conservation of the ancient residences is not so good as the conservation of public buildings. Due to the development of villages and towns and the increase of the population density, it is common that the villagers have reconstructed historical buildings, which causes a part of residential courtyards to lose the original style. After status quo and surveys, there are several problems in the conservation of buildings in this area:

- (1) Some empty houses are seriously damaged and in disrepair. The brick wall cracks locally, and the bottom wall brick has gradually weathered. Some wall bricks fall off (the wall around the window, under the window, and between the windows).

Figure 16: The distribution of the heritage conservation level in Xin County.

Figure 17: The distribution of the heritage types in Xin County.

- (2) The historic buildings are not used properly, and the rooms are crowded.
- (3) A large number of illegal buildings change the original appearance of historical buildings and reduce their potential cultural value.
- (4) The interior space of some buildings is narrow and chaotic, which have fire hazards.
- (5) The environment greening is poor and lacks corresponding open space.
- (4) The surrounding traffic environment will be improved and more tourist parking lots will be built.
- (5) Through the function replacement, the internal space is transformed and used, and the reasonable modes are selected for repair. The ways are as follows: (1) to restore the original space basic pattern; (2) to update the internal space equipment; and (3) to increase the appropriate amount of commercial services and exhibition space.

In view of the aforementioned problems, considering the current damage situation of the buildings and the original process, according to the principles of cultural relic conservation and restoration, the cultural relic buildings still in use are restored to repair their partial defects, so that the architectural heritage of Xin County and the Dabie Mountains can gradually restore their original style. The specific conservation measures are as follows:

- (1) The internal and external environment of historical buildings will be restored just as before. The building structure will be strengthened. The specific principles and methods for seismic protection and structural reinforcement are presented in Table 6.
- (2) Illegal and temporary buildings will be demolished in the courtyard to increase greening.
- (3) Some nonhistorical buildings will be demolished as parking land.

In particular, the conservation, utilization, and restoration of historical buildings should be focused on to make sure that they will not change the whole pattern and the appearance of buildings.

5 Conclusion and discussion

The modern and contemporary cultural heritage of the Dabie Mountains has essential historical, cultural, and spiritual values. Scientific and reasonable conservation and development of the cultural heritage in this region have more practical and far-reaching historical significance for carrying forward and cultivating the national spirit and promoting the coordinated economic and social development of the backward old regions. The application of digital

Table 6: Seismic protection and reinforcement measures for historical heritage in the Dabie Mountains

Problems	<div>1. The masonry brick walls are short of durability and protection against earthquakes.</div> <div>2. The timber beams (wooden gratings) do not have enough bearing capacity.</div> <div>3. Timber components like the purlins on the pitched roof are eroded.</div>
Reinforcement principles	<div>(1) Protection principle, (2) authenticity principle, (3) integrity principle, (4) safety principle</div>
Reinforcement methods [34]	<div>1. Basic reinforcement</div> <div>For half-timbered constructions where the stepped brick masonry footing is adopted as the foundation, reinforced concrete is added to increase the section area to improve the foundation's integrity and carrying capacity.</div> <div>2. Reinforcing interior walls</div> <div><div>(1) Reinforcing meshes and polymer mortar are combined to reinforce the walls, and reinforcing bars are added at junctions between walls;</div><div>(2) Structural adhesives are applied to paste fiber composites to the wall, thereby increasing its load-carrying capacity.</div></div> <div>3. Reinforcing exterior walls</div> <div>The exterior walls of half-timbered traditional buildings are principally plain brick walls, with lime mortar joints. Reinforcement of exterior walls should be performed according to the depth of weathering of the bricks.</div> <div><div>(1) Walls with a depth of weathering less than 10 mm are preserved as they were.</div><div>(2) For walls with a depth of weathering ranging from 10 to 20 mm, brick powder is used to patch the wall.</div><div>(3) For walls with a depth of weathering larger than 20 mm, the damaged wall surface is cleaned and brickbats are used to patch the wall.</div><div>(4) For plain brick walls that have been severely damaged, extra bricks are used to replace the damaged bricks. and the calcimine is applied to restore the wall.</div></div> <div>4. Reinforcing the floors</div> <div>The load-carrying capacity of the floor beam (wood gratings) is calculated.</div> <div><div>(1) If the calculated capacity meets the requirements, the removal and repairing method is employed. Specifically, the eroded part is removed first before preservative treatment is performed; the dry timber parts, as per their shapes and sizes, are pasted to the original components by adhesives. Meanwhile, fireproof treatment is performed on the timber floor structure.</div><div>(2) If the calculated carrying capacity does not meet the requirements, the section area will be increased. Specifically, new timber parts are pasted to the original timber component and fiber composites are pasted for reinforcement purposes.</div></div> <div>5. Reinforcement of the roof</div> <div>The timber roof and the supporting components and joints are examined one by one. Timber components that are subject to cracks, erosion, or deformation will be reinforced or replaced. The key areas for examination include the sheathing plank, the timber purlin, the bottom members of the timber roof truss, the joint points between the top chord and the timber purlins, and the joint points between other members of the timber roof truss. For cracked or damaged tiles, tiles of the original shape are prepared for replacement.</div>

technology provides a new method for the conservation and development of the Dabie Mountains cultural heritage and the deep value of cultural relics.

In this article, the new methods and technologies are applied to the practice of urban cultural heritage conservation and sustainable development at the present stage. With GIS technology, the architectural heritage in the Dabie Mountains during different historical periods is sorted out systematically, and the basic database of historical heritage is established. Then, the current situation of its conservation and utilization is evaluated. The conclusion is that the architectural heritage in this region has the following characteristics: (1) wide distribution, (2) a

large number, (3) rich types and distinct themes, (4) rational structure of resource grades and the characteristics of group distribution, and (5) the small-scale traffic location has certain advantages, which is easy to develop with the surrounding tourism. There are the following problems: (1) the poor preservation of ontology architecture; (2) the difficult integration of resources; and (3) the weak way of sustainable utilization and display.

Therefore, integrating GIS data, at the macro level, this article prepares to form the overall structure of the plan, which takes the core region of the Dabie Mountains as the center, extending northwest and southeast continuous cultural relics belt to connect Hefei and Wuhan

historical relics axis. Then, three groups of east, center, and west are divided, which creates conditions for the centralized development and utilization of cultural relics. At the medium and micro levels, the essential historical and strategic location of the junction of Xin County, Hong'an County, and Macheng City is confirmed because this region has the maximum dot density of cultural relics. So the region is taken as the core of medium and micro level areas to form regional cooperation demonstration.

Due to the large scope of this study and the great number of cultural relics involved, the evaluation of modern historical and cultural heritage resources in the Dabie Mountains is still in the step of data storage and simple analysis. The attribute database of cultural relics remains to be improved. In the future, new technologies and methods should be actively adopted to analyze the attribute data more thoroughly, so as to realize the transformation from section conservation to sustainable development.

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