Article

Spatial Differentiation and Determinants of Intangible Cultural Heritage in Chongqing

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Abstract: This study examines the spatial differentiation patterns and formation mechanisms of intangible cultural heritage in Chongqing within a cultural geography framework by integrating Geographic Information System spatial analysis and the geographic detector model. Focusing on a mountainous urban context, the research quantitatively assesses the combined effects of natural environmental constraints and socioeconomic drivers on the spatial distribution of ICH. The results indicate that Chongqing's ICH displays a clear core–periphery structure shaped by the interaction between cultural ecological adaptation and regional development dynamics. Spatially, a "one core, two wings" pattern is identified, in which the main urban area functions as a highly concentrated core, while northeastern and southeastern Chongqing form two distinct cultural zones with differentiated heritage characteristics. Significant heterogeneity is observed in the clustering patterns of different ICH categories, suggesting varying sensitivities to environmental and socioeconomic conditions. Factor detection results show that total retail sales of consumer goods constitute the most influential socioeconomic determinant of ICH distribution, whereas average digital elevation model elevation represents a key natural constraint in mountainous terrain. Interaction analysis further reveals pronounced nonlinear enhancement effects, particularly between economic development level and government support, indicating that institutional and economic forces jointly intensify spatial differentiation processes. By elucidating the dominant drivers and interaction mechanisms underlying ICH spatial patterns, this study advances the understanding of cultural space evolution in mountainous cities. Methodologically, it demonstrates the applicability of combining GIS-based spatial analysis with geographic detector techniques in cultural heritage research, while practically providing quantitative evidence to support culturally sensitive spatial planning and targeted conservation strategies in complex urban–mountain environments.

Keywords: Intangible Cultural Heritage; Spatial Differentiation; GIS; Geodetector; Driving Mechanism; Chongqing Municipality

1. Introduction

Intangible cultural heritage (ICH) [1], as living practices that sustain community identity and cultural transmission, manifests in diverse forms such as traditional skills, rituals, performing arts, and oral traditions. It serves as a vital vehicle for the continuity of civilisations worldwide. Since China acceded to the UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage in 2004 [2], increasing emphasis has been placed on the protection and management of ICH. The promulgation of the Law of the People's Republic of China on the Safeguarding of Intangible Cultural Heritage in 2011 [3] further incorporated ICH protection into a formal legal framework. Following the 18th National Congress of the Communist Party of China, national policy support for ICH safeguarding has continued to intensify. In 2021, the

14th Five-Year Plan for the Protection of Intangible Cultural Heritage [4] and the Opinions on Further Strengthening the Protection of Intangible Cultural Heritage [5] were successively issued, explicitly setting medium- and long-term objectives for establishing a scientific and systematic protection regime and marking the elevation of ICH safeguarding to a national strategic level. Beyond its cultural significance, intangible cultural heritage embodies regional cultural identity and plays an increasingly important role in cultural–tourism integration and rural revitalisation. Its spatial distribution reflects the long-term interaction between human societies and their natural environments. However, under rapid urbanisation, the cultural ecology on which ICH depends is undergoing profound transformation, increasing the risk of disruption to traditional transmission chains. This situation underscores the necessity of spatially explicit research with both theoretical depth and policy relevance.

Chongqing Municipality is located at the southeastern edge of the Sichuan Basin, spanning 105°11′–110°11′ E and 28°10′–32°13′ N. Covering approximately 82,400 km ² and comprising 38 districts and counties, Chongqing exhibits a composite territorial structure integrating metropolitan areas, extensive rural regions, mountainous terrain, and reservoir zones, making it a typical and representative cultural–geographical unit in central and western China [6]. Predominantly mountainous and intersected by dense river systems, the city is characterised by a subtropical humid monsoon climate and complex topographic conditions. As a nationally designated historical and cultural city, Chongqing has accumulated a multilayered cultural system encompassing Ba–Yu culture, immigrant culture, and the culture of the War of Resistance, resulting in rich and diverse intangible cultural heritage resources, including traditional craftsmanship, folk customs, and other categories. In recent years, Chongqing has actively promoted the integration of intangible cultural heritage with tourism and related industries, achieving notable outcomes. Nevertheless, increasing spatial imbalance in the distribution of ICH has gradually emerged, constraining the effectiveness of coordinated protection and sustainable utilisation. Accordingly, using Chongqing as a case study can deepen theoretical understanding of cultural–geographical evolution mechanisms and provide practical references for ICH conservation and regional development in similar mountainous areas.

Current domestic and international research on intangible cultural heritage has developed a multidimensional analytical framework. At the theoretical level, scholars have focused on defining the conceptual scope of ICH [7], constructing classification systems [8], and developing preservation theories adapted to the Chinese context [9]. From legal and institutional perspectives, attention has been directed toward improving ICH-related legislation, clarifying property rights, and safeguarding the rights of inheritors [10], thereby supporting practical protection efforts. In terms of conservation and development pathways, studies have explored approaches such as digital technologies [11] and tourism revitalisation [12], alongside the gradual establishment of frameworks for assessing cultural and economic value. In spatial analysis, Geographic Information Systems (GIS) and spatial statistical methods [13] have been widely applied to reveal the clustering characteristics of intangible cultural heritage at multiple scales [14] and to preliminarily examine the influence of natural and socioeconomic factors on its distribution. Despite these advances, existing studies remain constrained by limited spatial scales and insufficient depth in analysing driving mechanisms. In particular, systematic quantitative analyses at the provincial and municipal levels in China are still relatively scarce, and regionally differentiated ICH protection strategies lack robust empirical support.

Against this background, this study examines all national- and municipal-level intangible cultural heritage projects in Chongqing by integrating GIS-based spatial analysis [15] with the geographic detector model to systematically identify spatial differentiation patterns and quantitatively assess the driving roles of natural geographic and socioeconomic factors. By providing a citywide empirical investigation rather than focusing solely on provincial aggregates or individual ICH categories, this study addresses key limitations of existing research. Methodologically, the application of the geographic detector model overcomes linear assumptions inherent in conventional statistical approaches and enhances the identification of interaction effects among driving factors. By integrating multi-source geographic information and socioeconomic data, this research constructs a comprehensive analytical framework to elucidate the mechanisms shaping the spatial distribution of intangible cultural heritage. The findings aim to provide spatial evidence to inform ICH protection policies in Chongqing and to contribute methodological insights to cultural geography research in complex mountainous urban systems.

2. Data Sources and Methods

This study employs a multi-source data framework to analyse the spatial distribution characteristics of intangible cultural heritage (ICH) projects in Chongqing. The dataset comprises three main categories: the spatial locations of ICH projects, natural geographic variables, and socioeconomic indicators. Data on ICH projects were obtained from five batches of the national intangible cultural heritage list published by the state [16] and six batches of the municipal-level lists released by Chongqing Municipality [17]. In total, 707 municipal-level and above ICH projects were identified, corresponding to 762 inheritance sites. The geographic coordinates of these sites

were obtained through geocoding using the AutoNavi Maps API. All geocoded points were manually verified and standardised, and a spatial database of ICH projects with complete categorical attributes was subsequently constructed.

Natural geographic data included Chongqing's administrative boundary vector data, a digital elevation model (DEM) with a spatial resolution of 30 m, as well as water system and road network datasets. All geographic data were sourced from the National Geographic Information Public Service Platform [18]. The administrative boundary data were based on the officially approved standard map (review number GS20240650), and no modifications were made to the base map. Based on the DEM data, terrain-related variables such as elevation and slope were extracted through spatial analysis to provide fundamental geographic parameters for subsequent analyses.

Socioeconomic data were primarily collected from the Chongqing Statistical Yearbook 2024 [19] and statistical bulletins published by individual districts and counties. Key indicators, including population size, regional gross domestic product (GDP), and total retail sales of consumer goods, were compiled using districts and counties as the basic statistical units. To enable effective integration of multi-source datasets, all spatial and attribute data underwent unified preprocessing procedures, including spatial registration and standardisation within a consistent geographic reference framework. This ensured data comparability across spatial units and provided a reliable data foundation for subsequent spatial pattern analysis and driving mechanism identification.

To systematically examine the spatial differentiation characteristics of intangible cultural heritage (ICH) projects in Chongqing and to explore their underlying formation mechanisms, this study integrates spatial statistical analysis and geographic detection techniques. A comprehensive analytical framework is constructed following the logical sequence of "spatial pattern identification – distribution type diagnosis – driving factor detection", enabling an integrated interpretation of spatial structures and explanatory mechanisms. This methodological design allows for the combined analysis of point-based spatial clustering characteristics and the quantitative assessment of the influence of natural, socioeconomic, and cultural factors on the observed spatial patterns. All analyses were conducted using ArcGIS 10.8 and related spatial statistical tools, ensuring consistency and reproducibility throughout the analytical process.

2.1 Spatial Pattern Identification

2.1.1 Kernel Density Estimation

Kernel Density Estimation (KDE)[20] is employed to analyse the spatial agglomeration characteristics of ICH projects. By smoothing the spatial distribution of discrete point features, KDE transforms point-based data into a continuous density surface, enabling the identification of high-density clusters, low-density areas, and spatial gradients of ICH distribution. This method is particularly suitable for revealing localised concentration patterns and identifying core areas of cultural resource aggregation.

The kernel density function is expressed as:

$$f(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x - X_i}{h}\right)$$

where K denotes the kernel function, h represents the bandwidth, n is the total number of sample points, and X_i indicates the spatial location of each ICH project.

In this study, a bandwidth of 10 km was selected for kernel density analysis. The choice of this bandwidth was guided by three considerations. First, according to Silverman's rule of thumb, the calculated optimal bandwidth range encompasses 10 km. Second, given the large territorial extent of Chongqing (approximately 82,400 km²), a 10 km bandwidth balances the need to capture localised clustering in the core urban area while maintaining a macro-level representation of the broader regional structure, particularly the "two wings" regions. Third, robustness tests using alternative bandwidths of 5 km and 15 km produced consistent spatial patterns, confirming that the identified "one core, two wings" spatial structure is stable and not sensitive to bandwidth selection. Through KDE analysis, the spatial intensity and aggregation characteristics of ICH projects are visually and quantitatively represented, providing a foundation for subsequent distribution type identification and driving mechanism analysis.

2.1.2 Average Nearest Neighbour Index

To complement the local clustering analysis provided by KDE, the Average Nearest Neighbour Index (ANNI) [21] is applied to assess the overall spatial distribution pattern of ICH projects from a global perspective. This method evaluates whether the observed spatial distribution deviates from a random pattern by comparing the observed mean nearest-neighbour distance with the expected distance under conditions of spatial randomness.

The ANNI is calculated as follows:

$$\mathrm{ANNI} = \frac{\bar{D}_{\mathrm{obs}}}{\bar{D}_{\mathrm{exp}}}$$

where $\bar{D}_{obs}$ is the observed average nearest-neighbour distance and $\bar{D}_{exp}$ is the theoretical expected distance under a random distribution.

An ANNI value less than 1 indicates a clustered spatial pattern, a value greater than 1 suggests a dispersed or uniform pattern, and a value approximately equal to 1 implies a random distribution. By quantifying the overall spatial arrangement of ICH projects, the ANNI provides a

statistical basis for judging the degree of spatial aggregation and serves as an important reference for interpreting kernel density results.

2.2 Driving Mechanism Analysis: Geodetector

To further investigate the factors influencing the spatial differentiation of ICH projects, this study employs the Geodetector method [22]. Based on the principle of spatial variance decomposition, Geodetector quantitatively measures the explanatory power of different driving factors on the spatial distribution of ICH and identifies the interaction effects between multiple factors.

Unlike traditional regression-based methods, Geodetector does not rely on linear assumptions and is capable of handling both categorical and continuous variables. This characteristic makes it particularly suitable for analysing complex spatial phenomena influenced by coupled natural and socioeconomic processes.

The factor detection model of Geodetector is expressed as:

$$q = 1 - \frac{\sum_{h=1}^{L} N_h \, \sigma_h^2}{N\sigma^2}$$

where q represents the explanatory power of a given factor, N_h and σ_h^2 denote the number of samples and variance within stratum h, respectively, N is the total sample size, and σ^2 is the overall variance. A higher q-value indicates a stronger explanatory effect of the corresponding factor on the spatial differentiation of ICH projects.

A critical step in applying the Geodetector method involves the discretisation of continuous independent variables. To reduce subjective classification bias and enhance methodological rigour, the Natural Breaks (Jenks) method was used to discretise all continuous driving factors, including both socioeconomic and natural geographic variables. This method optimises class boundaries by maximising inter-class variance while minimising intra-class variance, ensuring that the classification results reflect the inherent structure of the data.

All discretisation procedures were performed within the ArcGIS 10.8 platform. Each continuous variable was classified into five levels, enabling a consistent characterisation of spatial heterogeneity across districts and counties. This standardised preprocessing workflow provides a reliable data foundation for subsequent q-value calculations and ensures the robustness and reproducibility of the analytical results.

3. Results

3.1 Spatial Distribution Characteristics of Intangible Cultural Heritage

Using 707 intangible cultural heritage (ICH) items and 762 corresponding transmission sites from the first to sixth batches announced by the Chongqing Municipal Culture and Tourism Commission, this study analyses the spatial distribution and category structure of ICH in Chongqing from an interdisciplinary perspective integrating cultural geography and ICH studies [23,24] (Table 1). Overall, ICH exhibits a markedly uneven spatial distribution across districts and counties, with a limited number of core areas concentrating a disproportionately large share of heritage items, while several industrialised or newly urbanising districts contain comparatively few listings (Table 1).

In terms of category composition, traditional craftsmanship constitutes the dominant type, accounting for nearly 40% of all transmission sites, followed by traditional music and traditional fine arts (Table 1). By contrast, categories that rely heavily on oral or performance-based transmission—such as folk arts, traditional theatre, and folk literature—represent a relatively small proportion of the total inventory, indicating greater vulnerability under modernisation pressures [25].

3.1.1 Kernel Density Distribution Patterns

Kernel density estimation reveals a clear spatial gradient and pronounced clustering pattern in Chongqing's ICH distribution (Figure 1). The highest-density cluster is concentrated in the main urban core, forming the primary hotspot of ICH transmission. A secondary high-density belt extends along the Yangtze River corridor, linking western districts through the core urban area and further connecting to key northeastern nodes, indicating a corridor-like aggregation structure (Figure 1). Beyond the core and river corridor, several regional centres form identifiable secondary clusters, together constituting a multi-centre spatial pattern.

Nearest neighbour distance analysis further confirms that Chongqing's ICH distribution is predominantly clustered (Table 4). With the exception of folk arts, which exhibits a dispersed pattern, all other categories display nearest neighbour ratios below 1 accompanied by statistically significant Z-scores and P-values, indicating systematic spatial aggregation. Traditional craftsmanship shows the strongest clustering intensity, while traditional fine arts, traditional medicine, and folk customs exhibit moderate clustering levels (Table 4).

Category-based comparisons are consistent with the kernel density results (Figure 2; Table 4). Traditional craftsmanship concentrates in the main urban area and selected regional centres, forming a multi-tier spatial structure. Traditional music displays a distinct regional concentration pattern, with a primary cluster in southeastern Chongqing and secondary clusters in the urban core and northeastern subregions. Performing-arts-related categories exhibit stronger localised characteristics, with clustering confined to a limited number of districts and counties. Overall, kernel density mapping and spatial statistical analysis jointly indicate that Chongqing's ICH

distribution follows a pattern characterised by a dominant urban hotspot, a river-oriented aggregation belt, and multiple regional sub-centres, reflecting differentiated spatial organisation across categories [26].

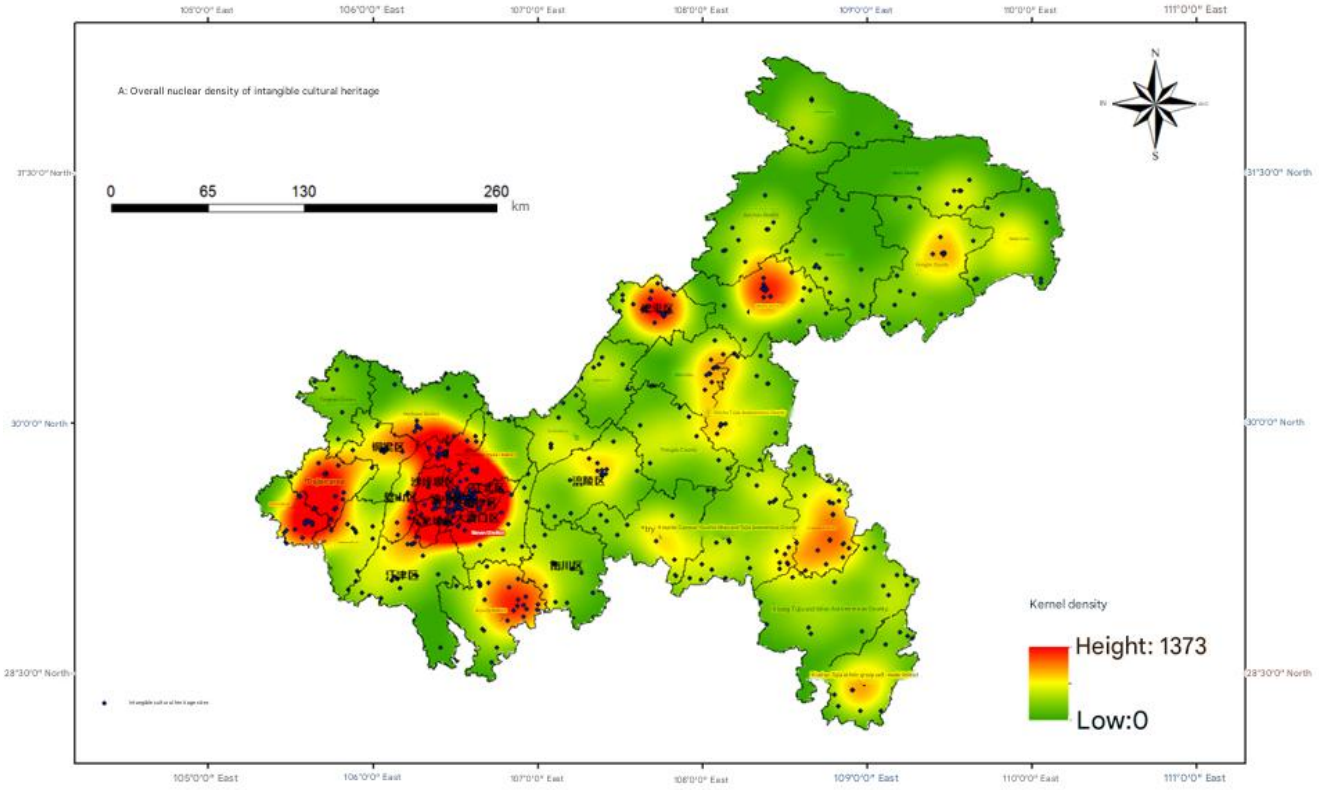


Figure 1. Overall Core Density of Chongqing's Intangible Cultural Heritage Projects

Table 1. Quantitative Distribution of Chongqing's Intangible Cultural Heritage Categories and Geographic Locations

District/County Name	L0	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
Yuzhong District	50	6.56%	1	1	0	3	3	7	20	7	7	1
Dadukou District	15	1.97%	2	2	0	1	0	5	3	1	0	1
Jiangbei District	10	1.31%	1	0	0	0	0	4	3	1	1	0
Shapingba District	14	1.84%	0	0	0	1	0	3	7	3	0	0
Jiulongpo District	22	2.89%	1	0	1	1	2	3	7	2	1	4
Nan'an District	27	3.54%	1	1	2	0	3	4	8	7	0	1

Beibei District	23	3.02%	1	1	2	0	1	7	9	2	0	0
Yubei District	16	2.10%	0	2	0	1	1	1	7	3	1	0
Banan District	13	1.71%	1	3	1	1	1	2	2	0	1	1
Jiangjin District	26	3.41%	1	1	1	1	5	0	9	1	1	6
Hechuan District	18	2.36%	1	2	1	0	0	2	9	1	0	2
Yongchuan District	13	1.71%	0	0	1	0	0	2	10	0	0	0
Bishan District	7	0.92%	0	2	1	0	0	0	4	0	0	0
Rongchang District	23	3.02%	0	0	1	0	5	1	11	1	1	3
Dazu District	25	3.28%	3	3	4	1	2	4	4	3	0	1
Tongliang District	13	1.71%	0	1	3	0	1	0	5	0	1	2
Tongnan District	9	1.18%	0	0	6	0	0	1	2	0	0	0
Fuling District	17	2.23%	1	3	0	1	0	1	9	2	0	0
Changshou District	12	1.57%	0	6	0	0	0	1	3	0	2	0
Nanchuan District	14	1.84%	0	2	1	0	0	0	10	1	0	0
Qijiang District	35	4.59%	2	5	2	3	0	2	12	1	0	8
Dianjiang County	10	1.31%	0	3	1	0	0	1	4	1	0	0
Wanzhou District	27	3.54%	0	3	3	1	2	7	7	1	3	0
Kaizhou District	14	1.84%	1	1	3	0	0	1	7	0	0	1
Liangping District	26	3.41%	0	5	1	2	1	2	11	0	1	3
Yunyang County	14	1.84%	0	6	1	1	0	0	6	0	0	0
Fengjie County	27	3.54%	2	3	2	0	1	1	12	1	2	3
Wushan County	18	2.36%	2	5	0	2	0	0	5	0	1	3
Wuxi County	12	1.57%	3	1	1	0	0	2	4	0	0	1
Chengkou County	12	1.57%	0	3	1	0	0	0	6	0	0	2
Zhong County	16	2.10%	2	2	2	0	0	2	8	0	0	0
Fengdu County	17	2.23%	1	4	3	0	0	1	5	0	0	3

Qianjiang District	34	4.46%	1	8	0	1	1	1	16	2	0	4
Wulong District	26	3.41%	1	6	1	0	1	1	13	0	0	3
Shizhu County	22	2.89%	2	4	3	1	1	1	5	2	0	3
Xiushan County	22	2.89%	0	3	1	5	1	1	5	0	0	6
Youyang County	28	3.67%	1	6	3	3	1	1	11	1	0	1
Pengshui County	35	4.59%	0	7	5	1	0	1	16	2	0	3
Total	762	——	32	105	58	31	33	73	295	46	23	66
Percentage	——	100.00%	4.20%	13.78%	7.61%	4.07%	4.33%	9.58%	38.71%	6.04%	3.02%	8.66%

Note: This table uses 762 municipal-level intangible cultural heritage transmission sites in Chongqing as the statistical benchmark. L0 represents the total number of intangible cultural heritage projects across all districts and counties, while L1 indicates the corresponding percentage of the total number of transmission sites citywide. Intangible cultural heritage types are categorised into ten major groups, denoted as follows: L2 Folklore, L3 Traditional Music, L4 Traditional Dance, L5 Traditional Theatre, L6 Traditional Sports, Games, and Acrobatics, L7 Traditional Fine Arts, L8 Traditional Craftsmanship, L9 Traditional Medicine, L10 Folk Arts, and L11 Folk Customs. The classification labels in Tables 2 and 3 below are consistent with those used here.

3.1.2 Global Spatial Clustering Characteristics

Based on the nearest neighbour distance index analysis in Table 4, Chongqing's intangible cultural heritage projects exhibit significant spatial clustering characteristics. Except for the performing arts category, which shows a dispersed distribution, the nearest neighbour ratios for the remaining nine categories are all less than 1. Their Z-scores are predominantly negative and accompanied by significant P-values, indicating a pronounced clustering pattern in their spatial distribution. Traditional crafts demonstrate the highest degree of clustering, with a nearest neighbour ratio of only 0.49, reflecting strong spatial dependency. Traditional arts, traditional medicine, and folk customs categories exhibited moderate clustering with ratios ranging from 0.59 to 0.66. While traditional sports, games, and acrobatics, along with folk literature, maintained clustering tendencies, their ratios reached 0.87 and 0.79, respectively, indicating relatively moderate clustering patterns. Notably, the nearest neighbour ratio for folk arts reached 1.05, indicating a dispersed distribution pattern. Overall, the spatial distribution of Chongqing's intangible cultural heritage projects exhibits a pronounced clustering dominance, with significant variations in aggregation intensity across different categories.

3.1.3 Category-Based Clustering Patterns

Kernel density maps and nearest neighbour distance statistics reveal pronounced differences in clustering intensity among intangible cultural heritage (ICH) categories in Chongqing (Figure 2; Table 4). Traditional craftsmanship exhibits the strongest spatial aggregation, forming high-density clusters concentrated in the main urban area and selected regional centres. Traditional music demonstrates a clear regional clustering pattern, with a dominant concentration in southeastern Chongqing and secondary clusters distributed across the urban core and northeastern subregions. In contrast, performing-arts-related categories, including traditional dance and traditional theatre, display moderate clustering, with spatial concentrations confined to a limited number of localised areas.

Folk arts constitute the only ICH category characterised by a dispersed spatial distribution, as indicated by a nearest neighbour ratio exceeding 1 and non-significant clustering statistics. This contrasts with all other categories, which exhibit nearest neighbour ratios below 1, confirming statistically significant spatial aggregation. The differentiated clustering patterns across categories reflect distinct spatial organisation forms, in which production-oriented heritage types tend to concentrate in urban and regional centres, while performance-oriented categories display greater spatial dispersion or locally constrained clustering.

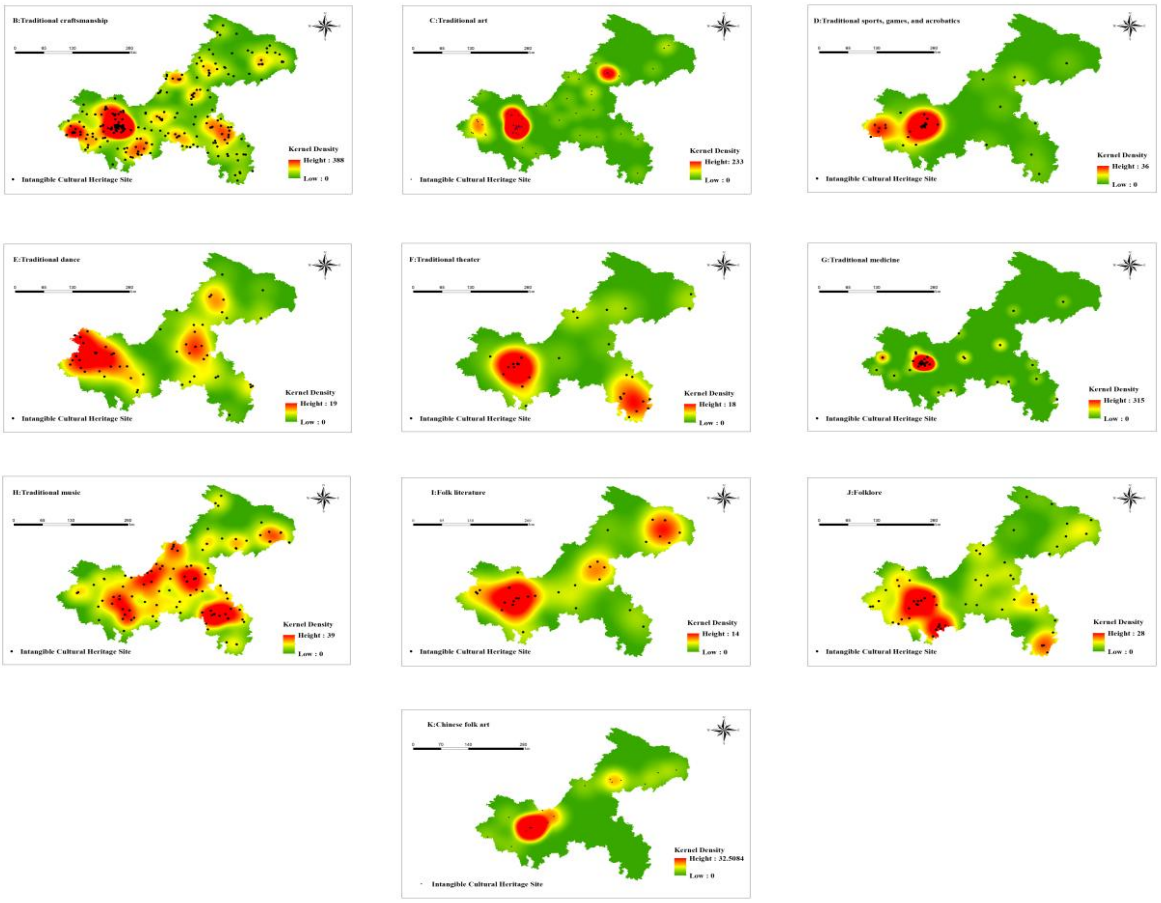


Figure 2. Kernel Density Spatial Distribution of Intangible Cultural Heritage Categories in Chongqing

3.2 Regional Differentiation of ICH under Spatial Planning Frameworks

Based on Chongqing's first integrated spatial master plan, the "Chongqing Territorial Space Master Plan (2021–2035)" (State Council Document [2024] No. 32) [27], the plan establishes a "three-region coordinated development" framework encompassing the Main Urban Area, the Northeast Chongqing Three Gorges Reservoir Area, and the Southeast Chongqing Wuling Mountain Area. The Main Urban Area comprises the Central Urban District, the West Chongqing Region, and the East Chongqing New City, forming a multi-centred cluster spatial structure characterised as "one core, two rivers, three valleys, and four mountains." This division is based on multidimensional factors, including socioeconomic foundations, ecological functional positioning, and ethnic composition, aiming to optimise coordinated regional development. Statistical data on Chongqing's intangible cultural heritage (as shown in Table 2 and Table 3) reveal distinct spatial differentiation across the three major economic functional zones: the Main Urban Area, the Northeast Chongqing Three Gorges Reservoir Area, and the Southeast Chongqing Wuling Mountain Area. This pattern profoundly reflects the differentiated influences of each region's natural geography, historical development trajectory, and functional positioning.

Table 2. Nearest Neighbour Distance Index for Chongqing Municipal Intangible Cultural Heritage

Economic Zone	Statistical Indicator	L0	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
Metropolitan Area	Number of Intangible Cultural Heritage Items	412	54.07%	16	38	28	14	24	51	158	37	16	30
	Type Proportion	54.07%	——	2.10%	4.99%	3.67%	1.84%	3.15%	6.69%	20.73%	4.86%	2.10%	3.94%
Three Gorges Reservoir Area in Northeast Chongqing	Number of Intangible Cultural Heritage Items	183	24.02%	11	33	17	6	4	16	71	2	7	16
	Type Proportion	24.02%	——	1.44%	4.33%	2.23%	0.79%	0.52%	2.10%	9.32%	0.26%	0.92%	2.10%
Wuling Mountain Area in Southeast Chongqing	Number of Intangible Cultural Heritage Items	167	21.92%	5	34	13	11	5	6	66	7	0	20
	Type Proportion	21.92%	——	0.66%	4.46%	1.71%	1.44%	0.66%	0.79%	8.66%	0.92%	0.00%	2.62%

Table 3. Distribution of Intangible Cultural Heritage Types Across Chongqing's Three Major Economic Planning Zones

Economic Zone	Statistical Indicator	L0	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
Metropolitan Area	Number of Items	412	54.07%	16	38	28	14	24	51	158	37	16	30
	Type Proportion	54.07%	——	2.10%	4.99%	3.67%	1.84%	3.15%	6.69%	20.73%	4.86%	2.10%	3.94%
Three Gorges Reservoir Area in Northeast Chongqing	Number of Items	183	24.02%	11	33	17	6	4	16	71	2	7	16
	Type Proportion	24.02%	——	1.44%	4.33%	2.23%	0.79%	0.52%	2.10%	9.32%	0.26%	0.92%	2.10%
Wuling Mountain Area in Southeast Chongqing	Number of Items	167	21.92%	5	34	13	11	5	6	66	7	0	20
	Type Proportion	21.92%	——	0.66%	4.46%	1.71%	1.44%	0.66%	0.79%	8.66%	0.92%	0.00%	2.62%

Table 4. Factors Influencing the Spatial Distribution of Chongqing's Intangible Cultural Heritage and Detection Results

Type	Number/Items	Average Observed Distance/m	Expected Average Distance/m	R Value	Z-score	P-value	Nearest Neighbour Ratio	Distribution Pattern
Traditional Craftsmanship	295	5837.08	11,804.09	0.49	-16.61	0.00	0.49	Clustering
Traditional Fine Arts	73	12313.57	20754.27	0.59	-6.65	0.00	0.59	Clustering
	33	25309.02	28,956.39	0.87	-1.38	0.17	0.87	Clustering

Traditional Physical Skills								
Traditional Dance	58	16,855.74	24,488.65	0.69	-4.54	0.00	0.69	Clustering
Traditional Theater	31	22705.04	32671.46	0.69	-3.25	0.00	0.69	Clustering
Traditional Medicine	46	14,933.30	23,301.14	0.64	-4.66	0.00	0.64	Clustering
Traditional Music	105	11562.22	18391.74	0.63	-7.28	0.00	0.63	Clustering
Folk Literature	32	23,642.38	29929.65	0.79	-2.27	0.02	0.79	Clustering
Folklore	66	16158.58	24,443.31	0.66	-5.27	0.00	0.66	Clustering
Variety Arts	23	20873.35	19963.48	1.05	0.42	0.68	1.05	Discrete

As the core area for intangible cultural heritage (ICH) concentration in the city, the main urban area boasts a total of 412 ICH items, accounting for 54.07% of the city's total, demonstrating an absolute advantage. The structure of ICH types in this area is dominated by traditional crafts, with 158 items, representing a significant 20.73% share. While traditional medicine projects also reached 37 items. Traditional crafts account for the largest proportion of ICH types in the metropolitan area. Additionally, categories such as traditional arts (51 items) and traditional sports, games, and acrobatics (24 items) are also well-developed, reflecting the comprehensive and diverse cultural functions of the metropolitan area, aligning with its role as the core of modern economic and cultural development.

The Three Gorges Reservoir Area in Northeast Chongqing holds 183 intangible cultural heritage items, accounting for 24.02% of the total. This region excels in traditional music with 33 items, forming a distinct regional characteristic. Together with 71 traditional craft items, they constitute the core of the region's intangible cultural heritage. However, traditional medicine has only 2 items, and traditional sports, games, and acrobatics only 4 items, indicating a relative weakness in the allocation of public service-related intangible cultural heritage within the ecological functional zones. This pattern is closely related to the geographical characteristics of Northeast Chongqing, as the Three Gorges Reservoir Area, with its developed water systems and continuous mountain ranges (Figure 4). Categories within traditional music, such as boatmen's chants and mountain songs, directly reflect the region's water-based labour and mountainous lifestyle culture.

The southeastern Wuling Mountain area holds 167 intangible cultural heritage items, accounting for 21.92% of the total. This region demonstrates significant strengths in traditional music and folk customs, with 34 and 20 items respectively, highlighting the living cultural traditions centred on song, dance, and festivals in ethnic minority areas. Notably, this region has no intangible cultural heritage items in the performing arts category, reflecting a structural gap in the transmission of performing arts within ethnic minority settlements. This distinctive feature aligns closely with the area's background as an ethnic minority settlement in the Wuling Mountains, characterised by complex terrain and diverse ethnic cultures. The distribution of intangible cultural heritage exhibits strong ethnic and regional characteristics.

Across the three functional zones, intangible cultural heritage distribution exhibits a "core-periphery" gradient and distinct typological differentiation: the main urban area centers on craft-based intangible cultural heritage, reflecting the resource aggregation effect of an economic hub; the Three Gorges Reservoir Area in northeastern Chongqing features music-based intangible cultural heritage, resonating with its natural landscape and ecological foundation; while the Wuling Mountain Area in southeastern Chongqing is dominated by folk customs and music-based intangible cultural heritage, showcasing the cultural characteristics of ethnic minorities.

3.3 Driving Factors of ICH Spatial Distribution

Drawing upon the analytical framework and research methodology for intangible cultural heritage drivers

previously established by scholars [28], this study systematically categorises the driving factors behind Chongqing's spatial differentiation of intangible cultural heritage into two broad categories: socioeconomic and natural geographic. The distribution pattern of Chongqing's intangible cultural heritage profoundly reflects the complex interplay between natural foundations and socioeconomic dynamics.

3.3.1 Socioeconomic Factors

Standardised analysis comparing Chongqing's intangible cultural heritage inventory size with driving factors [29] reveals (as shown in Figure 3) a significant correlation between the spatial distribution of intangible cultural heritage and regional socioeconomic factors. The analysis indicates that the curve representing the number of municipal-level intangible cultural heritage items exhibits pronounced synergistic variation with four other curves—registered population, total retail sales of consumer goods, general public budget expenditure, and number of legal entities—across most districts and counties.

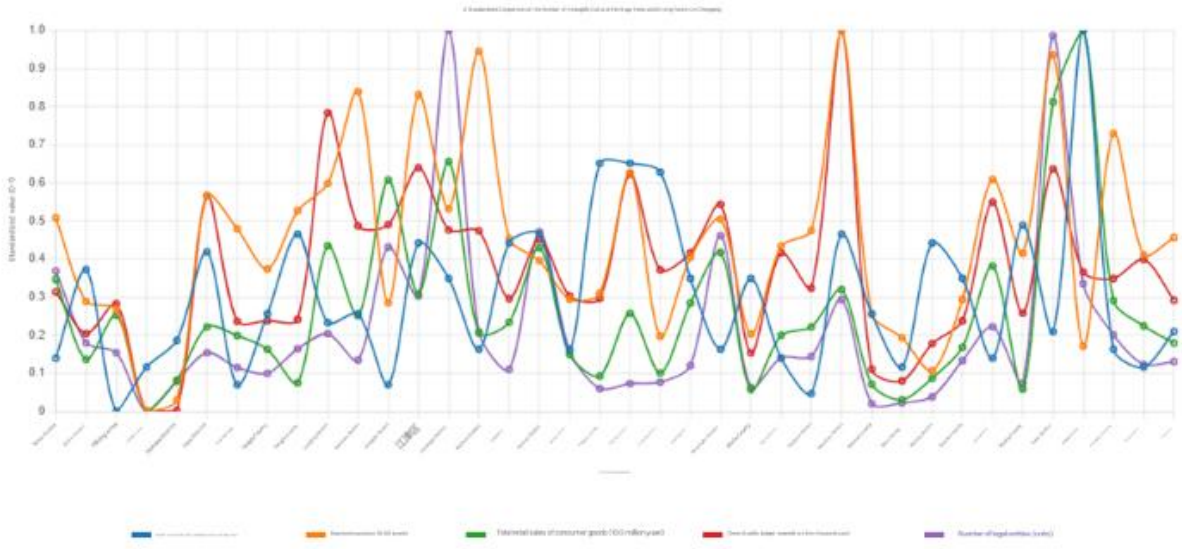


Figure 3. Standardised Comparison of Intangible Cultural Heritage Projects and Driving Factors in Chongqing

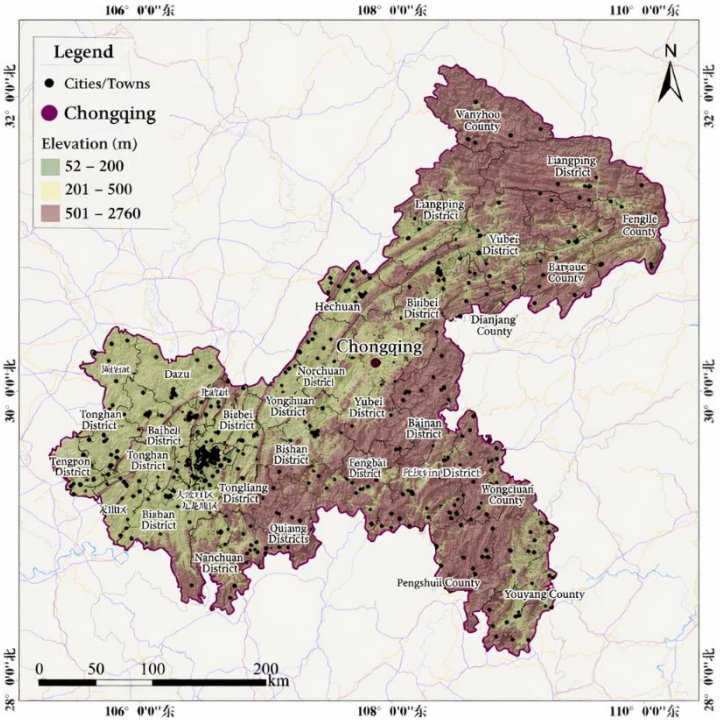


Figure 4. Average Elevation of Chongqing's Intangible Cultural Heritage Projects

From the perspective of the population base, the standardised values of intangible cultural heritage quantity and registered population remain highly synchronised across major districts and counties. Wanzhou District's intangible cultural heritage quantity reaches 80%, while its registered population also maintains a high level of 78%. In Kaizhou District, the intangible cultural heritage quantity stands at 75% and the registered population at 72%, with a difference of less than 5 percentage points between the two. This high degree of alignment confirms the fundamental role of population base in determining the scale of cultural inheritance. Market capacity factors exhibit distinct regional gradients. Yuzhong District, where total retail sales of consumer goods peaked at 100%, recorded an intangible cultural heritage count of 82%, highlighting the robust pull of market demand in core urban areas for revitalising intangible cultural heritage. In contrast, Pengshui County in southeastern Chongqing has 68% of its intangible cultural heritage, but its total retail sales of consumer goods are only 42%. This discrepancy reveals that intangible cultural heritage transmission in ethnic minority areas possesses endogenous characteristics relatively independent of the market economy. The fiscal support dimension exhibits a stepwise distribution pattern. Districts and counties with general public budget expenditures exceeding 60% generally maintain ICH inventories above 50%. Regional centres like Wanzhou District and Fuling District notably sustain both indicators above 65%, underscoring public finance's crucial role in safeguarding intangible cultural heritage. The influence of social organisation density is particularly pronounced. Jiulongpo District, where the number of legal entities reached 92%, recorded 78% of intangible cultural heritage items; Yubei District registered 88% and 75% respectively. This high correlation indicates that legal entity networks provide diverse implementation vehicles and innovation platforms for intangible cultural heritage transmission.

However, some districts and counties exhibit unique deviations. For instance, Pengshui County's intangible cultural heritage inventory significantly exceeds its socioeconomic indicators, suggesting that intangible cultural heritage protection in ethnic regions holds cultural value transcending economic development stages. Conversely, certain economically developed districts and counties have relatively low intangible cultural heritage inventories, implying that economic growth alone does not necessarily elevate intangible cultural heritage protection levels. Analysis reveals a systematic spatial coupling between ICH distribution and socioeconomic factors in Chongqing, though this relationship exhibits distinct nonlinear characteristics. Variations in regional combinations of population base, market conditions, fiscal support, and organisational networks collectively shape diverse pathways for ICH preservation and transmission.

3.3.2 Natural Geographic Factors

The spatial distribution and transmission characteristics of Chongqing's intangible cultural heritage are profoundly shaped by multiple natural geographical factors. Core elements such as the mean Digital Elevation Model (DEM) value, water system area, and road length interact to form the underlying logic of ICH differentiation. . The specific processing workflow is as follows: Digital Elevation Model (DEM) preprocessing is based on raster data [30. Road network preprocessing [31] targets vector road data. First, the "intersect" algorithm extracts road segments intersecting the study area, associating each segment with its county/district attribute. Subsequently, using county/district fields as the integration basis, the merge tool consolidates all roads within the same county/district and calculates the total road length for each county/district. Intermediate data is promptly cleaned during processing to maintain structural simplicity. Water System Preprocessing [32] Based on the more up-to-date China Land Cover Data (CLCD2024), spatial clipping is performed. Water pixels are then identified according to land type coding rules, and conditional functions are applied to filter water features. Finally, the pixel count is aggregated using the tabular display partition statistics tool, with the result directly representing the total water area for each district/county. This indicator exhibits dimensionless properties in geographic detector analysis, enabling direct application in subsequent modelling.

The fundamental constraining effect of terrain elevation (DEM mean) is illustrated in the figure. Terrain variations reflected by the DEM directly determine the typological composition and transmission patterns of intangible cultural heritage. In regions such as the Wuling Mountains in southeastern Chongqing and the Three Gorges Reservoir Area in northeastern Chongqing, the DEM mean typically ranges between 501 and 2760 meters in the medium-to-high elevation zone. The enclosed environment of mountainous gorges has shaped the cultural practices of the Tujia and Miao peoples, including the Three Gorges Reservoir Area in northeastern Chongqing, where the DEM average predominantly ranges between 501 and 2760 meters in the medium-to-high elevation zone. The enclosed environment of mountainous gorges has preserved the folk customs and song-and-dance arts of ethnic minorities such as the Tujia and Miao peoples—including the Baishou Dance, Miao songs, and Tujia wedding customs—in their entirety. Among the 762 intangible cultural heritage items, 186 are distributed in this elevation zone, showcasing distinct indigenous cultural characteristics. In contrast, the areas surrounding the main urban centre and the western regions feature DEM averages predominantly below 200 meters, characterised by hilly plains and flatlands. Favourable agricultural conditions and clustered settlements fostered large-scale clusters of traditional crafts. A total of 505 intangible cultural heritage items are concentrated here, encompassing projects closely tied to daily life and

production, such as Chongqing hotpot preparation techniques, Rongchang pottery, and Hechuan peach slices. These demonstrate stronger practicality and dissemination potential.

Corridor Effect of Water System Coverage. As historical conduits for population migration and cultural diffusion, water systems dictate the corridor-like distribution of intangible cultural heritage. The densely watered areas along the Yangtze River and its tributaries not only represent the birthplace of Ba-Yu culture but also connect numerous intangible cultural heritage projects related to fishing, hunting, shipping, and agriculture.Data reveals that 565 intangible cultural heritage items, accounting for over 74%, are concentrated in areas within 1-1343 meters of rivers. These include the Mudong Dragon Boat Festival, Qutang Gorge Boatmen's Chants, and Fuling Pickled Mustard Greens Production Techniques, forming a distinct "riverine cultural belt."Water systems not only provide fertile ground for intangible cultural heritage but also facilitate cultural exchange and integration across different regions. This allows riverside intangible cultural heritage to retain regional characteristics while exhibiting certain connections and commonalities.

The moderating effect of road length on transmission. Road length, reflecting transportation accessibility, further amplifies or mitigates the isolating effects of natural geography, becoming a key variable in the transmission and transformation of intangible cultural heritage. In the main urban districts and transportation hubs, characterised by long road lengths and high road network density (4.551–11.962 km/km²), 120 intangible cultural heritage items are distributed in the highest-density zones. The developed transportation network has facilitated the cross-regional transmission and modern transformation of intangible cultural heritage. For example, Shu embroidery from Yuzhong District and Chongqing hotpot have achieved widespread dissemination through market-oriented operations. Conversely, parts of southeastern and northeastern Chongqing feature shorter road lengths and lower road network densities (0.001–0.657 km/km²), with 176 intangible cultural heritage items located in these low-density zones. While the isolated environment preserves the original forms of these traditions, it also narrows transmission channels.

The interplay of natural geographic factors—including average DEM elevation, water body coverage, and road length—alongside other environmental elements profoundly reveals the formation mechanism of Chongqing's "one core, two wings" intangible cultural heritage pattern. The urban core and western plains form a cluster centred on traditional crafts, while the southeastern and northeastern mountainous regions constitute two wings characterised by ethnic minority customs and indigenous techniques.

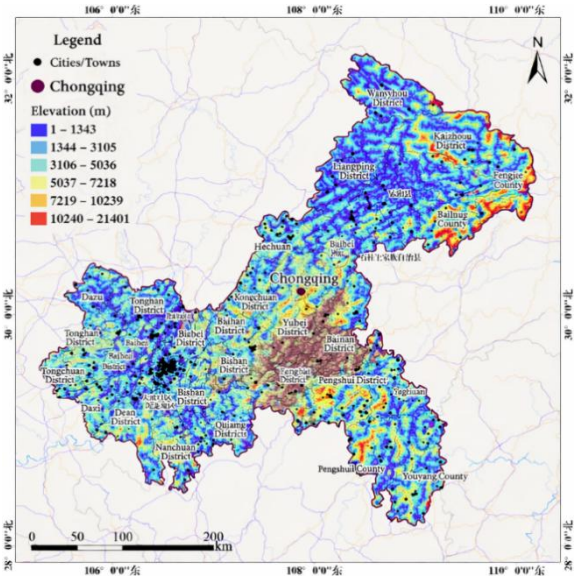


Figure 5. Distance of Chongqing's Intangible Cultural Heritage Projects from Rivers

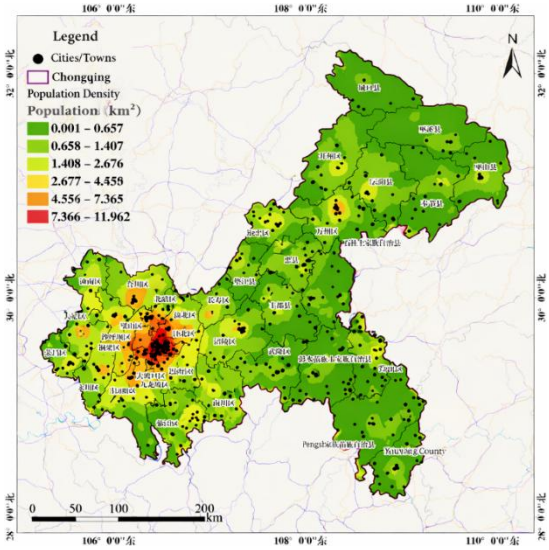


Figure 6. Road Density of Chongqing's Intangible Cultural Heritage Projects

3.3.3 Interaction Effects among Driving Factors

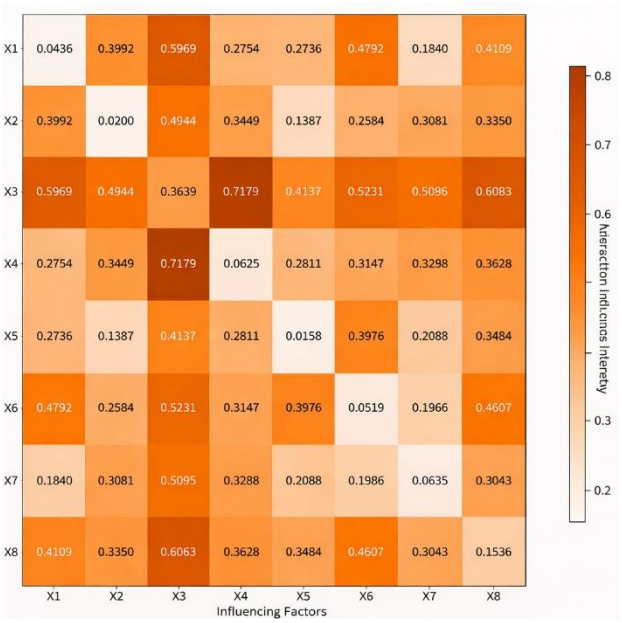
Based on the geographic detector principle, with "municipal-level intangible cultural heritage (items)" as the dependent variable (Y) and the other 10 indicators in the figure as independent variables (X), the influence of each factor on the spatial distribution pattern of intangible cultural heritage was calculated. The q-value, ranging from 0 to 1, indicates that a higher value signifies stronger explanatory power.

As a statistical method for detecting spatial differentiation of geographic phenomena and their driving factors, the geographic detector's core indicator—the q-value—represents the explanatory power of independent variables on the spatial differentiation of dependent variables. Its range is [0,1], with higher values indicating

greater influence of the factor. The p-value is used to determine whether this explanatory power is statistically significant (typically using $p<0.1$ or $p<0.05$ as the standard).In this study, the dependent variable is the spatial distribution of intangible cultural heritage (ICH) projects in Chongqing, while the independent variables encompass eight factors across two categories: socioeconomic and natural environment. The geographic detector method was employed to analyze the interactive effects of these factors on the spatial distribution of Chongqing's ICH projects. The eight key influencing factors selected are: X1(registered population), X2(regional GDP index), X3(total retail sales of consumer goods), X4(general public budget expenditure), X5(number of legal entities), X6(road length), X7(water system area), X8(average DEM elevation). By calculating the interaction q-values among these factors, this study reveals nonlinear enhancement, dual-factor enhancement, and independent effects between factors (See Figure 5). Detection Results of Interaction Factors Influencing the Spatial Distribution of Intangible Cultural Heritage Projects in Chongqing (Table 5).

Strongly interacting factor pairs. Analysis indicates that the interaction between X3(Total Retail Sales of Consumer Goods) and X4(General Public Budget Expenditure) is most significant (q=0.7179), suggesting that economic development level and government fiscal support exhibit a synergistic amplification effect in influencing the spatial distribution of intangible cultural heritage. Simultaneously, the interaction between X3and X8(Average DEM) was also prominent (q=0.6083), reflecting how economic factors and topographical conditions jointly constrain the spatial pattern of intangible cultural heritage. The interaction between X1(registered population) and X3is relatively strong (q=0.5969), indicating that the combination of population scale and consumption capacity significantly influences ICH distribution. The interaction between X3and X6(road length) (q=0.5231) suggests that transportation conditions amplify the spatial effects of economic factors.Moderate-strength interactions. The interaction between X2(regional GDP index) and X3(q=0.4944) reveals a complementary relationship between economic growth and consumer markets. The strong interaction between X4and X3further validates the stimulating effect of government expenditure on consumer markets. The interactions between X8and X3and X6(q-values of 0.6083 and 0.4607, respectively) highlight how topographical factors indirectly influence intangible cultural heritage distribution by affecting economic activity and transportation accessibility.

Table 5. Detection Results of Interaction Factors Influencing the Spatial Distribution of Intangible Cultural Heritage Projects in Chongqing



Weak interaction factor pairs. X5(number of legal entities) exhibits relatively weak interactions with other factors, with the highest value observed in its interaction with X3(q=0.4137), indicating that the number of market entities influences intangible cultural heritage distribution relatively independently.X7(Water System Area) exhibits generally low interaction with other factors, with the highest interaction observed with X3(q=0.5096), reflecting limited association between natural geographical conditions and economic factors.

Autocorrelation Analysis. Analysis of each factor's independent explanatory power shows that X3exhibits the highest autocorrelation value (q=0.3639), indicating that total retail sales of consumer goods are the core factor influencing intangible cultural heritage distribution. X8has the second-highest autocorrelation value (q=0.1536), suggesting that while terrain conditions have limited independent explanatory power, their influence is amplified through interactions.X2(q=0.0200) and X5(q=0.0158) exhibited the lowest self-effect values, indicating that economic growth and the number of market entities require synergistic interaction with other factors to effectively explain intangible cultural heritage distribution.

Interaction Type Determination. Based on the principle of geodetector theory, when the interaction q-value exceeds the maximum self-effect of either factor, it is classified as a two-factor enhancement; when the q-value exceeds the sum of the self-effects of both factors, it is classified as a nonlinear enhancement. In this study, the vast majority of factor pairs exhibit nonlinear enhancement characteristics. For instance, X3 ∩ X4(q=0.7179) is significantly greater than the sum of X3(q=0.3639) and X4(q=0.0625), indicating substantial synergistic effects among factors.

Geodetector analysis reveals that the spatial

distribution of Chongqing's intangible cultural heritage (ICH) results from complex interactions among multiple factors. Economic factors (X3) serve as the core driving force, topographical factors (X8) act as key constraints, while governmental factors (X4) and demographic factors (X1) provide supporting roles.

4. Discussion

The results confirm that the spatial distribution of intangible cultural heritage (ICH) in Chongqing exhibits a clear "core–periphery" structure characterised by a "one core, two wings" configuration. The main urban area functions as the cultural core, concentrating both the quantity and diversity of ICH projects. Northeastern and southeastern Chongqing form two peripheral zones with distinct cultural characteristics and relatively stable heritage systems. This spatial configuration reflects the long-term accumulation of cultural resources within urban centres and the differentiated functional roles of peripheral regions. Central urban districts benefit from dense populations, mature institutions, and strong cultural recognition mechanisms. These conditions facilitate the documentation, institutionalisation, and adaptive transformation of ICH. In contrast, peripheral mountainous regions maintain comparatively isolated cultural ecosystems. Such isolation contributes to the preservation of indigenous traditions while limiting large-scale diffusion. The spatial gradient observed in Chongqing aligns with patterns reported in other mountainous and river-based regions. Historical transport corridors, especially river systems, continue to shape contemporary cultural spatial structures. The persistence of river-oriented clustering highlights the enduring influence of natural corridors on cultural transmission.

The study reveals pronounced differences in the spatial behaviour of ICH categories. Traditional craftsmanship dominates the overall distribution and shows strong clustering in economically developed urban areas. This pattern indicates a high degree of adaptability to modern production systems and market-oriented environments. Craft-based ICH benefits from integration with tourism, cultural industries, and everyday consumption practices. Performing arts–related categories exhibit stronger regional specificity and narrower spatial ranges. These forms rely heavily on communal participation, ritual contexts, and localised transmission environments. Their spatial concentration in ethnic minority areas reflects deep cultural embeddedness rather than market accessibility. Folk art categories display relatively dispersed patterns, consistent with their mobile and itinerant transmission characteristics. These findings suggest that ICH categories differ fundamentally in their resilience to modernisation. Categories embedded in material production and daily consumption exhibit stronger adaptability. In contrast, orally transmitted and performance-based traditions face higher risks under rapid social transformation. This typological divergence underscores the limitations of uniform conservation approaches.

Geodetector results indicate that total retail sales of consumer goods exert the strongest influence on the spatial differentiation of ICH in Chongqing. This finding highlights the importance of consumption capacity and cultural demand in sustaining heritage transmission. Regions with stronger consumer markets are more capable of supporting cultural revitalisation initiatives. These areas provide favourable conditions for heritage commercialisation and creative transformation. In comparison, factors such as GDP scale and the number of legal entities show relatively weak independent explanatory power. This suggests that economic size alone does not guarantee effective ICH preservation. Fiscal expenditure plays a complementary role by supporting heritage forms with limited market viability. The interaction analysis reveals strong nonlinear enhancement effects between economic indicators and public expenditure. This indicates that market mechanisms and government intervention function most effectively when combined. ICH preservation, therefore, depends on coordinated governance rather than single-factor dominance.

Natural geographic conditions impose significant constraints on the spatial distribution and transmission of ICH. Average elevation emerges as a key factor shaping typological composition and preservation modes. High-altitude mountainous regions tend to preserve culturally intact but structurally fragile heritage systems. These areas face challenges related to accessibility and intergenerational transmission. Water systems continue to function as major cultural corridors. The concentration of ICH along river networks reflects long-standing interactions between livelihoods, settlement patterns, and cultural exchange. Transportation accessibility moderates the influence of terrain. Dense road networks facilitate diffusion and adaptive transformation of ICH. Conversely, limited accessibility reinforces cultural isolation and increases transmission risks. Natural and socioeconomic factors do not operate independently. Geographic constraints condition the effectiveness of economic development and policy support. Their interaction shapes region-specific pathways of heritage persistence and transformation.

The integrated findings suggest that ICH conservation requires differentiated regional strategies. In the main urban area, priority should be given to innovation-driven transformation and creative industry integration. Craft-based heritage forms are particularly suitable for such approaches. Peripheral mountainous regions require conservation strategies centred on living transmission and community participation. Emphasis should be placed on maintaining cultural authenticity and ecological integrity. The prevalence of nonlinear interaction effects highlights the need for coordinated governance frameworks. Policies

aligning market incentives with public investment and infrastructure planning are more likely to yield sustainable outcomes. Spatial planning should explicitly incorporate ICH distribution characteristics. This integration can prevent unintended cultural erosion during regional development and urban expansion.

This study is subject to several limitations. The analysis relies on cross-sectional data and does not capture temporal evolution. The geodetector method identifies interaction effects but does not fully address spatial autocorrelation. Future studies could incorporate longitudinal data and spatial econometric approaches. Micro-level qualitative research would further enrich the understanding of community-based transmission mechanisms. Combining quantitative spatial analysis with ethnographic perspectives would provide a more comprehensive interpretation of ICH dynamics.

5. Conclusion

This study investigated the spatial differentiation patterns and driving factors of intangible cultural heritage (ICH in Chongqing by integrating GIS-based spatial analysis with the geographic detector method. The results reveal a clear "core–periphery" structure characterised by a "one core, two wings" configuration, with the main urban area functioning as the primary concentration zone and northeastern and southeastern Chongqing forming two culturally distinctive regions. The spatial distribution of ICH is shaped by the combined influence of socioeconomic and natural geographic factors. Consumption capacity emerges as the most influential socioeconomic driver, while topographic conditions act as key natural constraints. Interaction analysis further demonstrates that these factors exhibit predominantly nonlinear enhancement effects, indicating that ICH spatial patterns are produced through multi-factor coupling rather than single-factor dominance. Methodologically, this study provides a comprehensive city-level analytical framework that combines kernel density estimation, spatial clustering measures, and geographic detector modelling. By overcoming linear assumptions and explicitly examining interaction effects, the approach enables a more nuanced understanding of cultural heritage distribution in complex mountainous regions. Although the analysis is based on cross-sectional data, the framework and findings offer a replicable basis for future comparative and longitudinal research. Overall, this study advances empirical understanding of ICH spatial differentiation and contributes a robust methodological reference for cultural geography and heritage studies in rapidly transforming urban–mountain contexts.

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Informed Consent Statement: Not applicable.

Data Availability Statement: All data generated or analysed during this study are openly accessible.

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