

# Quantitative Research on the Value Evaluation of Red Cultural Heritage in Mentougou District of Beijing Based on GIS–AHP

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**Abstract** Red cultural heritage is precious material and spiritual wealth, and is a non renewable cultural heritage with unique characteristics and protection value. In this paper, red cultural heritage in Mentougou District is taken as the research object. Through GIS, the classification and spatial distribution characteristics of the red cultural heritage in Mentougou are analyzed. On this basis, the analytic hierarchy process (AHP) is introduced to conduct quantitative value evaluation, determine evaluation factors and weights, and form a more systematic and scientific evaluation system suitable for Mentougou red cultural heritage. This paper aims to provide technical and methodological references for the evaluation and planning of the protection and utilization of red cultural heritage, and more scientifically protect and inherit red cultural heritage.

**Keywords** Mentougou, Red cultural heritage, GIS, AHP, Value evaluation

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Red cultural heritage is a special heritage left by the people under the leadership of the CPC in the revolution and war during the New Democracy Revolution, and has the value of historical research, social education, and cultural dissemination<sup>[1]</sup>. The 20<sup>th</sup> National Congress of the Communist Party of China pointed out the need to increase the protection of cultural relics and heritage, and strengthen the protection and inheritance of historical and cultural heritage in urban and rural construction. Beijing is a famous historical and cultural city with the tradition of glorious revolution. As the outer suburb of Beijing, Mentougou District is an old revolutionary base area with rich red resources in Beijing, and has had a revolutionary history of more than 100 years. Especially the preservation of relics such as the Pingxi Anti Japanese Base is a physical witness to the history of the Anti Japanese War in the Beijing region.

In this paper, red cultural heritage in Mentougou District is taken as the research object. Through GIS and AHP, a scientific and rigorous evaluation system for heritage value is established, in order to objectively measure and judge the value of the heritage, more scientifically protect and utilize the red cultural heritage, and leverage the regional impact of the red cultural heritage on Mentougou.

## 1 Classification of red cultural heritage in Mentougou District

Mentougou District is an old revolutionary base area with rich red resources in Beijing,

and has many former sites of revolutionary institutions, battles and revolutionary figures. According to the 2018 general survey of red cultural resources in Beijing, the list of immovable revolutionary cultural relics, the relevant data of Mentougou Government and field survey, there are 82 red heritage sites in Mentougou District, including 12 immovable revolutionary cultural relics: 2 immovable revolutionary cultural relics by municipal cultural relics protection units, 7 immovable revolutionary cultural relics by district-level cultural relics protection units and 3 immovable revolutionary cultural relics of cultural relics that have not been approved and announced (Table 1). A portion of the heritage is basically preserved intact, while some of the heritage is rebuilt on its original site.

The standard for the existence of the Mentougou red cultural heritage can be divided into material and intangible forms. The material forms mainly include revolutionary battle sites, memorial halls, exhibition halls, martyr cemeteries, etc. According to the research on the red cultural heritage of Mentougou District<sup>[2-8]</sup>, it is divided into five main categories based on the performance content: revolutionary institutions and conference sites, revolutionary battle and tragic sites, revolutionary figures' former residences, revolutionary martyrs' cemeteries, monuments (towers, halls) (Fig.1).

The intangible forms of red cultural heritage mainly include the deeds, songs of revolutionary figures, and their spirit of

revolutionary resistance. During the Anti Japanese War in Mentougou District, a large number of revolutionary figures emerged, including Cui Xianfang, Zhao Yongcheng, Cui Laizhong, Liu Yukun, et al. They left a large number of revolutionary hero stories and revolutionary deeds in Mentougou<sup>[9]</sup>.

## 2 Analysis of the spatial distribution characteristics of red cultural heritage

### 2.1 Data source and research methods

**2.1.1 Data source.** The information of Mentougou red cultural heritage list mainly comes from the website of Mentougou District People's Government, Beijing Municipal Bureau of Cultural Relics and related books. The geographic coordinates of the red cultural heritage are mainly obtained through Google Earth and online map queries. The vector layer of Mentougou administrative area and DEM (digital elevation model) data required for the research are both from the geospatial data cloud website.

**2.1.2 Research methods.** With the help of ArcGis10.7 software, taking geographical coordinate as the main body, the attribute database of spatial characteristics of red cultural heritage in Mentougou District is established, and quantitative analysis on the spatial distribution characteristics of red cultural heritage in Mentougou District is conducted. This paper explores the spatial distribution characteristics of red cultural heritage in Mentougou District from

the distribution type (nearest neighbor index) and distribution density (Kernel density estimation).

**2.2 Analysis of spatial distribution characteristics**

**2.2.1 Spatial distribution type.** The nearest neighbor index method (*R*) represents the degree of proximity between point like objects in geographic space. When *R* > 1, point like elements tend to be evenly distributed. When *R* < 1, point like elements are distributed in a condensed form<sup>[10]</sup>. Using the average nearest neighbor analysis of ArcGIS10.7 for operation (Fig.2), the distance between each heritage point and its nearest neighbor is calculated. The closest actual distance (*r<sub>i</sub>*) is 1,108 m, and the theoretical nearest distance (*r<sub>T</sub>*) is 2,052 m. The Mentougou red cultural heritage index (*R*) is 0.54, namely *R* < 1, indicating that the spatial distribution type of Mentougou red cultural heritage is a cohesive distribution.

**2.2.2 Spatial density analysis.** Seen from the nuclear density analysis of red cultural heritage in Mentougou District through GIS (Fig.3), the spatial distribution of red cultural heritage in Mentougou District presents a spatial pattern of “large dispersion and small concentration”, which is roughly divided into two high-density core areas and three sub density core areas. The first high-density core area is centered on Malan Village of Zhaitang Town, with a nuclear density of 0.569. The second high-density core area is located in Qingbaikou Village of Yanchi Town, with a nuclear density value of 0.428. The sub density core areas are centered around Tahe Village in Qingshui Town, Tianzhuang Village

in Yanchi Town, and Anjiazhuang Village in Wangping district, with a density value of up to 0.219.

Malan Village and Qingbaikou Village in the high-density core area are both located in the establishment zone of the Pingxi Anti Japanese Base Area of the Jin-Cha-Ji Army (Fig.4). Other core areas are also areas of local party activity. Overall, the red cultural heritage of Mentougou is closely related to the pre Anti Japanese War, the Anti Japanese War, and the Liberation War, and its distribution is closely related to the creation of the Pingxi Anti Japanese Base.

**2.2.3 Spatial distribution characteristics under the influence of natural factors.**

(1) Elevation analysis. Using ArcGIS10.7, the spatial distribution map of Mentougou red cultural heritage is overlaid with the topographic elevation map (Fig.5). Seen from Fig.5, there are only 5 red cultural heritage sites in Mentougou District in the plain area below 200 m above sea level, which are distributed in the east of Mentougou District; there are 25 red cultural heritage sites in hilly areas with an altitude of 200–400 m, accounting for 30.5%; there are 52 red cultural heritage sites in mountainous areas with an altitude of over 400 m, accounting for 63.4%.

Geographical advantage is the main objective condition for creating a base area. Mentougou District is a natural barrier in western Beijing, while Zhaitanchuan, located in the mountains and valleys of Mentougou District, is an ideal place to carry out guerrilla warfare and an important station for Pingxi base from

opening up to consolidating development.

(2) Slope analysis. Through slope analysis, the gradient distribution map of Mentougou red cultural heritage is obtained (Fig.6). Analysis shows that the red cultural heritage of Mentougou is mainly distributed in relatively flat areas with a slope of less than 10°. The red cultural heritage of Mentougou is mainly distributed in areas with small slopes and less undulating terrain, located in deep canyons. Due to the constraints of the mountain and river situation, there is less randomness and more inevitability. Rivers, valleys, and mountain passes are essential places for transportation, without which there is no feasible path.

**3 Quantitative evaluation of the value of Mentougou red cultural heritage**

As a special type of architectural heritage, the red cultural heritage of Mentougou contains rich and colorful values. But if want to evaluate and determine its value, it needs to establish a set of dedicated evaluation system. Through a set of scientific, complete, and sustainable value evaluation system, the value of the Mentougou red cultural heritage is determined. Establishing a complete evaluation system requires the process of selecting evaluation indicators, assigning indicator weights, determining evaluation rules, and implementing evaluation<sup>[11]</sup>.

**3.1 Selection of indicators for the evaluation system of red cultural heritage value**

According to the revised *Guidelines for*

**Table 1 List of immovable revolutionary cultural relics in Mentougou District**

No.	Name	Batch	Geographic location	Classification of cultural relics protection units
1	Former Site of the Eighth Route Army Ji-Re-Cha Advance Command	First	Malan Village of Zhaitang Town	Beijing Cultural Relics Protection Unit
2	Monument to the Martyrs Sacrificed for the Country during the War of Resistance Against Japan in Wanping County	First	Jiutoulong Village of Zhaitang Town	Beijing Cultural Relics Protection Unit
3	Former Site of the Meeting Place of Song and Deng Detachment of the Eighth Route Army	First	Dujiazhuang Village of Qingshui Town	Mentougou District Cultural Relics Protection Unit
4	Yiyuanchun Drugstore	First	Qingbaikou Village of Yanchi Town	Mentougou District Cultural Relics Protection Unit
5	Former Site of Tahe Village of Ji-Re-Cha Military and Political Committee	First	Tahe Village of Qingshui Town	Mentougou District Cultural Relics Protection Unit
6	Former Site of the Fourth Column of the Eighth Route Army	First	Dujiazhuang Village of Qingshui Town	Mentougou District Cultural Relics Protection Unit
7	Former Site of the Tenth Regiment Headquarters of the Progressive Army	First	Malan Village of Zhaitang Town	Mentougou District Cultural Relics Protection Unit
8	Tahe Former Site of the Advance Command	First	Tahe Village of Qingshui Town	Mentougou District Cultural Relics Protection Unit
9	Former Site of Ji-Re-Cha Party Committee	First	Dasanli Village of Zhaitang Town	Mentougou District Cultural Relics Protection Unit
10	Monument to Chairman Mao on the Approval of Production Cooperatives	First	Huang’antuo Village of Qingshui Town	Non yet approved and announced as non movable cultural relics of cultural relics protection units
11	Red Cultural Relics Building Complex in Malan Village	First	Malan Village of Zhaitang Town	Non yet approved and announced as non movable cultural relics of cultural relics protection units
12	Fengsha Line Martyrs Monument	Second	Liuliqu Village of Longquan Town	Non yet approved and announced as non movable cultural relics of cultural relics protection units

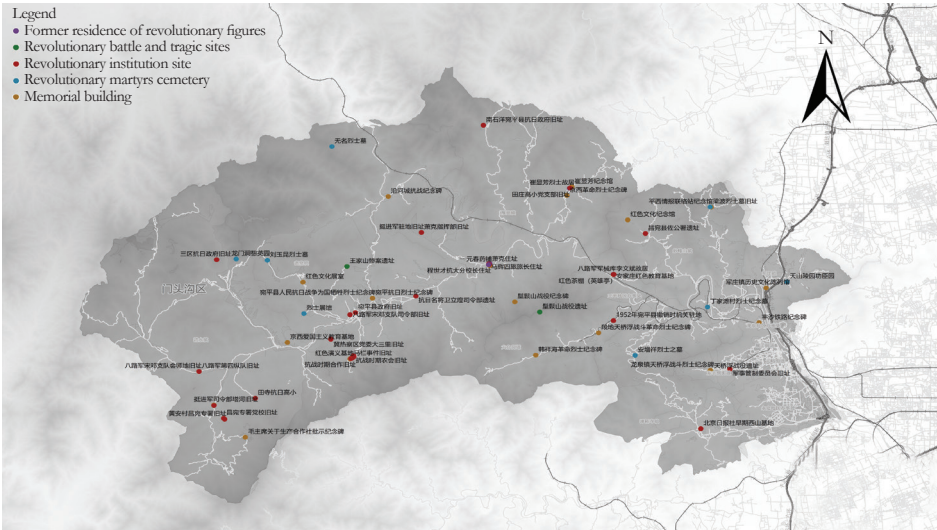


Fig.1 Classification and distribution of red cultural heritage in Mentougou

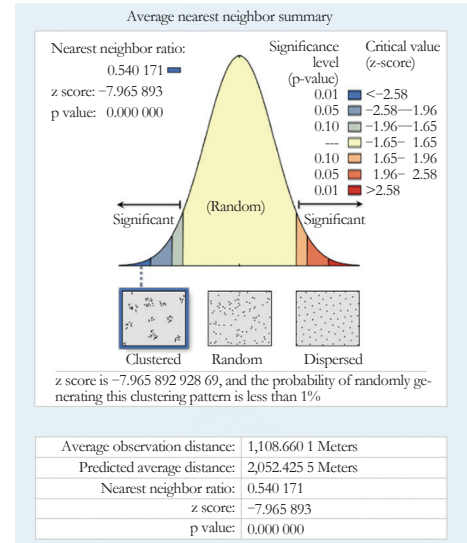


Fig.2 Average nearest neighbor processing results

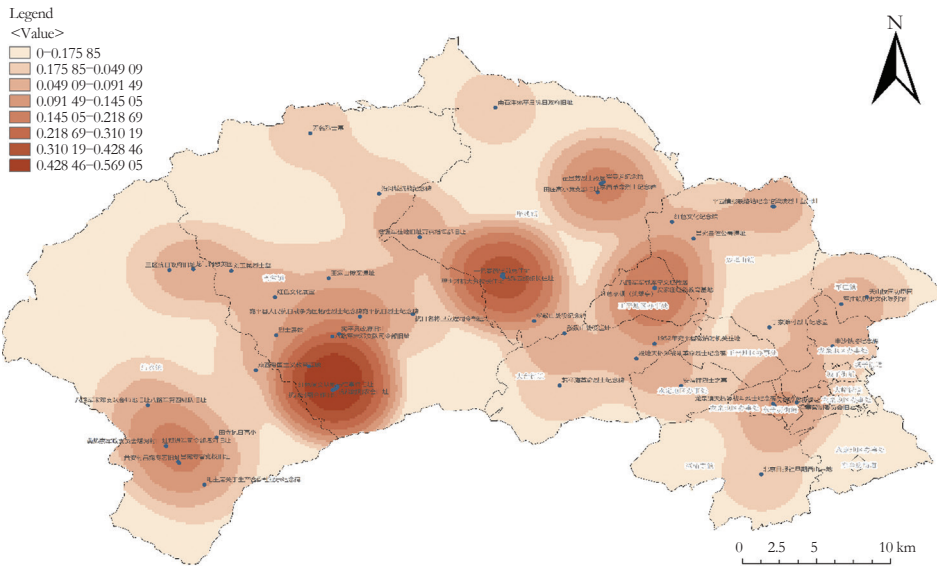


Fig.3 Nuclear density analysis of red cultural heritage in Mentougou District

the Protection of Chinese Cultural Relics and Monuments in 2015, the five major values for the recognition of cultural relics value are taken as the target layer for the recognition of the red cultural heritage value in Mentougou. That is, the measurement of the value of red cultural heritage mainly starts from these five major directions, including historical value, artistic value, scientific value, social value, and cultural value. Afterwards, a sub index evaluation is conducted on the value of the Mentougou red cultural heritage from aspects such as the level of heritage protection and the integrity of heritage sites. Finally, 5 first-level indicators and 13 second-level indicators are determined.

### 3.2 Determination of the weight of red heritage value

For the determination of the weight of the evaluation indicators for the value of Mentougou red cultural heritage, the analytic hierarchy process (AHP) method, which is currently widely used in various fields, is used to compare the importance of each indicator. It is necessary to compare the importance of the evaluation indicators at the same level in pairs and create a judgment matrix for the weight based on the comparison results. When judging the importance of indicators, it is necessary to maintain consistency. That is, if indicator A is more important than indicator B, and indicator B is more important than indicator C, then indicator A must be more important than C<sup>[12]</sup>.

After expert scoring, the original scoring data of the AHP judgment matrix for the

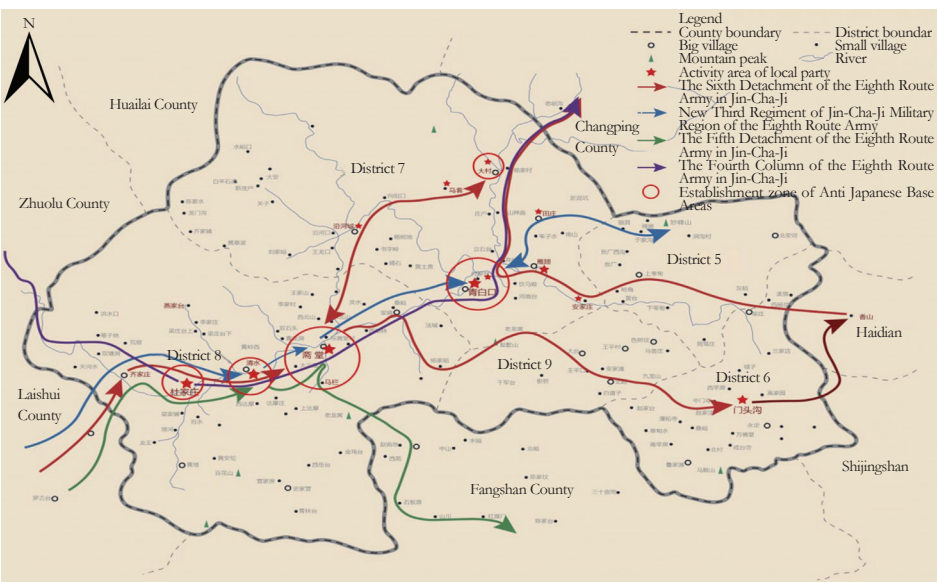


Fig.4 Establishment zone of Pingxi Anti Japanese Base Area



evaluation indicators of the red cultural heritage value in Mentougou is obtained. Then, the data of each group is averaged to obtain the final comprehensive judgment matrix. The data of the judgment matrix is then substituted into the AHP software for calculation, and the weight values between the same level indicators can be obtained (Table 2).

### 3.3 Detailed rules for rating the value of red heritage

According to the evaluation criteria for cultural relics indicators, the scoring criteria for each factor is divided into 4 levels: 1, 2, 3, and 4 points, with 4 points being the highest and 1 point being the lowest. According to the actual situation of the red heritage in Mentougou District, the average value of each secondary index score is obtained through the scoring of experts. After determining the scores of each secondary indicator, combined with the weights of each indicator, the combined weight score and the final score for each heritage are calculated. A higher score indicates higher value, while a lower score indicates lower value. By evaluating the value indicators of the Mentougou red heritage, the value is divided into three levels (Table 3), namely level one: red cultural heritage with significant value; level two: red cultural heritage with certain value; level three: red cultural heritage with relatively small value. The results indicate that there are 21 items in the first level, 46 items in the second level, and 15 items in the third level<sup>[12]</sup>. The quantity of each type of red cultural heritage in different value levels is simultaneously counted (Fig.7), to understand the quantity and proportion of different heritage types in each value level. Among the red cultural heritage with the first-level value, the main focus is on the former sites of revolutionary institutions; among the red cultural heritage with the second-level value, the total amount of red cultural heritage is the largest, with most of the commemorative buildings and revolutionary institution sites; the red cultural heritage with the third-level value is the least, with martyr cemeteries being the majority.

The first-level value: the red cultural heritage is often prominent in one or several aspects of the heritage value. This type of heritage is mainly composed of former sites of revolutionary institutions with good existing conditions and prominent value. For example, the Tianzhuang Gaoxiao Party Branch was the earliest party

branch in the mountain area of west Beijing and also played an important role in the Anti Japanese War in the birthplace of the party organization of west Beijing. Additionally, this building was built in the Qing Dynasty. The main rooms in the courtyard are three rooms wide and one room deep. One of the courtyards has a wing room with two rooms wide and one room deep. The current condition is well preserved and has been effectively protected. Therefore, it is recommended to preserve, protect, and renovate the overall red cultural heritage with first-level value in parallel.

The second-level value: the red cultural heritage has certain heritage value in one or several aspects. This type of heritage is mainly composed of commemorative buildings and former sites of revolutionary institutions. The Former Site of the Red Army Guerrilla Detachment Appointed by Zhu De is located in Qingbaikou Village of Yanyi Town. Qingbaikou Village is a revolutionary old area and a place where revolutionary activities were carried out relatively early. However, the existing condition of the old site is average. Although it has been listed, it is still used as a private residence and has been damaged to a certain extent. Therefore, it is recommended to strengthen the importance and play value of heritage with the second-level value in the red cultural heritage.

The third-level value: the red cultural heritage has certain characteristics in a certain aspect but its value is not prominent enough, and there is no distinct heritage value. It is

recommended to use it flexibly in combination with planning. In the Tianqiao Floating Campaign Site, there are only a few remnants of bunkers hidden in the bushes, and many of which have collapsed and been buried.

## 4 Conclusions

Red cultural heritage is the carrier of the revolutionary anti Japanese spirit, an indispensable part of cultural resource management, and has high value. The protection and utilization of the red cultural heritage of Mentougou is not only about simple maintenance and utilization, but also about inheriting its carried revolutionary history and fighting spirit, using reasonable means to realize its utilization value and sustainable development.

Through sorting out the red cultural heritage of Mentougou, it is found that its time covers the period from the early days of the founding of the Communist Party of China to the pre liberation war. According to existing form, it is divided into five principal types for research. Through the analysis of the spatial distribution of red cultural heritage, it is found that its distribution type is cohesive, and the spatial distribution characteristics show a spatial pattern of “large dispersion and small concentration”. In addition, it is mainly distributed in relatively flat areas in mountainous areas and has the characteristic of being distributed in strips along rivers. Finally, based on the analysis of the red cultural heritage in Mentougou, a quantitative evaluation of its

**Table 2 Weights of red heritage value indicators in Mentougou**

Target layer	Weight	Criterion layer	Weight	Indicator layer	Weight
Comprehensive evaluation of the value of Mentougou red cultural heritage	1	Historical value	0.413 9	Heritage protection level	0.310 8
				Intactness of heritage sites	0.195 8
				Related historical events and figures	0.493 4
		Scientific value	0.248 3	Architectural technology	0.250 0
				Architectural structure and materials	0.750 0
				Architectural modeling and decoration	0.333 3
		Artistic value	0.186 7	Typical architectural style	0.666 7
				Value of education in current society	0.332 5
				Development and utilization value	0.139 6
		Social value	0.089 4	Individual and collective memory	0.527 8
				Symbolic value of revolutionary spirit	0.539 6
				Historical inheritance value	0.297 0
		Cultural value	0.061 7	Cultural diversity embodiment	0.163 4

**Table 3 Classification and statistics of scoring results**

Heritage value level	Score definition//points	Number	Proportion//%
One	> 2- ≤ 3	21	25.6
Two	> 1- ≤ 2	46	56.1
Three	0- ≤ 1	15	18.3

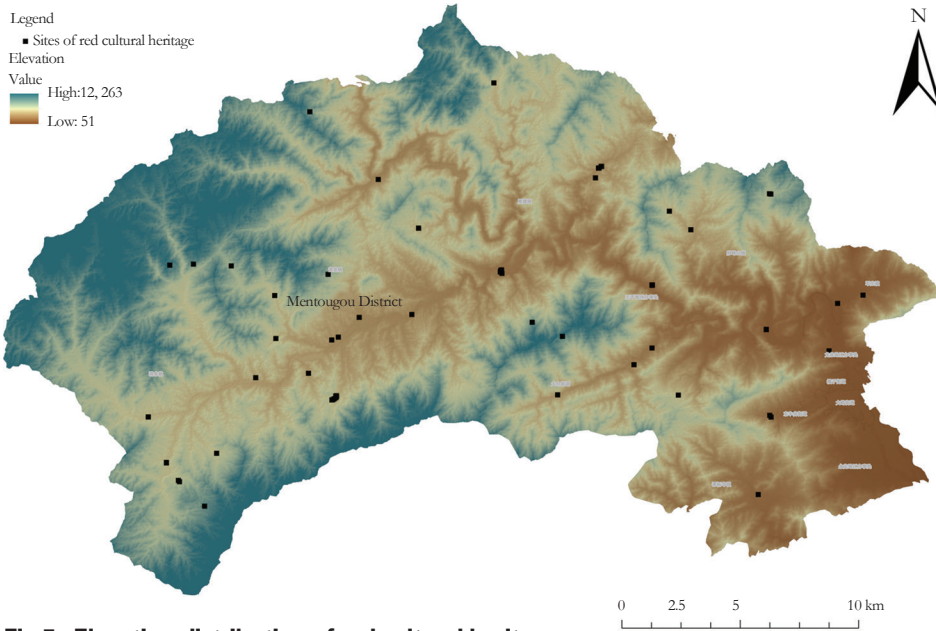


Fig.5 Elevation distribution of red cultural heritage

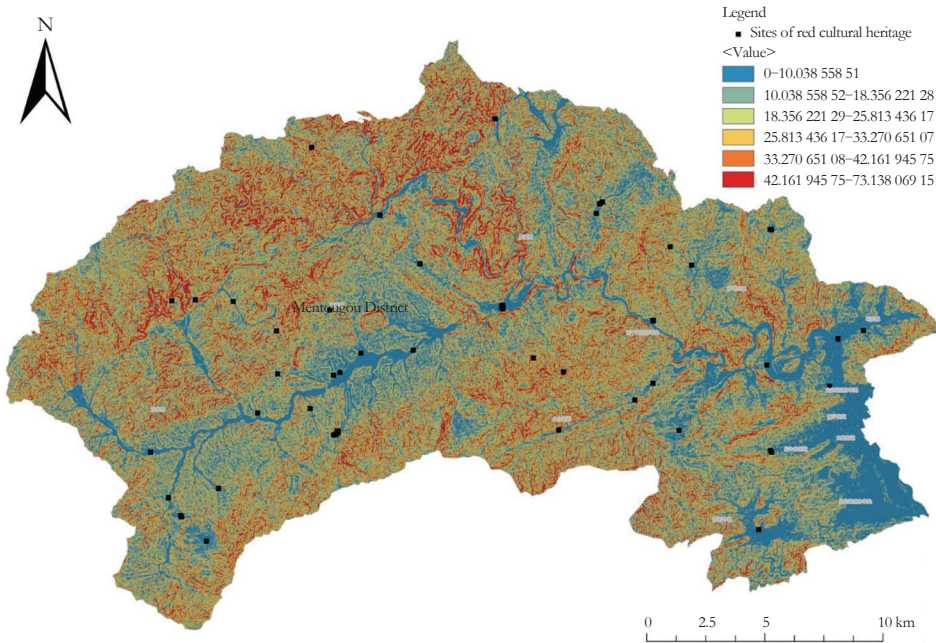


Fig.6 Slope distribution of red cultural heritage

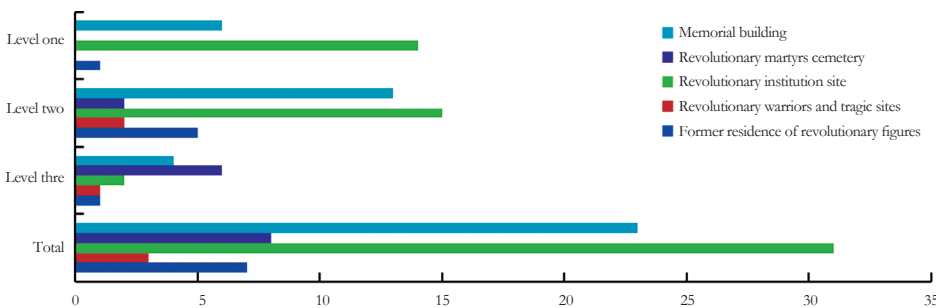


Fig.7 Value level of red cultural heritage

value is conducted. The study finds that it has high protection and utilization value in history,

art, society, science, and culture. By scoring and grading the value of Mentougou cultural

heritage sites, it can more effectively protect and utilize the red cultural heritage, unleash its special value, and serve the rejuvenation of the Chinese nation.

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