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RESEARCH ARTICLE

Perception of indigenous people of climate change and its impact on the Everest National Nature Preserve

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Abstract

Using interviews and surveys of 212 households in villages situated at different elevations in the Everest National Nature Preserve (ENNP), correlations and comparative analyses were employed to reveal the residents' perceptions and understanding of climate change and its effects on the ENNP. Results showed that: (1) nearly all residents thought that climate warming and ice–snow landscape decrease were very significant, but there was an obvious difference between the residents' cognition and observations to the change of runoff; (2) higher altitude is, more obvious warming is, and stronger residents' perception of climate change and its impacts is in the ENNP, for which educational level and age were the main factors affecting their degree of perception; (3) especially, higher altitude is, more frequent the tourism participation of residents is and higher their income is; and (4) because the centralized pollutant treatment facilities have a low efficiency, and because the area receives a large number of tourists whose activities are spatially scattered, the potential risk of environmental pollution has been increasing in recent years. At present there is an urgent need for policy suggestions at the strategic level of national ecological security and interregional equity principles concerning the adaptation to climate and environmental changes in the ENNP.

KEYWORDS

climate change, Everest National Nature Preserve (ENNP), local perception and knowledge, tourism

1 | INTRODUCTION

Global climate change will have a range of direct and indirect impacts on both natural and social environments. These impacts are closely interlinked, ranging from the climate, cryosphere change impacts and related effects on water, ecosystem services and the socioeconomic system (Capstick *et al*., 2015; Roco *et al*., 2015; Panda, 2016; Belfer *et al*., 2017; Running *et al*., 2017; Aitor *et al*., 2018; Bardsley *et al*., 2018; Kimaro *et al*., 2018). Some researchers are attempting to predict future trends in climate change and their impacts (Bhatt *et al*., 2014; Brown, 2018). Since humans, as members of society, will be aware of the global system, be responsible and equitable participants, and realize the potential role they can play in climate regulation (Yu *et al*., 2013), it is necessary to study the cognition of local residents regarding climate change and its impacts.

Publics who accurately recognize the shifting climate change may be more likely to support policies that mitigate climate risks (Jørgensen and Termansen, 2016; Ingty, 2017). The role of experience in the public's assessment of climate change and extreme climate events has received increasing attention over the past decade (Hansen *et al*., 2012; Scruggs and Benegal, 2012; Akerlof *et al*., 2013; Capstick and Pidgeon, 2014; Capstick *et al*., 2015; Domingos *et al*., 2018; Howe *et al*., 2019). Especially, residents' perceptions of climate and environment change may also be affected by other factors, such as demographics, subjective feelings, and spiritual and cultural beliefs (O'Connor *et al*., 1999; Leiserowitz, 2006; Byg and Salick, 2009; Maria, 2015; Panno *et al*., 2015; Pratoomchai *et al*., 2015; Tindall and Piggot, 2015; Domingos *et al*., 2018; Hassan *et al*., 2018; House *et al*., 2018; Libarkin *et al*., 2018; Sun and Han, 2018). Thus, a better knowledge of the ways different socio-cultural groups perceive climate change is crucial for the effective implementation of climate polices (Tesfahunegn, 2018; Ruiz *et al*., 2020). The study quantified the relative strength of drivers of climate change perception, taking into account differences in the social, geographical, economic and educational identities of any considered community.

Local residents' cognition, particularly in alpine areas, has a unique grounding in the climate, ecological system, agriculture environmental change and other natural factors, and as such can offset some of the shortcomings of scientific research, which has neglected these topics to some extent (Devkota, 2014; Wang and Cao, 2015; Ingty, 2017; Negi *et al*., 2017; Dey *et al*., 2018). As the world's highest plateau, climate change and its impacts are having a more pronounced effect on the physical and social properties of the Qinghai–Tibet Plateau (QTP) (Wu and Zhang, 2008; Yao *et al*., 2012; Chakraborty *et al*., 2015; Li *et al*., 2018; Gao *et al*., 2019). The Everest National Nature Preserve (ENNP), as the highest area within the QTP, is a more sensitive region of climate change response and climate change impacts.

In order to understand better environmental change at the regional scale and to adapt effectively to climate change impacts, as well as to provide a social scientific basis for local governments' decision-making to adapt climate change impacts, the study took the ENNP as a case study area and used data from a survey of 212 households in 20 villages, which are located in areas with different elevation gradients, in order to examine their perceptions and attitudes regarding climate, environment change and its impacts. The main objectives of the study were as follows:

- To understand local residents' perceptions and knowledge degree of climate and environmental change, as well as its social and economic impacts.
- To reveal the influencing factors of residents' perceptions toward climate change, environment, its impacts and adaptation, and to analyse in depth the spatial and temporal characteristics of these factors.
- To compare and analyse the differences between the scientific research and social survey results.

2 | METHODS

2.1 | Study area

Mount Everest is the Earth's highest mountain with an elevation of 8,848 masl. The international border between Nepal and China (Tibetan Autonomous Region) runs across its summit. Five of the world's 11 peaks > 8,000 masl in height are located in the ENNP. The ENNP covers a wide area that extends from Jilong county in the west to Gangba county in the east, and from Mt Laguigangri in the north to the international border in the south (Figure 1). Most of study area is located in the ENNP. Most glaciers and snow cover are distributed at middle–high elevations, while warmer and hotter climate conditions only exist in the south of Zhangmu, Chentang and other areas < 2,000 masl. Snow cover and glacier resources are not only natural landscapes but also important repositories of the mountain cultural landscape. The world's sixth highest peak, Cho Oyu (8,201 m), as well as the 14th highest peak, Shishapangma (8,012 m), are sacred mountains worshipped by local residents, and have been the inspiration for many mythological tales.

In the study area, the agricultural population represents 73.8% of total respondents, and the economy is relatively underdeveloped. The foundation of agriculture is weak and the income of farmers and herdsmen is low, resulting in somewhat limited abilities for adapting to climate change and its impacts. In recent years a growing number of residents began to participate in tourism activities in the ENNP. In the present study the interviews and surveys were conducted in 20 villages; each village has an average of more than 30 households. The altitude of these villages ranged from 2,040 to 5,100 masl, in which Chentang village is at 2,040 masl and Quzong village at 5,100 masl (Figure 1). The surveys indicated that water and heat conditions, transportation conditions, land resources, accessibility and human living conditions all exhibited a significant decreasing trend with altitude increases. However, the higher the altitude, the higher the degree of participation of residents in tourism activities, with their income showing an associated increasing trend.

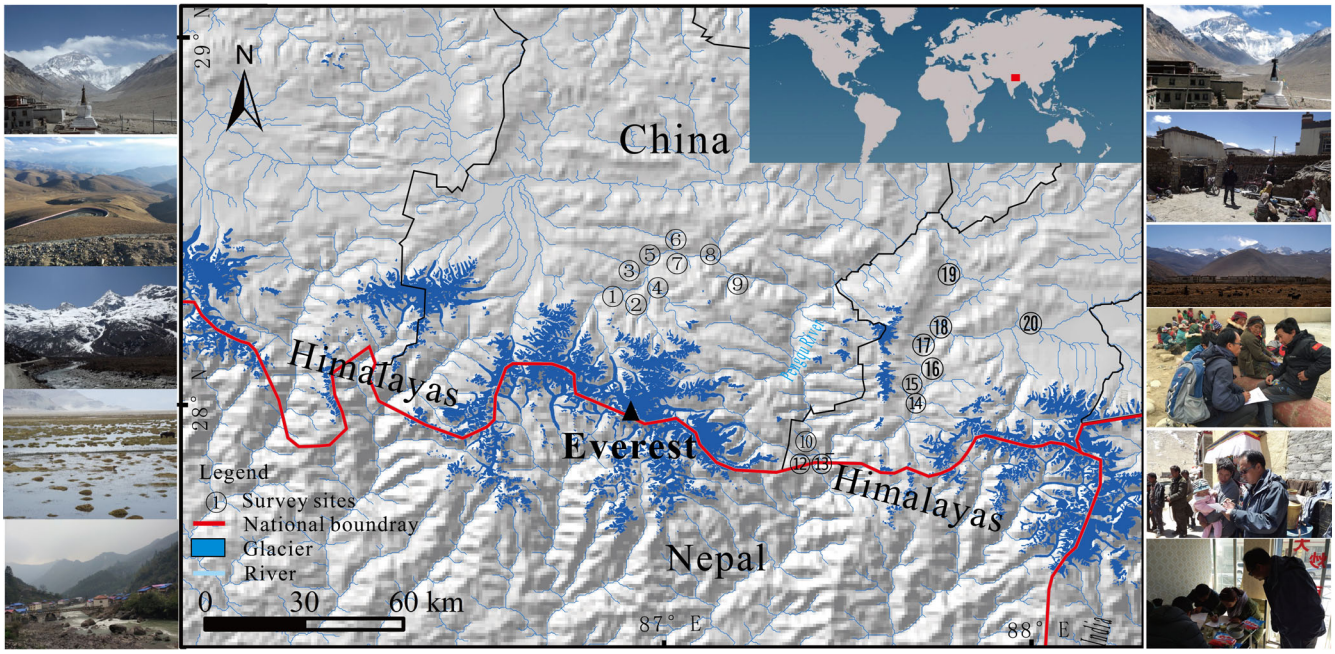

FIGURE 1 Landscapes with different altitudinal gradients (left), spatial distribution of glaciers and rivers (middle), and survey sites (scenes) (right) in the Everest National Nature Preserve (ENNP): 1, Quzong village; 2, Gabu village; 3, Zhabu village; 4, Jiapeng village; 5, Basong village; 6, Xisa village; 7, Kalong village; 8, Naicang village; 9, Pingan village; 10, Xiuxiuma village; 11, Sali village; 12, Chentang town; 13, Zangga village; 14, Riwu village; 15, Lure village; 16, Qugezong village; 17, Jiangpu village; 18, Saer country; 19, Jiangga town; and 20, Qiongzi village

2.2 | Data sources and processing

To obtain a better understanding of local climate change and its impacts on ecology, environment and the socioeconomic system, some personal interviews were conducted with local residents between 2015 and 2017. In the 20 villages with different elevations, 212 local respondents were randomly selected (Figure 1). The sample size was basically 30% of the total number of households (about 600 households). A total of 212 questionnaires were distributed and 168 valid questionnaires were received, with an effective rate of 79.3%. The questionnaires include three main sections: (1) the respondents' characteristics (age, sex, outcome, education, and so on), (2) their perspectives on climate (temperature, precipitation, snow cover, nature disaster, glacier, extreme weather frequency and solar radiation), environment change (water and ecology) and their impacts; and (3) tourism environmental problems (positive and negative) (see Table A1 in Appendix A). The following section used the five-point Likert scale to quantify each question, asking respondents to indicate on the questionnaire that their answer to each question was either 5 (strongly agree), 4 (agree), 3 (neutral or uncertain), 2 (disagree) or 1 (extremely disagree) (Likert, 1932). In general, when the average of Likert's 1–5 scores has ranges of 1.0–2.4, 2.5–3.4 or 3.5–5.0, they represent opposition, neutrality or support (Tosun, 2002), respectively.

Following the interviews, every question was codified for statistical analysis, single-factor analysis of variance (one-way ANOVA) was conducted and their means, standard deviation and correlation were computed by Statistical Program for Social Sciences (SPSS19) software. Correlation analysis was used to analyse the effects of the respondents' characteristics on their perception of using a perception strength model. Perception strength was calculated using the following formula:

$$A = \frac{\sum V_i \times N_{ij}}{\sum N_{ij}},$$

where A is the perception strength of residents; V_i is the support score for the i view; and N_{ij} is the number of the people who support the i view of the j factor. The perception strength of each view is based on the average score of each factor (Wang and Cao, 2015; Sun and Han, 2018).

3 | RESULTS

3.1 | Simple characteristics

The results revealed that 66.7% of respondents were male, and the remainder female. The majority of respondents

were middle aged and elders, with 71.4% of the total sample being at least 45 years old, while 28.6% of the total respondents were < 44 years old. In general, elders' perceptions of climate, environment change and their impacts are often more accurate than youths', suggesting that this survey is more credible. Respondents with average annual incomes > 20,000 CNY (Chinese yuan) only accounted for 23.8%, while 76.2% had incomes < 20,000 CNY, indicating that residents' average annual income was relatively low. Most of respondents (90.5%) were Tibetan, with only 9.5% from other ethnic groups. A majority (64.3%) of respondents had a low level of education, while the remainder had varying amounts of higher education. Most of the respondents were either farmers or herders (51.8% and 40.6%, respectively), with tourism practitioners accounting for 6.1%, and 1.5% employed in other occupations (Table 1).

TABLE 1 Basic social attributes of the residents

Property	Category	Frequency (%)
Gender	Male	66.7%
	Female	33.3%
Age (years)	≤ 24	4.8%
	25–44	23.8%
	45–64	35.7%
	≥ 65	35.7%
Average annual income (CNY)	≤ 5,000	4.8%
	5,001–10,000	38.1%
	10,001–20,000	33.3%
	20,001–30,000	19.0%
	> 30,000	4.8%
Nationality	Tibetan	90.5%
	Han	0%
	Other	9.5%
Education level	Illiterate	64.3%
	Primary school	9.5%
	Junior middle school	9.5%
	Senior middle school	16.7%
Occupation	Farmer	51.8%
	Herder	40.6%
	Tourism practitioner	6.1%
	Other	1.5%

3.2 | Residents' views of climate change and its impacts on water and the environment

Among all questions, 11 concerned climate and environmental change. These questions can be classified into three sections. Questions in the first section (Q1–Q6) were all related to climate change and its direct impacts; thus, they can be summarized as climate change. Questions in the second section (Q7 and Q8) were related to hydrology and can be summarized as the water environment. Questions in the third section (Q9–Q11) were all related to vegetation and ecology; therefore, they can be summarized as the eco-environment (Table 1). Residents exhibited stronger perceptions for climate change (average perception strength = 3.64), yet relatively low strengths for both the water environment and eco-environment (perception strengths of 2.21 and 2.52, respectively) (see Table A1 in Appendix A), presumably because these factors are relatively difficult to recognize directly.

The survey suggests that most residents perceive climate and water environment changes in the ENNP. More than 85% of respondents either agreed or strongly agreed that warming and glacier and snow cover retreat are obvious and solar radiation has been enhanced significantly. Fewer than 80% agreed that the frequency of extreme weather and continuous drought events has increased, while nearly 90% of respondents think precipitation has decreased significantly. Over 70% of respondents degreed that runoff has decreased. Overall, the most frequently described personal experiences of global warming reflected their concerns about climate change. Warming, precipitation and runoff increasing are closely related to changes in ecological vegetation (Shen *et al*., 2015b; Gao *et al*., 2019). However, 52.4% of respondents were unsure whether ecosystems were degraded; half of respondents agreed that plant diseases and insects were more fearsome; and only 23.81% of respondents agreed that grasslands were facing serious desertification, degeneration and salinization. In addition, 69.05% of respondents thought that the rapidly reduced ice and snow landscape had affected their cultural structure and spiritual world (Q21), while most respondents held uncertain or opposed attitudes. The residents' perceptions were not consistent with climate and water environment changes and their direct impacts, indicating that their perspectives were affected due to the pessimism and worry from climate and environment change, and they lacked understanding and knowledge about the impacts of climate and water environmental changes (see Table A1 in Appendix A).

3.3 | Residents' views of socioeconomic system changes and their influences

The 13 questions concerned socioeconomic system changes and their influences. These questions can also be classified into three sections. Questions in the first section (Q12–Q17) were all related to socioeconomic system changes and their direct impacts; questions in the second section (Q18–Q20) were all related to positive socioeconomic impacts; and questions in the third section (Q21–Q24) were all related to the pessimistic (negative) effects of socioeconomic impacts. On the whole, residents displayed stronger perceptions for the socioeconomic system (perception strength = 3.44) and positive impacts on the socioeconomic system (3.59), with relative low perceptions for negative impacts on the socioeconomic system (1.89).

The development of the ENNP's tourism has greatly changed socioeconomic conditions and industry structure (the major industry in this region is agriculture). More than 90% of respondents either agreed or strongly agreed that tourism had improved local infrastructure conditions (water and electricity supply, communications, medical treatment, and mass transit), created and expanded new income sources for local residents, and improved residents' quality of life. However, there were some negative impacts due to the improvement of socioeconomic conditions and the rapid development of tourism. Only 88.3% of respondents either agreed or strongly agreed that tourism has provided benefits to the minority, with the majority of earnings going to foreign enterprises and staff, indicating that although the local tourism was developing very quickly, the degree of residents' participation in the tourism industry was not high. They were eager to earn more income through tourism. In particular, 95.2% of respondents either agreed or strongly agreed that domestic waste was increasing, and the environment was damaged to some extent. Residents generally reported that the development of tourism was associated with serious problems such as solid waste pollution, untidy tourism environments and some degree of water pollution, which still means that local residents were commonly worried about the problem of environmental change and pollution (see Table A1 in Appendix A).

During the field survey, it was noted that large amounts of domestic waste are discarded as litter throughout the region instead of being centrally processed. The spatial range of tourist activities is vast, while the distribution of pollutant treatment facilities was highly concentrated, thus making it difficult to sustain a clean environment. Local residents strongly agree to protect the environment, in which almost 90.5% of respondents either agreed or with the view of protecting the environment primarily, 90.5% of respondents either agreed or strongly agreed that environmental protection was more important than economic development. Only 71.4% thought that the positive effects of tourism development far outweighed the negative impacts. More than 97% of respondents thought that the ENNP's tourism had benefited and developed communication between local and external regions, improved the exploration and propagation of local traditional culture, and promoted the improvement of local residents' thoughts and opinions.

However, residents' cognition has an obvious uncertain attitude to the negative impacts on the socio-cultural environment from ENNP's tourism. Only 28.6% of respondents either agreed or strongly agreed that tourism had dealt a blow to the local culture, with levels of social morality decreasing and the honesty of staff dropping, while 71.4% held an uncertain or opposed attitude. Only 16.7% of respondents agreed or strongly agreed that the ENNP's tourism was destroying their peaceful lifestyle, while 83.3% held an uncertain or opposed attitude. Only 23.8% of respondents agreed or strongly agreed that the ENNP's tourism was making local traditional culture (art and folk customs, and so on) more commercial and philistine, while 76.2% were either uncertain or disagreed. This uncertain view indicated that local residents were potentially worried about the negative impacts on the socio-cultural environment from ENNP's tourism and they had some vigilance for the irruption of foreign culture.

Since tourism development is still in its infancy in the ENNP, any potential interference by it to the local social and cultural environment is not yet obvious or significant. On the other hand, due to the benefits associated with tourism activities, these activities were more popular among local residents, with respondents' emotional subjectivity counteracting their negative emotions, and thus blurring their perception. In general, residents had a positive attitude towards the improvement of the socioeconomic system and its positive impacts, and their perceptions were highly consistent (see Table A1 in Appendix A). This indicates that the improvements in social and economic conditions are yielding tangible benefits and profits for local residents. Tourism has made a real contribution to the local economic and social development. While enjoying the conveniences associated with the improvement of economic and social conditions, residents have also expressed concerns about its widespread negative effects and required environmental protection, with some also worried about the impact of foreign culture on the local area.

4 | DISCUSSION

4.1 | Observational facts and social surveys

Using experimental and survey data on the relationship between temperature changes and climate change beliefs, researchers have found that both the perceptions of having experienced warming and physical data are showing warmer temperatures and trends (Risen and Critcher, 2011; Akerlof *et al*., 2013). Of course, some evidence suggests that the perspectives of residents may not be based on actual environmental changes or didn't coincide with the scientific climatic record (Byg and Salick, 2009).

Observation facts showed that during the last century, especially since the 1960s, warming has become the main feature of climate change in the QTP (Wang *et al*., 2018a, b). The temperature increase in this region reached 0.3–0.4°C·decade^{-1} in the past 50 years (1960–2012), which was more than twice the global temperature rise during the same period (Chen *et al*., 2015). Gridded precipitation data revealed that the average annual precipitation between 1961 and 2012 increased, with fluctuations, at a rate of 5.07 mm·decade^{-1} (Wang *et al*., 2018b). Global warming has led to the mass retreat of glaciers in the Himalayas (Yong *et al*., 2010). From the 1970s to the 2010s, glacial areal coverage in the Chinese Everest region decreased by approximately 28.4% (0.83%·year^{-1}) (Guo *et al*., 2015). Snow cover over the entire QTP decreased at 4.0%·decade^{-1} between 1997 and 2011, especially after 2005, and the perennial snow cover has diminished sharply (Pubu *et al*., 2013). Distinct decreasing chiefly appears in high elevation areas (Shen *et al*., 2015a). Over the past 30 years, the trend of the normalized difference vegetation index (NDVI) in the Everest region indicates that vegetation coverage and aboveground biomass are increasing, and this trend is more significant in lower altitude regions. At the same time, grassland greening has advanced and the growth period has lengthened (Shen *et al*., 2015b).

Residents' perceptions of temperature, extreme weather, ice and snow, and glacial retreat were found to be similar to the actual changes. Rainfall has exhibited a decreasing trend, and the number of days of persistent drought has tended to increase (Ji and Kang, 2013). The increase of runoff has been obvious (Liu *et al*., 2006; Wang *et al*., 2013; Ye *et al*., 2015), and vegetation coverage, aboveground biomass and vegetation growth are also increasing (Shen *et al*., 2015b). However, many residents believed that precipitation and runoff have been significantly decreasing in the ENNP, grassland vegetation growth is as not vigorous as it was in the past, a significant amount of tree death has occurred due to disease and pests, and grassland degeneration is serious. This perceived bias likely originates from the increasing trend of drought in recent years that has seen precipitation and runoff decrease, vegetative degradation, and is also likely related to a lack understanding and knowledge about climate and environmental change. The comparative study revealed that residents' perceptions are accurate for environmental features that are easy for the senses to perceive and understand, such as temperature rise, glacier retreat, ice and snow cover decrease, and infrastructure improvement. Yet for features the senses find it difficult to recognize and understand, due to lack related knowledge, such as the volume of runoff and vegetative growth, their perceptions deviate noticeably from actual conditions.

In some areas, especially in alpine areas such as the QTP, observing equipment, such as weather stations, is very sparsely distributed. Respondents' residences are far from the locations of observing equipment, while extremely complex terrain reduces the observation accuracy of the observation equipment and remote sensing satellites. The scientific observed data may not reflect the environmental features at villages where people live since there is great variation in microclimates within the regions (Aryal *et al*., 2016; Budhathoki and Zander, 2019). Although there are significant objections and uncertainty about local residents' perceptions, their cognition of climate and eco-environment change is of certain reference significance to the alpine areas which lack observation equipment.

4.2 | Influencing factors of residents' perceptions

Results from the relevant literature indicate that some factors affect the perception and attitude of residents

TABLE 2 Residents' comprehensive perceptual intensity

Type of factors	Climate change	Water environment	Eco-environment	Socioeconomic environment	Positive impacts	Negative impacts
Strength of perception	3.6	2.2	2.5	3.4	3.6	1.9

TABLE 3 Results of Kendall correlation analysis

	Altitude (study site)		Age		Income		Education level	
	Correlation co-efficient	Significance (bilateral)	Correlation co-efficient	Significance (bilateral)	Correlation co-efficient	Significance (bilateral)	Correlation co-efficient	Significance (bilateral)
Climate environment	0.405**	0.001	0.389**	0.002	−0.179	0.159	−0.583**	0
Water environment	0.124	0.307	0.19	0.149	−0.031	0.81	−0.151	0.256
Eco-environment	0.121	0.302	0.142	0.264	0.232	0.065	−0.195	0.131
Socioeconomic system	−0.084	0.48	0.346**	0.007	−0.083	0.512	−0.423**	0.001
Positive impacts	−0.229	0.071	−0.204	0.139	−0.241	0.077	0.255	0.068
Negative impacts	0.168	0.153	−0.261*	0.04	0.055	0.66	0.370**	0.004

Note: Significant correlation at a confidence level of *$p < 0.05$ bilateral; and **$p < 0.01$ bilateral.

towards climate change and impacts, which subsequently influences their behaviour and capability to adapt to climate change. These factors include residents' age, income and education level (Frank, 1998; Yan *et al.*, 2006; Deressa *et al.*, 2009; Wang and Cao, 2015). Table 2 shows the strength of residents' perception of six types of factors (see Table A1 in Appendix A). No one strength of residents' perception is > 4 or < 1. Residents have a stronger perception for climate change, the socioeconomic environment and positive socioeconomic impacts, and their strengths of perception are all close to 3.5. For the water environment, eco-environment and negative socioeconomic impacts, residents have middle or lower perceptions because these factors are difficult to recognize directly.

In order to explore the specific degree of influence from each factor, correlation testing and the Chi-squared test were used to analyse the relationship between study site (altitude), residents' demographic characteristics and the degree of their perceptions. Meanwhile, study site (altitude), age, income and education level are all ranked variables for which Kendall's co-efficient of correlation should be employed. If a significant correlation exists between residents' demographic characteristics and the degree of their perceptions, this indicates that residents' demographic characteristics have a significant influence on their perceptions, and the correlation co-efficient can indicate the specific degree of that influence. After running the Chi-squared tests, it was found that there were no significant correlations between gender or nationality and residents' perception degree ($p < 0.05$) (Table 3).

Kendall's correlation analysis indicated that the study site (altitude) exerts a significant influence on the perception of residents of climate change ($p < 0.01$). Age and education level also have significant effects on residents' perception of climate change, the socioeconomic system and negative impacts on the socioeconomic system. The great differences in elevation have given rise to enormous differences in environmental conditions and have affected the perceptions of residents to their surrounding environment. Generally, since it is in the extreme environmental conditions and frail eco-environment of high-altitude areas where the natural responses to climate change have been more dramatic than in lower altitude areas, high-altitude residents have a more obvious recognition of climate and environmental change. The elders have experienced a longer period of the natural environment and socioeconomic change, and thus they have a more pronounced and accurate recognition of the changes than those of the younger residents. In terms of education level, respondents with a better education exhibit more uncertain perceptions of the climate and socioeconomic system changes, as well as a stronger

perception of the negative socioeconomic impacts. Of course, residents with a better education understand climate change and impact, while most of them are younger and have experienced climate change over a relatively short period. The results revealed that younger respondents tend to have a higher education level, while the elders generally have little education (Table 3).

Tourism resources have dominated the region's magnificent and precipitous natural scenery, long history, and the mysterious and colourful traditional culture of Tibet and Tibetan Buddhism. Local residents have maintained their unique reverence for the elements of the natural landscape. Each peak has its own beautiful and magical myths and legends for residents in the ENNP. The glaciers have special significance in the eyes of the people from the alpine region. They not only provide local people with water for agricultural production and daily life, but also have special religious significance. The alterations of the local natural landscape resulting from climate change will have impacts on the local tourism industry as well as the daily lives and beliefs of residents, threatening the local socioeconomic development and cultural heritage and ultimately leading to a series of social problems.

The survey revealed that respondents are more worried about ecological degradation problems and extreme weather disasters. At present, there is an urgent need for policy suggestions dealing with climate and environmental changes in the ENNP from the perspective of a national ecological security strategy and the principle of interregional equity. In particular, local indigenous knowledge, community management systems and macro-policy mechanisms are the key factors that will promote the adaptation of indigenous peoples to the impacts of climate change.

5 | CONCLUSIONS

The Everest National Nature Preserve (ENNP) has experienced significant climate change, and local residents have profoundly perceived this change. Residents have relatively strong perceptions of temperature, extreme weather, and ice and snow retreat, which is consistent with the actual changes. However, scientific studies have shown significant increases in precipitation and runoff, as well as significant greening of vegetation, but local residents thought that precipitation and runoff had significantly decreased and grassland vegetation growth was as not vigorous. Overall, altitude (study site), residents' age and outcome have a significant influence on their perceptions, while there were no significant differences between either gender or nationality on residents' perception degree.

In response to the issue of environmental protection in the ENNP, residents agreed that the state has made great efforts to protect the natural environment. The wetland area in the protected area has been increased, infrastructure has been improved and the income of residents has also increased steadily. However, the natural conditions are fragile, the industry is simple, and tourism and animal husbandry are its leading industries, resulting in local farmers' and herdsmen's limited ability to cope with climate change impact and environmental problems. On the one hand, the country needs to enhance the education level of its people in this region, so as to improve the cognition ability of residents about the impacts of and adaptation to climate change. On the other hand, the state also needs to increase investment in the region to support the development of tourism and animal husbandry.

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APPENDIX A

TABLE A1 Percentage of residents' perspectives on climate, ecology and socioeconomic environment

		Problem	Mean	SD	Agree (%)	Neutral (%)	Disagree (%)
Climate change	Q1	Obvious warming?	3.70	0.68	64.28	35.71	0
	Q2	Snow cover day is decreasing?	3.90	1.10	61.91	35.71	2.38
	Q3	Obvious increase in avalanche, rock avalanche and ice avalanche frequency?	4.10	0.70	19.09	69.05	11.90
	Q4	Obvious glaciers recession?	4.80	0.49	97.62	2.38	0
	Q5	Increase in extreme weather frequency (e.g. torrential rain, hail and continuous drought)?	3.87	1.06	52.38	35.71	11.90
	Q6	Obvious enhancement of solar radiation?[a]	2.78	1.32	35.71	64.29	0
Water environment	Q7	Obvious decrease of rainfall?	4.43	0.56	90.47	9.52	0
	Q8	Obvious decrease of runoff?	2.22	0.89	0	26.19	73.81
Eco-environment	Q9	Significant degradation of vegetation?	3.51	0.78	42.86	52.38	4.76
	Q10	Plant diseases and insects are more fearsome?	3.78	1.02	50.00	35.71	14.28
	Q11	Grassland is facing serious desertification, degeneration, and salinization?	2.28	1.01	23.81	61.90	14.29
Socioeconomic environment	Q12	Improved levels of ENNP local infrastructure (water and electricity supply, communication, medical treatment, and mass transit) have been established?	4.83	0.84	100	0	0
	Q13	ENNP tourism has improved local socioeconomic development levels, added work availability for local residents, and improved the quality of life?	4.63	0.50	100	0	0
	Q14	Tourism has provided benefits to the minority, with the majority of earnings going to foreign enterprises and staff?	3.52	1.05	50.00	21.43	28.57
	Q15	Domestic trash is increasing, and the environment has been damaged to some extent?	4.50	0.78	95.24	4.76	0
	Q16	Environmental protection is more important than economic development?	4.89	0.37	100	0	0
	Q17	The positive effect of tourism is far greater than the negative impact?	4.52	0.77	95.24	4.76	0
Positive impacts	Q18	ENNP tourism has benefited and developed communication between local and external regions?	4.10	0.57	88.10	11.9	0
	Q19	ENNP tourism has improved the exploration and propagation of local traditional culture?	4.70	0.74	83.33	16.67	0
	Q20	ENNP tourism has promoted the improvement of local residents' thoughts and opinions?	4.71	0.75	83.34	16.67	0
Negative impacts	Q21	The decrease of glaciers and snow cover has had some impacts on residents' cultural structure?	3.80	0.73	69.05	23.81	7.14

(Continues)

TABLE A1 (Continued)

	Problem	Mean	SD	Agree (%)	Neutral (%)	Disagree (%)
Q22	ENNP tourism has dealt a blow to local culture, with levels of social morality decreasing and the honesty of staff dropping?	4.12	1.21	76.19	23.81	0
Q23	ENNP tourism is destroying the residents' peaceful lifestyle?	2.77	1.10	26.19	38.10	35.71
Q24	ENNP tourism is making local traditional culture (art and folk customs, and so on) more commercial and philistine?	3.00	1.31	35.72	47.62	16.67

[a]Note: Solar radiation mainly interviewed elderly, since their perception on the interdeadal scale is greater.