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Authors: An, Yi-Da, Yi, Xin, Wang, Qing, Yan, Wei-Po, and Guo, Ya-Lin

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Yi-da An[1], Xin Yi[2], Qing Wang[1]*, Wei-po Yan[1,3], and Ya-lin Guo[1]

* Corresponding author: qingw@imde.ac.cn

[1] Southwest University of Science and Technology, School of Environment and Resource, 621010, Fucheng District, Mianyang City, Sichuan Province, People's Republic of China
[2] Communication University of Shanxi, Department of Art and Design, 030619, Yuci District, Jinzhong City, Shanxi Province, People's Republic of China
[3] Sichuan Academy of Environmental Policy and Planning, 610041, High-tech District, Chengdu City, Sichuan Province, People's Republic of China

The Chiang are a significant ethnic group in China. Their traditional costumes have distinctive regional styles and represent strong cultural diversity. This research deconstructs the Chiang costume and examines its elements. Here, we clarified the status of the current heritage value of the Chiang costume and the main factors affecting its spatial differentiation. The spatial differentiation pattern of Chiang costume heritage values was determined and correlated with natural factors. The research suggests the following: (1) Chiang embroidery is the most important element of the Chiang costume in terms of heritage, whereas the Shibi costume has the lowest heritage value, illustrating that the heritage value of the costume is closely related to its practicality and how much it is worn in daily life. (2) Natural factors (temperature > elevation > precipitation) best explain the spatial differentiation of Chiang costume heritage values. (3) The heritage values of the Chiang costume in the study area show distinct spatial differentiation, increasing with elevation. Finally, the research method (identification of elements, establishment of the element list, clarification of current heritage status, clarification of the driving force, and finally determination of pattern) can be applied to studies of other ethnic cultures to improve monitoring and management of regional cultural heritage conditions.

Keywords: Chiang nationality; costume geography; cultural heritage; cultural symbol; spatial differentiation; geodetector.

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Introduction

The Chiang ethnic group, known as the "nationality above the clouds," is an extremely ancient minority group in China. The Chiang costume has a long history and profound cultural background. It has a unique cultural form and typical cultural intention, and it is a treasure of Chinese national culture. Although the Chiang people are an ethnic minority in China, as part of human civilization, their culture and heritage extend far beyond this. Henry Wilson, a famous British botanist, documented this as early as 1908 (Figure 1).

The cultural landscape of costumes is the product of long-term interaction between humans and nature, culture, and history (Farina 1998; Taylor and Lennon 2011; Shamsuddin et al 2012). Furthermore, as mirrors of national culture, costumes reflect the material and intangible cultural characteristics of a nation (Emelyanenko 2012). They also incorporate the essence of philosophy and aesthetics (Lin 1997). As a symbol, a national costume not only embodies the customs and aesthetic concepts of a people (Dai 1994) but also reveals their religious beliefs and cultural norms (Frey and Frey 2018). The heritage of traditional costumes is an essential part of inherited cultural heritage. It involves the process of forward transmission (from the past to the present) within the community, incorporating the processes of dissemination and the continuation of costume culture. In essence, it is the process of traditional cultural education (Yang and Liu 2017). Its ultimate goal is to form a cultural tradition and reinforce national and local identity (Pop 2016; Stanik et al 2018).

The relationships among national costume, national identity, and politics are inseparable. For instance, in the 19th century, Estonia was divided into parishes; women who married outside of their parish would sometimes still wear their own parish's folk costume in later life. In addition, at the end of the Soviet period, folk costumes were often worn at public gatherings and demonstrations, playing a vital symbolic role (Barrett and Roper 2006). Eriksen (2004) conducted a study on the bunad, a symbol of rural Norwegian identity. The study highlighted the importance of iconic elements in the national costume for identity recognition. Problems may arise when the minority culture adapts or adjusts to the culture of the majority. Xu et al (2013) concluded that a national costume is a symbol of the nation that conveys the essence of national history and represents the identity of national culture and the nation itself.

FIGURE 1 Chiang costume in the early 20th century, photographed by the British botanist E.H. Wilson in 1908, in Weizhou town, Wenchuan County. (Reproduced from Wilson 1929)

Costume geography investigates the influence of geographical factors on costume culture (Zhang and Luo 1995); the regional character of costumes is central to this research. In China, national costumes are influenced by various environmental, geographical, and cultural factors, reflecting distinctive national cultures with different ethnic styles (Zhang 1996). Qi et al (2011) point out that the characteristics of the natural geographical environment are the most basic and stable elements in the formation of a national costume style, stating that climate conditions directly affect a costume's origin, form, function, and design. Zheng et al (2015) discussed the influence of geographical environment on costume culture from the perspectives of climate, terrain, and biological and farming environment. They suggested that the unique geographical environment of mountainous areas directly affects the type, size, craft, color, pattern, and detail of a costume. Wang and Yan (2003) qualitatively analyzed the influence of geographical environment on minority costumes and highlighted that ethnic costumes can attract tourists. At present, systematic and empirical research on the relationship between classical costume elements of ethnic minorities and geographical environment is relatively weak (Xu and Situ 2007).

Against the background of urbanization, industrialization, and declining rural population in China,

many classical elements of the Chiang costume are facing extinction in a geographical sense, because dwindling numbers people carry the culture (Zhan and Jiang 2015). Establishing the pedigree and a list of regional symbols of costumes to be protected is particularly urgent to maintain the diversity of the Chinese nation and the cultural context of the Chiang nationality and to reveal their influence on the heritage of national culture (Wang 2017).

The objectives of this research are to (1) identify and list the costume elements of the Chiang nationality, (2) clarify the current heritage condition of the Chiang costume in the study area, (3) determine the main factors affecting the heritage values of the Chiang costume, and (4) reveal the pattern of spatial differentiation of Chiang costume heritage values.

Overview of the study area

The study area is located in the upper reaches of Minjiang River (30°45′–32°16′ N, 102°41′–103°56′ E), on the southeastern margin of the Qinghai–Tibet Plateau. It lies at the junction of the Tibet autonomous region and Xichuan Province. The area is about 9450 km^2 (Figure 2). China's Chiang population is centralized in this region, accounting for approximately 49.8% of the total Chiang population in

FIGURE 2 Location of the study area. (Map by Yida An)
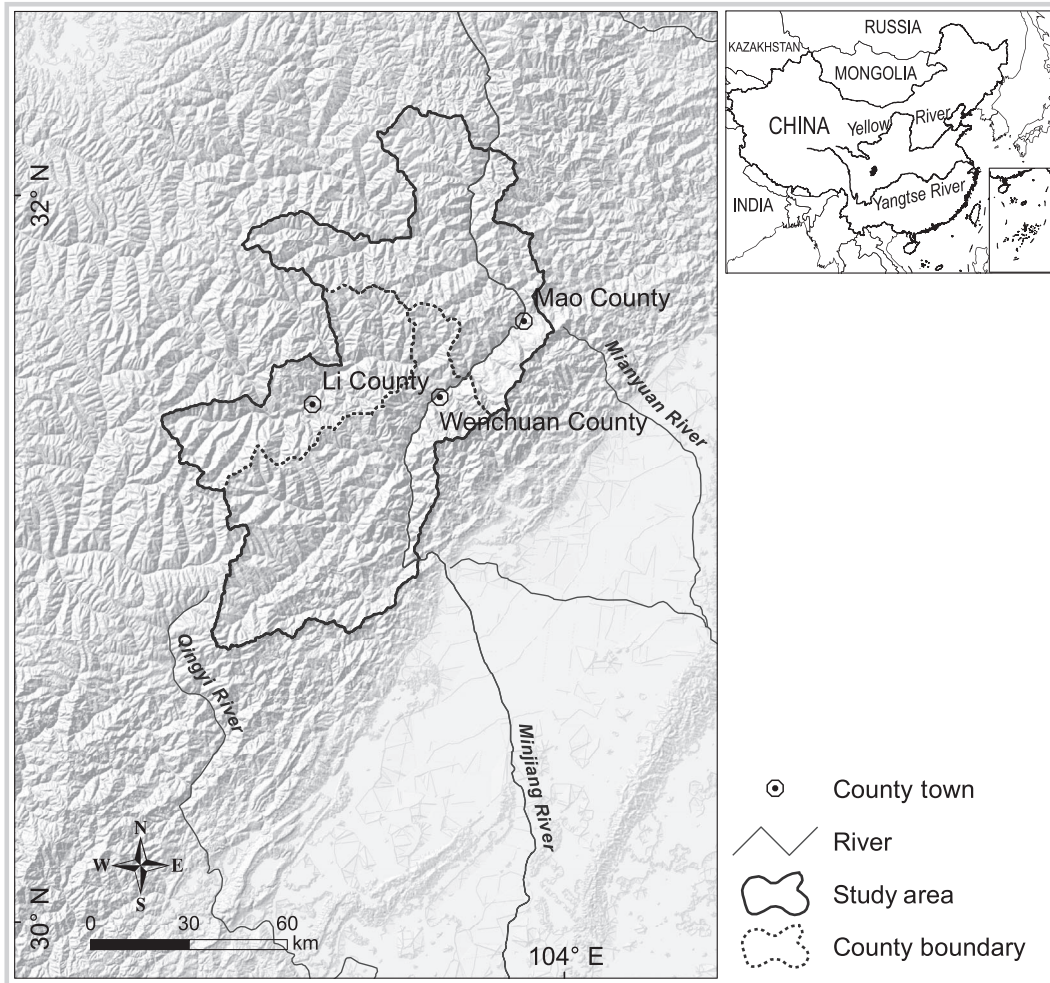
the province (Wu et al 2003). The Chiang people mainly practice agriculture and animal husbandry. Chiang settlements in the study area are concentrated in an altitude range of 1000 to 3000 m (Wang et al 2013). At a watershed scale, the Chiang settlements are located in arid valleys and on the gentle slopes of low hills. The lifestyle and livelihoods of the Chiang are closely related to natural conditions. This considerably affects their dietary structure and patterns (food is mainly produced locally). The Chiang people living in the downstream valley of the upper reaches of Minjiang River largely depend on agricultural practices. There are relatively large Chiang settlements in the arid valley, where residents mainly practice agriculture and animal husbandry and cultivate orchards (apples, peppers, etc). Between the arid valleys and the alpine forest are Chiang and Tibetan settlements. In this cooler region, people mainly engage in animal husbandry (Wang et al 2013; Fan et al 2017). The ideology and beliefs of the Chiang people are also influenced by the natural environment. Their costume, food production, construction, and living materials are influenced by mountains. Thus, the unique belief culture of Chiang people is centered on mountains. The terrain of the study area is complex and prone to natural disasters. Crop growth is limited by local climate and land conditions. Together, these factors have led to underdevelopment of the regional economy and slow overall development,

marginalizing the residents of the study area in terms of economy, society, and politics (Fang et al 2012; Gentle and Maraseni 2012; Liu et al 2017).

Methods

Field study and survey

Chiang villages were recorded through field visits, household interviews, and photographic recordings in different seasons from September 2017 to February 2019; the field investigation route ran from Mao to Wenchuan and then Li Counties.

According to the fifth census of China in 2000, the general level of education of the population in the study area is relatively low (McCulloch and Calandrino 2003). The proportion of illiterate and semi-illiterate people more than 15 years old is relatively high; the proportion in Li, Wenchuan, and Mao Counties is 11.5, 10.7, and 9.58%, respectively. To improve the authenticity of the results, junior and senior high schools in different regions of the study area were selected to complete the survey, because students in the school (aged 13–18 years) are relatively well educated and are more likely to understand the questions. Because the chosen respondents belong to the generation inheriting traditional culture, their answers are representative of the current status of Chiang culture. The

TABLE 1 Statistical data on the questionnaire.

Variable	No. of valid questionnaires	% of questionnaires
Study area		
Mao County	159	44.8
Wenchuan County	137	38.6
Li County	59	16.6
Age		
13	51	14.4
14	49	13.8
15	42	11.8
16	91	25.6
17	93	26.2
18	29	8.2
Education level		
Junior high school	140	39.4
Senior high school	215	60.6
Total questionnaires	355	100

TABLE 2 Interaction types and criteria.

Criterion[a]	Interaction type[b]
$P_{D,H}(x \cap y) < \min(P_{D,H}(x), P_{D,H}(y))$	Weakening, nonlinear
$\min(P_{D,H}(x), P_{D,H}(y)) < P_{D,H}(x \cap y) < \max(P_{D,H}(x), P_{D,H}(y))$	Weakening, unilinear
$P_{D,H}(x \cap y) > \max(P_{D,H}(x), P_{D,H}(y))$	Enhancing, bilinear
$P_{D,H}(x \cap y) = P_{D,H}(x) + P_{D,H}(y)$	Independent
$P_{D,H}(x \cap y) > P_{D,H}(x) + P_{D,H}(y)$	Enhancing, nonlinear

[a]$P_{D,H}$ refers to its statistic of factor x and/or y.
[b]The interaction type is determined by the location of $P_{D,H}(x \cap y)$ in the five intervals of a coordinate axis (http://geodetector.cn/).

$$Y_i = \frac{\sum_{w=1}^{k} Y_{wi}}{k} \quad (4)$$

In the equations, R questionnaires were collected in w ($w = 1, 2, \ldots, k$) townships. x_{ij} is the number of choices of index element j in subsystem i of the region. X_{ij} is the probability of choosing index element j in subsystem i of the region (the heritage value). Y_{wi} is the heritage value of subsystem i in w township. Y_w is the comprehensive heritage value of the Chiang costume of w township. Y_i is the comprehensive heritage value of subsystem i within the designated region.

Geographical detector: Geodetector (http://geodetector.cn) is a novel tool that identifies spatially stratified heterogeneity and helps explain the patterns observed (Wang and Xu 2017). In recent years, it has been widely applied in ecology and related fields (Wu et al 2016; Li et al 2019). It detects the consistency of spatial distribution patterns between dependent variables and independent variables through spatial heterogeneity. On this basis, the explanatory power of variables can be measured (Xu et al 2018).

Using factor detection, and in the absence of linear assumptions for variables, the main factors that significantly affect the heritage value of the Chiang costume system can be identified:

$$P_{D,H} = 1 - \frac{1}{n\sigma^2} \sum_{i=1}^{L} n_i \sigma_i^2 \quad (5)$$

In Equation 5, $P_{D,H}$ is the explanatory power of D for heritage value H; the level of P indicates the extent to which factor D explains the spatial differentiation of attribute H. n and σ^2 are sample size and variance, respectively, n_i is the sample size of layer i ($i = 1, 2, \ldots, L$). The value range of $P_{D,H}$ is [0,1]. A larger value indicates a stronger explanatory power of D for H.

The $P_{D,H}$ values of single factors and paired factors are compared to identify interactions between factors and determine whether they enhance or weaken the explanatory power of the spatial differentiation of attribute H. Table 2 shows the interaction between paired factors (Hu et al 2011; Dong et al 2017; Wang et al 2019).

respondents came from different villages in their respective counties, giving the perspective of a wider range of people in the region. The questionnaire was written in Chinese (for the English translation, see *Supplemental material*, Table S1: https://doi.org/10.1659/MRD-JOURNAL-D-19-00043.1.S1).

The study area covered 3 counties and 39 townships. A total of 500 questionnaires were sent out, and 355 were returned. The effective rate of questionnaires was 71%. Related data are shown in Table 1. The questionnaire descriptive statistics are given in *Supplemental material*, Table S2 (https://doi.org/10.1659/MRD-JOURNAL-D-19-00043.1.S1).

Mathematical model

Statistical model: The frequency and probability of index elements appearing in a certain place can represent their heritage state. In this paper, we adopted the method of heritage valuation (average probability of index elements appearing in each area). By integrating the results of the questionnaire, the costume element pedigree (Y) of the Chiang nationality is obtained. This is composed of the costume subsystem i ($i = 1, 2, \ldots, n$). Each subsystem consists of index element j ($j = 1, 2, \ldots, m$), as shown in Equations 1–4:

$$X_{ij} = \frac{x_{ij}}{R} \quad (1)$$

$$Y_{wi} = \frac{\sum_{j=1}^{m} X_{ij}}{m} \quad (2)$$

$$Y_w = \frac{\sum_{i=1}^{n} Y_{wi}}{n} \quad (3)$$

Data sources and processing

The natural environment has created a considerable degree of cultural difference across different regions and affected the preservation and heritage of minority cultures (Liu et al 2005). Elevation, slope, annual precipitation (AP), annual

FIGURE 3 Impact factors. (A) Elevation; (B) slope; (C) AP, annual precipitation; (D) AT, annual average temperature; (E) AH, annual average humidity; (F) Chiang settlements and Chiang–Tibetan–Han cohabitation areas; (G) PD, population density; (H) ANLI, average night lighting index.
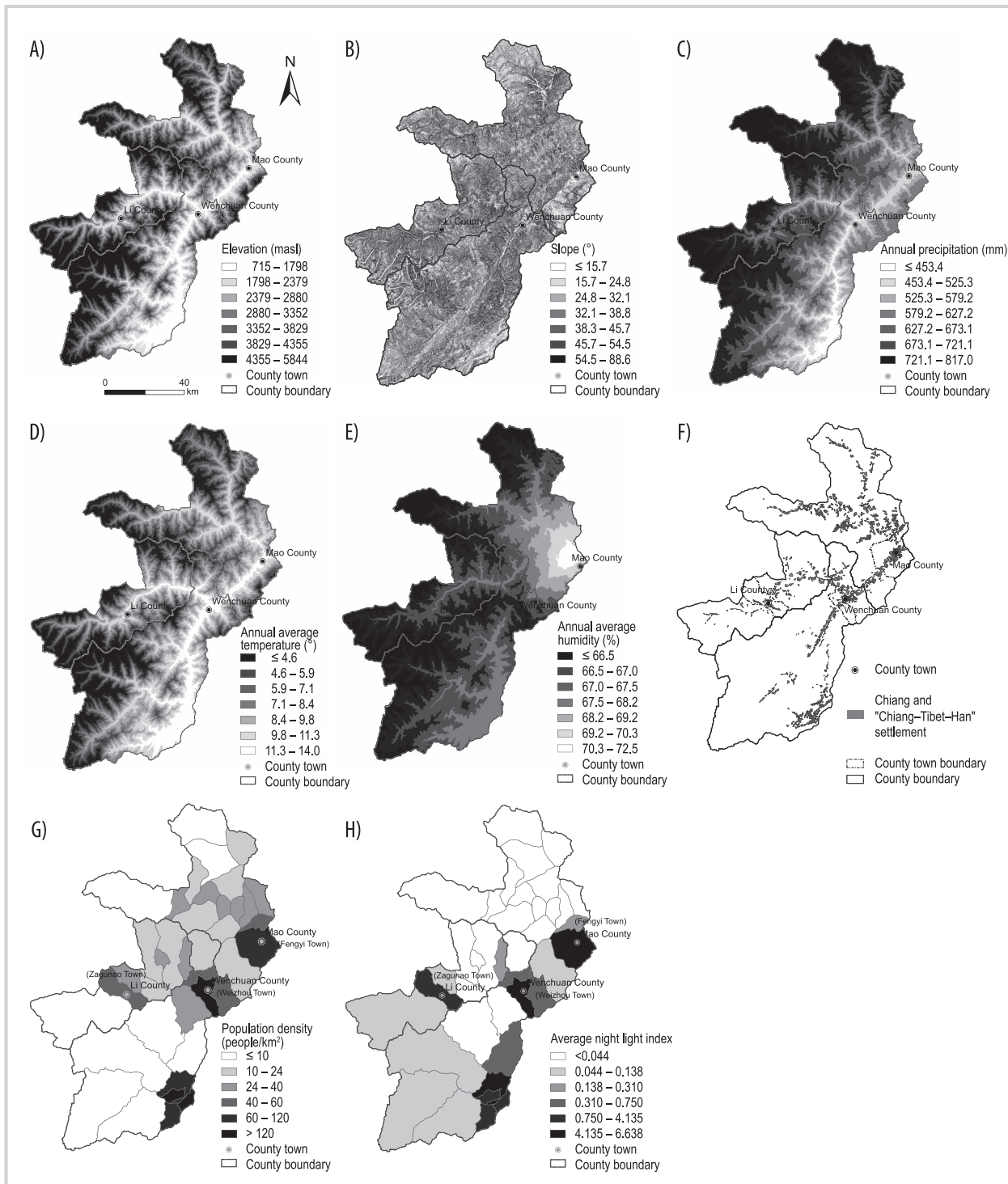
average temperature (AT), and annual average humidity (AH) were selected as natural factors; population density (PD) and average night light index (ANLI) were selected as impact factors to characterize the population features and economic level of the study area (Wang and Lu 2009; Li et al 2013; Wu et al 2013; Fang et al 2014).

Data sources: Digital elevation model (DEM) data were extracted from global DEM 30-m resolution elevation data (downloaded from the Geospatial Data Cloud of the

Computer Network Information Center of the Chinese Academy of Sciences). They were transformed into vector data after reclassification (Figure 3A, B).

Meteorological data were from the National Meteorological Information Center of China Meteorological Administration, including AP, AT, and AH data from 5 meteorological stations in the upper reaches of Minjiang River from 1999 to 2013 (Figure 3C–E). Vector data of Chiang settlements and Chiang–Tibetan–Han cohabitation

FIGURE 4 Decomposition of Chiang costume elements.

areas were extracted from existing research data in published articles (Wang et al 2013) (Figure 3F). PD data were extracted from the *Atlas of Mountain Hazards and Soil Erosion in the Upper Yangtze* (Cui 2014: 12–13) (Figure 3G). ANLI data were extracted from Defense Meteorological Program Operational Line-Scan System data for 2013 provided by the National Geophysical Data Center of the US National Oceanic and Atmospheric Administration (NGDC 2019) (Figure 3H).

Data processing: Data collation and preprocessing were conducted using the ArcGIS platform (Wang et al 2013; Genton and Kleiber 2015). The Jenks natural breaks classification method was used to discretize vectored data into 6 to 8 grades to allow input of these data into Geodetector (Cao et al 2013).

Results and discussions

Element recognition of the Chiang costume

Long-term migration is a characteristic of the Chiang people. This has led them to adopt many lifestyles from other nationalities but also shapes their distinctive culture. The Chiang costume is brightly colored and intricate; the result of a complex production process. The Chiang people

wear the traditional costume in daily life and, more importantly, for traditional festivals. As a significant carrier of national culture, the Chiang costume has accumulated rich cultural information. Both its content and its form illustrate the Chiang people's deep aesthetic accomplishment and their love of nature.

Chiang embroidery is quite distinctive and features on all garments from headdresses to footwear. Therefore, the style of the Chiang embroidery pattern is the principal way to identify costume elements (Figure 4).

Cloud patterns: The cloud shape comes from *huolian,* a fire-making tool. Fire is an important object of worship for the Chiang people. They combine the figurative image of *huolian* with that of a cloud to form the distinctive cloud pattern. As an auspicious pattern, it implies happiness. Shoes embroidered with the cloud pattern are called *yunyun* shoes. The soles are made by hand, and the shoe edges are colorful. They are described as "stepping on auspicious clouds" when viewed from distance. In spiritual terms, *yunyun* shoes reflect the Chiang people's love of and respect for nature.

Swastika pattern (卍): The swastika is a traditional and auspicious Chinese pattern that expresses inclusiveness. Some believe that it was introduced to China through

TABLE 3 Mean heritage value of each costume subclass in the study area.

Costume subclass	Heritage value[a]			
	Li County	Wenchuan County	Mao County	Study area
Headdresses	0.657 (0.204)	0.416 (0.183)	0.722 (0.095)	0.599 (0.207)
Clothes	0.526 (0.127)	0.378 (0.165)	0.533 (0.113)	0.476 (0.152)
Shoes	0.626 (0.121)	0.449 (0.251)	0.717 (0.089)	0.602 (0.206)
Waist ornaments	0.541 (0.097)	0.395 (0.227)	0.620 (0.136)	0.523 (0.194)
Accessories	0.338 (0.218)	0.189 (0.113)	0.394 (0.144)	0.309 (0.175)
Chiang embroidery	0.719 (0.191)	0.519 (0.217)	0.776 (0.089)	0.672 (0.200)
Ceremonial costume	0.483 (0.105)	0.338 (0.139)	0.531 (0.108)	0.452 (0.146)
Shibi costume	0.271 (0.092)	0.201 (0.083)	0.205 (0.083)	0.217 (0.087)

[a]The standard deviation is given in parentheses.

Buddhism, but it appeared in Gansu, Qinghai, as early as 6000 years ago. It represents the sun and is the embodiment of the sun worship of the ancient Chiang people (Tang 1995). Currently, the swastika pattern is widely used in Chiang embroidery and is the main pattern in the waistband, as well as the front, cuff, and hem of the long gown.

Animal and plant patterns: Chiang people not only admire nature but also are frightened by its force. Auspicious patterns were created to reflect the Chiang people's wish for success (Wang 2012). Peonies and animals symbolizing auspiciousness are the most common combination. The peony is the king of flowers, representing wealth and honor. It symbolizes auspiciousness and festivity when combined with a phoenix and wealth when combined with a golden pheasant. Animal and plant patterns are normally used in Chiang women's headscarves and handkerchiefs (Zhong et al 2012). Peony embroidery is also used in *yunyun* shoes and is combined with the cloud pattern to give a sense of innovation.

Totem patterns: Among all religious forms of the Chiang nationality, the most common type of adoration is sheep totem worship. The Chiang people's worship of the sheep totem can be traced back to Yandi, who was chief of the Jiang tribe, the ancestors of the Chiang nationality, in the last phase of *Yangshao* culture. The terms *Jiang* and *Chiang* both come from the same Chinese character and express matrilineal or patrilineal society. Both *Jiang* and *Chiang* are represented by an image of a person wearing a goat's horn, which indicates that both Chiang and Jiang people are descended from sheep. As a result, worship of the sheep totem by Chiang people is also worship of their ancestors (Ren 1986; Shen 2011). Sheep and Chiang people are still closely linked. Sheep represent material wealth and are a spiritual pillar of the Chiang people. In addition, dragon, monkey, and dog totem patterns are widely used in Chiang embroidery and are major patterns of the sheepskin jacket, apron, and *Shibi* costume, or the costume of the executor of religion.

List of elements of the Chiang costume

A full list of Chiang costume elements was established through the integration and classification of the cultural resources of the Chiang costume. The Chiang costume system is divided into 2 categories: traditional and formal. It is further divided into 8 subclasses, each of which is composed of multiple types. Most elements in each type are indivisible objects. The full elements list is shown in *Supplemental material*, Table S3 (https://doi.org/10.1659/MRD-JOURNAL-D-19-00043.1.S1).

Current heritage condition of the Chiang costume

Using Equation 1, a heritage value and its ranking were obtained for each costume subclass in different areas (Table 3). The result reveals that although the Chiang costume has a distinctive style in different regions, there is an overall difference at the level of the heritage value. Table 3 shows that the heritage value ranking (from high to low) of each subclass of the Chiang costume in the study area is Chiang embroidery, shoes, headdresses, waist ornaments, clothes, the ceremonial costume, accessories, and the *Shibi* costume. In terms of ranking, the heritage values of Chiang costume subclasses in each county are relatively consistent with the overall heritage value of the study area. All regions of the study area have higher heritage values for Chiang embroidery, headwear, and shoes, whereas the heritage values of waist ornaments, clothes, and ceremonial costume are in the middle. Chiang accessories and the *Shibi* costume have lower heritage values.

Assessment of Chiang costume heritage values: SPSS software was used to conduct an analysis of variance (ANOVA). Using the least significant difference comparison, further sources of intergroup differences were identified; details can be found in *Supplemental material*, Table S4 (https://doi.org/10.1659/MRD-JOURNAL-D-19-00043.1.S1). The Levene variance homogeneity test statistic was 0.992, $p = 0.471$, which met the preconditions for homogeneity of variance, allowing multiple comparisons can be conducted. The ANOVA gave the F-test statistic as 5.202, $p = 0.003$, indicating that the heritage value of different subclasses differs significantly.

Among the costume subclasses with lower heritage values, the *Shibi* costume is significantly different from all other Chiang costumes, except accessories. Accessories' heritage value is significantly different from 4 subclasses. As the

TABLE 4 $P_{D,H}$ values and ranking of impact factors.[a]

Factor	$P_{D,H}$ value	p value[b]	Ranking
Economic			
ANLI	0.447	0.03*	4
Geographical			
PD	0.308	0.04*	5
Natural			
Elevation	0.596	0.03*	2
Slope	0.263	0.72	—
AP	0.498	0.02*	3
AT	0.632	0.00**	1
AH	0.280	0.71	—

[a] ANLI, average night light index; PD, population density; AP, annual precipitation; AT, annual average temperature; AH, annual average humidity.
[b] * denotes 5% significance level; ** denotes 1% significance level.

costume subclass with the highest heritage value, Chiang embroidery differs significantly from accessories, the ceremonial costume, and the *Shibi* costume. Headdresses, Chiang shoes, and waist ornaments have similar values, and all of their heritage values are significantly different from those of accessories and the *Shibi* costume. Among the 8 costume subclasses, the heritage value of clothes is only significantly different from that of the *Shibi* costume.

Discussion of the current heritage situation of the Chiang costume: As the costume subsystem with the highest heritage value in all regions, Chiang embroidery is widely used in all Chiang costumes. It is not only a manifestation of the Chiang people's spirit but also creates income for the people. Moreover, according to replies to open questions, approximately 42% of respondents believe that Chiang embroidery is the most representative symbol in the Chiang costume.

After a long history of cultural blending, Chiang headdresses, clothes, shoes, and waist ornaments are mainly governed by practicality, cost performance, aesthetics, and environmental protection. For instance, with the change of production and lifestyles, cotton and silk are now used as fabrics in the traditionally linen long gown. Moreover, the sheepskin jacket is gradually being replaced by a cotton jacket (Xu and La 2015). However, the style worn by the ancient Chiang people during their nomadic period is maintained. Jewelry-making is complicated and quite costly. This is hard to maintain for the Chiang people, who mainly depend on agriculture and animal husbandry and find jewelry expensive and impractical to make. Jewelry is mainly worn in etiquette rituals.

As the embodiment and executor of religion, the Chiang's *Shibi* is selected according to strict criteria. People who are selected undergo complex training procedures (Ma 2008). After the 5.12 earthquake in 2008, which severely damaged many Chiang villages, the Chiang's remaining *Shibi* were aging and successors were hard to find. Although there were efforts to restore the traditional architecture and develop cultural tourism, the Chiang people are increasingly adopting concepts and ideas from other cultures, leaving less

space for traditional Chiang culture. Overall, the heritage status of each Chiang costume subsystem reflects the lived situation of Chiang nationality.

Accessories and the *Shibi* costume are at risk. Compared with other subclasses, their heritage values are significantly lower. As a result, more policy support and protection are needed to restore the diversity of the *Shibi* costume's original classical elements. In addition, further economic and policy support is needed for other costume subclasses, as well as the establishment of a clear heritage protection system.

Driving forces of spatial differentiation of heritage values
Using Equation 2, potential impact factors can be filtered to identify the ones that significantly affect the heritage values of the Chiang costume system. In addition, as shown in Table 2, the influence on dependent variables when factors interact jointly can be determined.

Factor detection: The influence of elevation, slope, AP, AT, AH, PD, and ANLI on the heritage values of the Chiang costume was assessed using the factor detector (Table 4). The $P_{D,H}$ values of natural, economic, and geographical factors of Chiang costume heritage value rank as follows: AT (0.63) > elevation (0.596) > AP (0.498) > ANLI (0.447) > PD (0.308). The natural factor slope and AH were not statistically significant. In general, there are gaps between each factor in the numerical value of the $P_{D,H}$ statistic (0.632–0.308). Among the statistically significant factors, the top 3 $P_{D,H}$ values are all natural factors. The economic factor ANLI is slightly lower than the $P_{D,H}$ value for AP. The $P_{D,H}$ value for AT is more than twice that of PD. Therefore, the natural factor has the most impact on spatial differentiation of Chiang costume heritage, whereas the influence of economic and geographical factors is relatively low.

Interaction detection of driving factors: The detected effects of interaction between driving factors on spatial differentiation of Chiang costume heritage values are indicated in Table 5. In terms of $P_{D,H}$ value, the interaction of any 2 factors is greater than that of a single factor, doubling the impact of most factors. Among them, slope and AH were not statistically significant and were not taken into account. The ranking of the explanatory power of larger interactions was as follows: elevation∩ANLI > PD∩AT > PD∩elevation > PD∩AP > AT∩ANLI > AP∩ANLI > AT∩AP. The explanatory power of the interaction of these factors is more than 70%. Increasing explanatory power values in interactions ranked as follows: ANLI∩PD (0.346) > PD∩AP (0.313) > ANLI∩elevation (0.303) > PD∩AT (0.253). The explanatory power of these factors increased by more than 25% when interacting. Although the $P_{D,H}$ values of economic and geographical factors are relatively low when acting alone, the coeffect is greatly increased when interacting with natural factors.

Correlation analysis between factors and heritage value: Correlation analysis is commonly used to measure the strength of the linear relationship between variables and express it with appropriate statistical indicators. Here, it is used to measure the depth of the relationship between each factor and the heritage value of the Chiang costume. The results supplement those of the geographical detector.

TABLE 5 Interactive $P_{D,H}$ values of impact factors.[a]

Factors	Elevation	AT	Slope	AP	PD	AH	ANLI
Elevation	0.596						
AT	0.677	0.632					
Slope	0.743	0.804	0.263				
AP	0.635	0.704	0.691	0.498			
PD	0.820	0.885	0.788	0.811	0.308		
AH	0.676	0.836	0.736	0.665	0.830	0.280	
ANLI	0.899	0.779	0.802	0.766	0.654	0.825	0.447

[a]AT, annual average temperature; AP, annual precipitation; PD, population density; AH, annual average humidity; ANLI, average night light index.

First, the factors with strong collinearity between natural factors are excluded based on experience. Using SPSS software, the correlation analysis between Chiang costume heritage value and elevation, PD, and ANLI was carried out. In the normal distribution test of the data, the skewness and kurtosis of DEM data were −0.848 and −0.128, respectively, indicating that they can be considered to have a normal distribution. The skewness and kurtosis of the ANLI and PD data are greater than 1, indicating that they are not normally distributed; therefore, the Spearman correlation coefficient was used. The results showed that there is a significant positive correlation between DEM and heritage value ($r = 0.615$, $p < 0.01$, 2 tailed), and there is no correlation of PD, ANLI, and heritage value.

Discussion of driving forces: In the study area of the upper reaches of Minjiang River, where the geographical environment is complex, natural factors are the dominant factors influencing the spatial differentiation of the Chiang costume heritage values. Of these, AT is the main controlling factor. The natural environment is the foundation of culture: variations in it determine the diversity of culture (White 2018). Climate factors can directly or indirectly affect human activities. Rainfall and temperature directly determine the comfort of the human body (Wang and Lu 2009). Elevation and climate factors in the research area follow the usual pattern; for instance, precipitation increases significantly with increasing elevation (Yao et al 2016). The distribution of Chiang settlements in the study area varies (valley bottom area to upper half of the hill). Residents make clothes according to their localities and prepare clothes according to the season, which may imperceptibly lead to differences in the retention of traditional costume features.

The economic factor (ANLI) and geographical factor (PD) have the highest explanatory power when interacting. According to existing research, the economic returns from agricultural activities of Chinese mountain dwellers are limited (Glauben et al 2012). A growing number of farmers participate in the nonagricultural economy, which has reduced their exposure to climate conditions (Tian and Lemos 2018). The PD of settlements in the study area shows obvious vertical differentiation (Wang et al 2013). After the 5.12 earthquake, the tourism industry was vigorously developed, and many more settlements with convenient transportation were developed into a high-density tourism area (Xu and La 2015). This concentrates economies. This result partly reflects the importance of economic and geographical factors to traditional costume heritage.

The variation in elevation leads to different living environments. The corresponding potential danger from natural disasters also varies. High elevation zones are generally subject to severe weather conditions, which, directly or indirectly, result in different means of livelihood for residents and subtly affect the economy (Bhadwal et al 2019). However, the influence of economic level on the Chiang costume heritage value cannot be ignored. The inheritance and promotion of complex and costly traditional costume elements, such as Chiang metal jewelry and the traditional linen gown, have an economic basis. However, the income of mountain residents in the upper reaches of Minjiang River decreases with increasing altitude (Fang et al 2012). On this level, the interaction between ANLI and elevation has an explanatory power of 90% regarding the spatial differentiation of Chiang costume heritage values, which reflects the mutually reinforcing influence of its 2 factors to a certain degree.

As the factor that represents the overall economic level of a region, ANLI's effect is not as obvious as that of natural factors, but it evidently improves the explanatory power of other indicators with which it interacts. The role of economy in cultural inheritance cannot be ignored. PD has the lowest explanatory power for spatial differentiation of heritage values as a single factor and has no correlation with heritage values of the costume. However, in Chinese history, ethnic blending is closely related to the inheritance of national culture. In the process of multiethnic cultural infiltration, different cultures merge, as shown by the homogenization of regional cultures (Chen 2011; Hu and Li 2018). Many Chiang settlements in the study area have been assimilated into the Han nationality. The daily costumes that have been preserved are simpler than traditional Chiang costumes (Liu et al 2005). Therefore, future studies of cultural heritage should also consider the humanistic level.

Studies have analyzed changes of PD and precipitation from the perspective of livelihood, food security, and vegetation degradation (Pricope et al 2013). The interaction between PD and natural factors has a high explanatory power, which may signify that the natural resource conditions required by local residents affect the inheritance of the traditional costume. However, it is difficult to measure this precisely because of the interaction of multiple factors on many levels. In addition, because of the limits of data

FIGURE 5 Heritage values of the Chiang costume and natural vertical belt map in the study area.
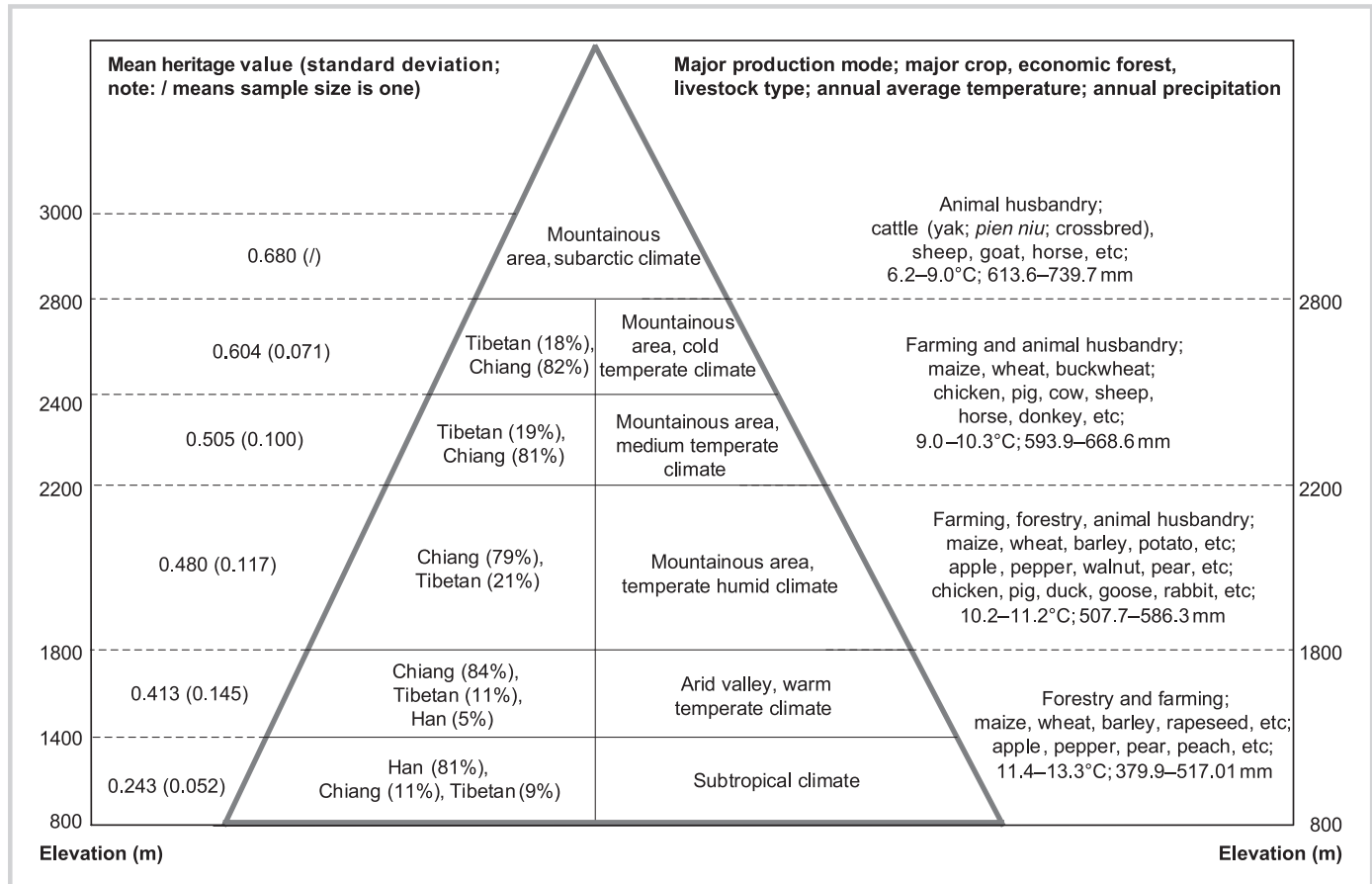
acquisition, the geodetector cannot cover all impact factors, limiting the analysis. However, the analysis shows that the mechanism of spatial differentiation of the costume heritage values is complex, and the factors are closely linked.

Spatial differentiation of Chiang costume heritage values

The analysis showed a significant positive correlation between elevation and costume heritage value. Combining research on the settlement niche in the mountain area of the upper reaches of Minjiang River (Wang et al 2013) with statistics on climate and industrial structure (Li County Agricultural Division Committee 1987; Guo 2018), and superimposing this with ethnic settlement data for the study area, revealed the spatial differentiation characteristics of the Chiang costume. Figure 5 shows the climate types, major production methods, products, temperature, and precipitation in each elevation zone and the Chiang costume heritage value (mean) corresponding to the population structure (ethnic group). Patterns in the spatial distribution can be observed.

800–1400 m: There are relatively few Chiang settlements located in the valley bottom area of the upper reach of Minjiang River, and the residents are mainly Han. They mainly practice farming and forestry. The Chiang costume heritage value is the lowest in this area.

1400–2200 m: This is a typical arid valley area in the upper reaches of Minjiang River. The climate is mainly a warm temperate mountain climate. This area has the largest

number of Chiang settlements. It is a national corridor formed by Chiang–Tibetan–Han cohabitation areas. Residents mainly engage in farming, forestry, and animal husbandry (eg pigs, chicken, and ducks). The Chiang costume heritage value is relatively high in this area.

2200–2800 m: This is the upper half of hills in the upper reaches of Minjiang River. The residents are mainly Chiang. They mainly practice farming and animal husbandry. With increasing altitude, the cultivated land is gradually restricted by temperature and reaches its limit in mountainous areas above 2800 m. Here, the main mode of production is animal husbandry. The Chiang costume heritage value shows a continuous upward trend with elevation.

This paper reveals the spatial differentiation characteristics of Chiang costume heritage values in the upper reaches of Minjiang River. However, the results obtained are not causal but rather an objective description of the regularity of spatial differentiation based on statistical relations.

Conclusions

As a symbol system, a national costume embodies the customs, religious beliefs, moral code, and aesthetic concepts of a nationality. This study takes national costume heritage as the starting point of national culture heritage. It identifies elements of the costume, collating a full list, and then goes on to clarify the current heritage status of each element. The driving forces behind the development of the elements are

identified, and the spatial differentiation pattern reflecting the occurrence of each element are determined. Statistical analysis is used to reveal the heritage status, main driving factors, and objective spatial differentiation pattern of Chiang costume heritage.

The heritage value of each costume subsystem in the study area was ranked as follows: Chiang embroidery > headdresses > shoes > waist ornaments > clothes > ceremonial costume > accessories > *Shibi* costume. The influence of each factor on the spatial differentiation of Chiang costume heritage values was ranked as follows: AT > elevation > AP > ANLI > PD. There is a significant positive correlation between increasing elevation and heritage value.

Based on the results, we make the following policy recommendations. More targeted policy support is needed for costume items with poor heritage status. A starting point for this would be to establish a directory of endangered items to focus protection initiatives. For items with superior heritage status (eg Chiang embroidery), continuous attention and economic support should be given, allowing them to be used as a cultural focus to drive the national cultural industry. Technical and economic support for mountain residents in the study area would help to conserve the costume, for example, through providing special fabrics. This would allow costlier, more labor-intensive elements to be made without negatively affecting livelihood activities and income streams. As costume-making gradually becomes integrated into the daily lives of residents, support should continue and measures should be adjusted to local conditions, restoring the cultural diversity of the costume in the Chiang settlements according to different environmental conditions.

This paper provides a set of research methods and ideas based on statistical relations, which build on research in human geography (Song and Zhao 2018). China is a multiethnic country, and each group has a rich cultural diversity. China's mountainous area accounts for about one third of the land area, and there are many ethnic groups among the mountain residents. The methods and ideas presented here can be used to carry out research in similar areas to improve understanding of cultural heritage status and its spatial differentiation patterns. In this way, a protection directory can be established, allowing policy support to be targeted effectively and cultural tourism to be developed. This is critical for the protection of the minorities' culture, as well as for the sustainable development of mountain areas.

This study is a useful exploration of human geography for the protection of national cultural heritage. It outlines effective scientific and technological support for the maintenance of national cultural heritage diversity, the construction of beautiful villages, and other national strategic needs. It is also the social responsibility and subject value of human geography to recognize the human–environmental systems in mountainous areas and serve the scientific development of minority areas.

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Supplemental material

TABLE S1   Questionnaire on costume culture of Chiang nationality.
TABLE S2   Questionnaire descriptive statistics.
TABLE S3   Full elements list of the Chiang costume.
TABLE S4   Multiple comparison of the heritage values of costume subclasses.

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