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Sustainability assessment of tourism in protected areas: A relational perspective

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ABSTRACT

Tourism is important in that protected areas (PAs) provide cultural ecosystem services. However, interactions between humans and nature, between stakeholders, and between environmental elements make it complex and variable. To promote sustainable tourism development in PAs, this study (i) established an evaluation framework reflecting the relationships among stakeholders and different environmental system dimensions considering human–environment systems' complexities, dynamics, and interactivity, (ii) identified 52 sustainability indicators (31 belonging to the social system and 21 to the environmental system) in accordance with sustainable tourism development goals for PAs using the fuzzy Delphi method, and (iii) applied these indicators to Qinghai Lake Nature Reserve. The results indicated that its overall sustainability is intermediate, with the sustainability of its social system being better than that of the environmental system. We effectively combined the stakeholder theory and coupling coordination degree, and assessed the sustainability of PA tourism with the relational perspective.

1. Introduction

Protected areas (PAs) play a critical role in protecting the planet's biodiversity and promoting human well-being (Buckley et al., 2019; Jones et al., 2018). An important way for PAs to provide cultural ecosystem services is through tourism (Buckley, 2020). Except strict nature reserves (Ia), the other five of the International Union for Conservation of Nature's (IUCN) PA management categories regard tourism as a management objective to varying degrees (Dudley, 2008). World Heritage sites and biosphere reserves are also important tourist destinations (Liu et al., 2016).

PA tourism can contribute outstandingly to biodiversity conservation by enhancing awareness and investment in nature protection (Leung et al., 2018). In addition, it can also provide multiple livelihood opportunities for local communities and contribute to the physical and mental health of human beings by helping them recover from stress, reducing depression, improving happiness, among others (Buckley, 2020; Harris et al., 2021; Yergeau, 2020; Zhang et al., 2020a). However, tourism, if not properly managed, can also engender negative environmental effects, such as biodiversity loss, decreasing soil porosity, and social conflicts among stakeholders in or around PAs (Monz et al., 2013; Snyman, 2012; Zhong et al., 2020). Therefore, World Tourism Organization (WTO) and IUCN proposed the sustainability indicators for tourism destinations and the pursuit of sustainable PA tourism (Leung et al., 2018; WTO, 2004).

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Although still a controversial topic, sustainability in the context of tourism is generally considered to aim to strike a balance between the economic, environmental and social needs of all stakeholders (Buckley, 2012; Hall et al., 2015; Rasoolimanesh et al., 2018). Indicators are key in sustainable tourism development and effective managerial tools for contending various sustainable tourism challenges (WTO, 2004). Since the 1990 s, researchers and managers in many countries and tourist destinations have been developing tourism sustainability indicators (Asmelash and Kumar, 2019; Kristjansdottir et al., 2018; WTO, 2004). Nevertheless, most disregard the interaction among the elements of the tourism system and the complexity of such relationship, and focus more on explaining individual system variables (Schianetz and Kavanagh, 2008; Zhang et al., 2015). In fact, complex relationships among subsystems and system variables are critical to understand the sustainability of complex tourism systems (Nyaupane and Poudel, 2011; Ross and Wall, 1999a; Tsaur et al., 2006). Analyzing sustainability of complex social-ecological systems requires knowledge about specific variables, how their component parts are related (Ostrom, 2009), and how complex interactions and feedback among subsystems and elements make the system adaptable (Liu et al., 2007).

Farrell and Twining-Ward (2004) pointed out that interpreting tourism as a complex system had lagged behind to some degree. Nevertheless, acknowledging the existence of and understanding the complex adaptive tourism systems is crucial to the transition of scientific study of tourism sustainability (Zhang et al., 2015). Complex adaptive tourism systems cannot be evaluated in isolation from the environment upon which they depend, especially for destinations located in or near ecologically sensitive sites, such as PAs (Farrell and Twining-Ward, 2004; Schianetz and Kavanagh, 2008; Schianetz et al., 2007).

PAs are complex, adaptive social-ecological systems with multiple stakeholders and affected by the society, economy, and environment factors operating through the interplay of global and local drivers of change (Becken and Job, 2014; Cumming and Allen, 2017; Fisichelli et al., 2015). Failure to recognize the plurality of PAs has created many conservation problems in the past (Cumming and Allen, 2017). The significant impact of the COVID-19 pandemic on PA tourism highlighted the complex interdependencies between tourism, local community, and PA, which, to improve PA sustainability, should not be ignored (Smith et al., 2021).

Therefore, from a relational perspective, we developed a sustainability indicator system for PA tourism that focuses on the interrelationships among various factors. We then applied this index system to evaluate tourism in Qinghai Lake Nature Reserve (QLNR), China (Buckley et al., 2017; Zhong et al., 2020).

2. Related literature review

2.1. Sustainable tourism indicator

Sustainable development aims to strike a balance between resource conservation and social development, emphasizing social justice in both process and outcome (Tsaur et al., 2006). Therefore, sustainable tourism requires not only low natural environmental impact, but also fair stakeholder benefits and participation rights (Lee and Hsieh, 2016; Leung et al., 2018). Sustainable tourism indicators can be divided into two categories: stakeholder perception or attitude assessment, usually qualitative indicators (Ng et al., 2017), and assessment of tourism effects on the environment (e.g., ecological, economic, and sociocultural), usually quantitative indicators (Asmelash and Kumar, 2019; Ng et al., 2017; Zhang et al., 2017). However, few studies have focused on both these aspects and their internal relationships. Lee and Hsieh (2016) identified two dimensions (stakeholders and the ecological environment) of sustainability for wetland-based tourism but overlooked sociocultural and economic sustainability.

Sustainability indicators can be subjective or objective; both are useful in sustainable tourism planning and management (Tsaur et al., 2006; WTO, 2004). Despite the current preference for objective indicators, subjective indicators are crucial for effective PA tourism governance (Meuleman, 2019). Therefore, future research should integrate the advantages of subjective and objective indicators when developing sustainable tourism indicators (Rasoolimanesh et al., 2020).

Subjective indicators, often used to assess perceptions and attitudes, are usually qualitative in nature. However, their usefulness in promoting sustainability management is not diminished (Miller, 2001). Ko (2005) summarized that perception research is one of the most appropriate ways to integrate different stakeholder opinions on the sustainability of tourist destinations. Researchers have identified five important stakeholders in the tourism context: tourists, local communities, businesses, governments, and NGOs (Lee and Hsieh, 2016; Rasoolimanesh et al., 2020; Tsaur et al., 2006; WTO, 2004). For multiple goals, including biodiversity conservation, community livelihoods, and tourism (Nyaupane et al., 2020), tourists, community, and resource managers are the most frequently mentioned stakeholders regarding PA tourism (Strickland-Munro and Moore, 2014; Strickland-Munro et al., 2010). In contrast, existing sustainable tourism indicator studies failed to acknowledge tourists as key stakeholders (Rasoolimanesh et al., 2020).

Scholars and institutions have proposed various indicators of ecological, social, and economic effects to assess tourism sustainability in different destinations (Leposa, 2020; Qiu et al., 2019; Torres-Delgado and Saarinen, 2014). After a systematic review of sustainable tourism indicators, Kristjansdottir et al. (2018) found that many studies still ignored the social dimension of sustainability, which may be an explanatory factor for the very limited use of tourism sustainability indicators.

Although extant literature has developed many tourism sustainability indicators, few have been applied in practice (Asmelash and Kumar, 2019). It is also premature to conduct systematic tourism sustainability assessments in real cases (Ko, 2001, 2005; Ocampo et al., 2018) and criticize them for their limited application in specific cases (Cernat and Gourdon, 2012). Thus, filling the above gaps in the literature is one of our most important objectives.

2.2. Human-environment system

A growing number of interdisciplinary projects integrate natural and social sciences to study and better understand the complexity

of coupled systems (e.g., social-ecological systems and human-environment systems) for sustainable development (Liu et al., 2007; Ostrom, 2009). One of the most recognized and potentially useful frameworks for regional sustainable development in China is the human-environment system (also termed the man-land system; Liu, 2020).

The "territorial system of human-environment interaction" was proposed by Wu (1991). He believed that coupled human-environment systems are complex, integrated, and composed of geographical environment and human activity intersystems (Wu, 1998). The geographical environment subsystem consists of economic, sociocultural, and ecological environments, and the human activity subsystem consists of stakeholders (Lu, 2002), consistent with the social ecological perspective (Stokols et al., 2013). The multidimensionality of environments enables us to understand the interaction and complexity of system elements better.

In the past 30 years, the human-environment system theory greatly promoted scientific research and theoretical innovation of Chinese human-environmental relations and sustainable development (Fan, 2018; Fang, 2004; Liu, 2020; Lu and Guo, 1998), making it fundamental to the sustainability evaluation and management of human–environment systems at different scales (Li et al., 2021; Liu et al., 2020). It is also widely used in tourism research (e.g., Feng, 2006; He, 2011; Huang et al., 2008). Furthermore, based on tourism-related human-environment interactions, Huang and Huang (2015) claimed that the tourism activity system and its geographical environment system constitute the tourism regional system.

2.3. Sustainability of PA tourism system

According to the human-environment system framework, the PA tourism system consists of two subsystems: human system and environment system (Huang and Huang, 2015; Wu, 1998). Ko (2005) used the human system and ecosystem as the conceptual framework for tourism sustainability. Lee and Hsieh (2016) identified two dimensions (stakeholders and the ecological environment) for wetland-based sustainable tourism indicators. However, both the ecosystem and environmental dimension only focus on the natural environment, ignoring the equally important and ever-changing sociocultural and economic environments.

According to stakeholder theory, sustainable development of the human system depends heavily on all stakeholders' support (Freeman, 1984). Ross and Wall (1999a) believed that relationships between resource managers, communities, and tourists can be used to assess the status of PA tourism and presented a framework applied to three Indonesian PAs (Ross and Wall, 1999b). Following the evaluation framework, Tsaur et al. (2006) developed a sustainable ecotourism indicator system (SEIS) to investigate one group's perception of relationships with the other two groups. The SEIS has been used to assess the tourism sustainability of Tioman Island, a marine park in Malaysia (Ng et al., 2017) and Jiuzhaigou, a nature reserve in China (Liu, 2009). Thus, SEIS is our main source of human system indicators.

Environmental system sustainability comprises three dimensions: sociocultural, economic, and ecological sustainability (Huang and Huang, 2015). Scholars have used these dimensions' sustainability indicators to evaluate sustainable PA tourism. Their findings proved these indicators' usefulness in assessing the sustainability of the practices objectively (Jitpakdee and Thapa, 2012; Perez et al., 2013; WTO, 2004). In contrast, PA tourism sustainability studies paid more attention to ecological sustainability than social and economic sustainability due to primary PA conservation objectives (Lee and Hsieh, 2016; Li, 2004). However, unlike social systems, few scholars focused on the relationship between the three dimensions of the environmental system.

The coupling coordination degree is an effective way to evaluate the consistency and positive interaction between systems (e.g., economic, sociocultural, and ecological systems), which can reflect the tendency of the complex system's transition from disorder to

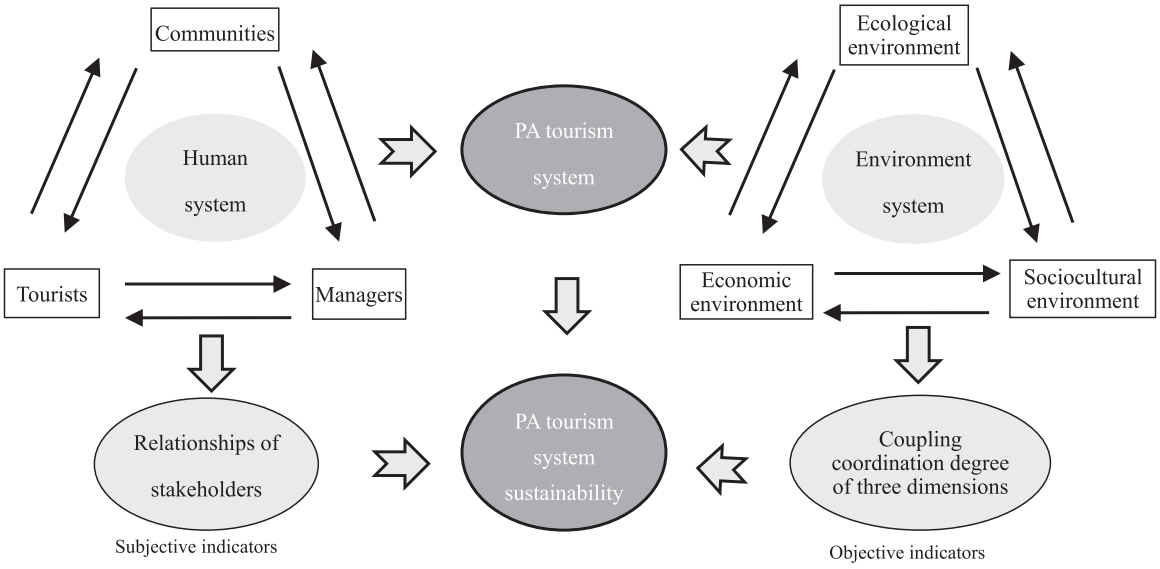


Fig. 1. The sustainable PA tourism evaluation framework. Note: managers refer to the managers of the PA.

order (Li et al., 2012). Currently, it is widely used in tourism destination research in China. Recent empirical studies investigated the coupling relationship between tourism and the environment in Heilongjiang Province (Tang, 2015) and Jilin Province (Cong et al., 2019), the coordinated development of the economy, society, and ecology of China (Cheng et al., 2019), and the coupling coordination between the social-economic and ecological environment of the Songshan Geopark (Yi and Fang, 2014). These studies revealed the importance and applicability of coupling coordination in measuring a complex tourism system's interactive effects.

Thus, we established an evaluation framework for sustainable PA tourism (Fig. 1) from stakeholder relationships (the human system) and the coupling coordination degree among the three geographical environment dimensions (the environment system). The two systems must simultaneously be sustainable for the tourist destination to be sustainable as a human-environment system (Wu, 1998). Therefore, we applied Ko's (2001) Barometer of Tourism Sustainability (BTS) model to represent the comprehensive level of PA tourism sustainability, which combines human and environment indicators into an index of sustainable PA tourism without trade-offs. The evaluation framework focuses on the interactions and relationships between system elements and fully combines the advantages of subjective and objective indicators.

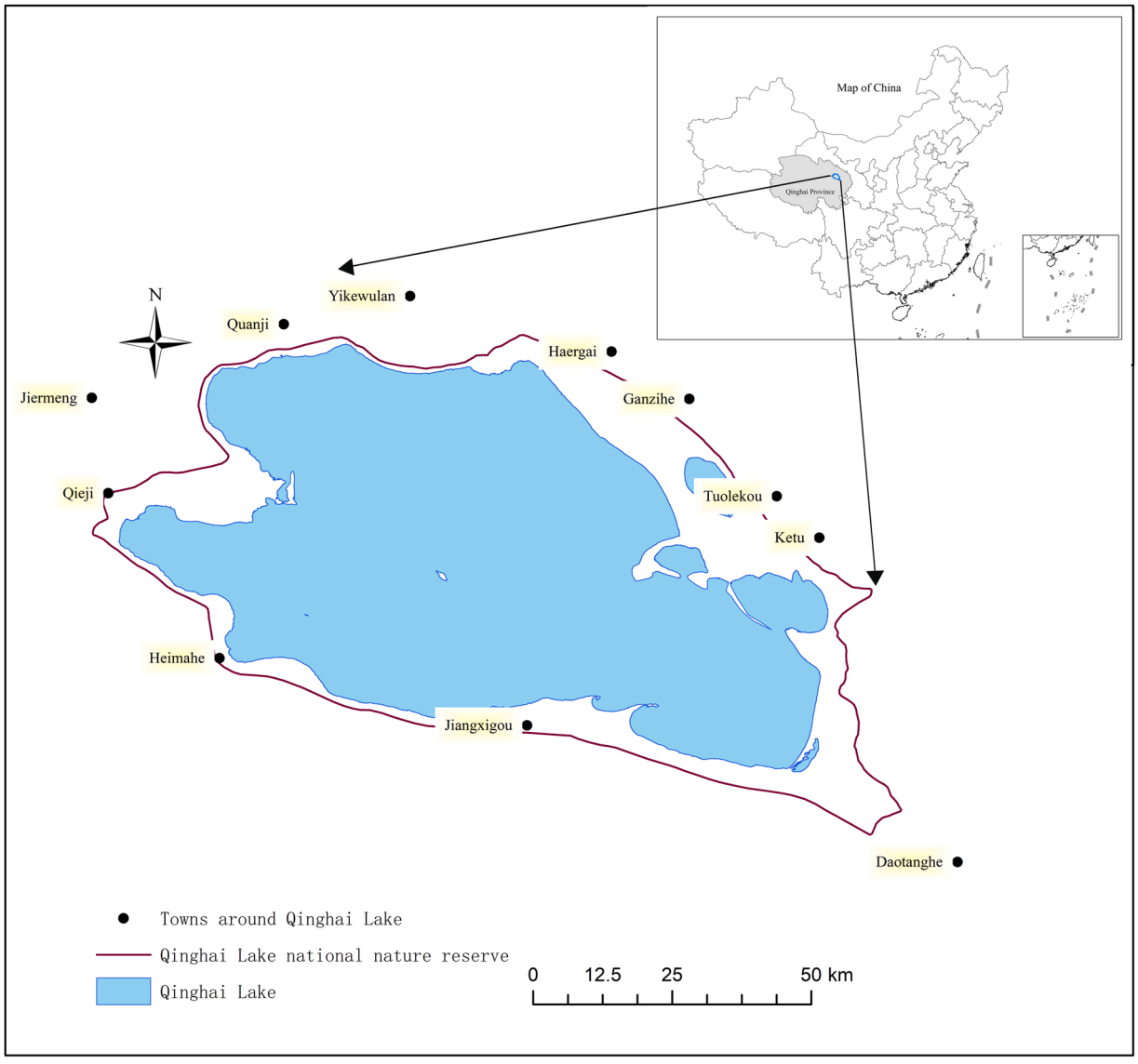


Fig. 2. Location of QLNR in China.

3. Materials and methods

3.1. Case study: Qinghai Lake Nature Reserve

QLNR (N 36.51–37.25°; E 99.58–100.79°) is a national nature reserve situated in the Qinghai Province, northwest of China (Fig. 2). It has the largest brackish lake in China and is famous for its landscape and wetland ecosystem. It is planning to establish the national park by the governments. The reasons for choosing it as a case study are as follows.

First, Qinghai Lake is a popular nature-based destination. In 2019 (before COVID-19), it welcomed 4.43 million tourists, generating a revenue of 625 million yuan. Tourism has been one of the important functions of this region.

Second, like many other PAs in China, it is home to many local people whose livelihoods and lives are affected by nature conservation and tourism. The Qinghai Lake basin is one of the areas where human activities are relatively concentrated on the Qinghai-Tibet Plateau. There are 11 towns around the reserve and 5870 residents, 76.55 km^2 farmlands in the reserve. Local residents' activities such as grazing and planting are restricted due to the establishment of the PA. Tourism commodity sales and tourism services have become alternative sources of income for them.

Third, as the first reserve in China that has been recognized as a "wetland of international importance' by Ramsar Convention, QLNR is an important node of two international bird migration channels in East Asia and Central Asia and also the only habitat of the Przewalski's gazelle (Li et al., 2016). However, according to the results of the 25 largest lakes in the world from 2008 to 2010 as monitored by the United Nations Environment Programme (UNEP), the human activity load of Qinghai Lake has reached 90% (UNEP, 2016). Indeed, the management of human activity has become a pressing problem for the sustainable development of Qinghai Lake.

Last, the QLNR was turned into a transit point from a tourist destination after a few of attractions were shut down and many tourist facilities (such as tents and B&Bs) demolished due to noncompliance with PA management regulations during the central environmental protection inspection of China in 2017. The coordination of the relationships between ecological protection, recreational use, and community prosperity, as well as the promotion of the reserve's sustainability, have become urgent issues.

3.2. Indicator development procedure

According to the evaluation framework (Fig. 1), PA tourism sustainability can be evaluated from human and environmental systems. Based on the SEIS, we identified six dimensions for the human system: community on PA, tourism on PA, PA on community, tourism on community, community on tourism, and PA on tourism. The indicators were obtained from previous studies (i.e., Bhuiyan et al., 2016; Liu, 2009; Ng et al., 2017; Ross and Wall, 1999a; 199b; Tsaur et al., 2006).

The environmental system includes three dimensions: economy, socioculture, and ecology. Indicators were obtained using two

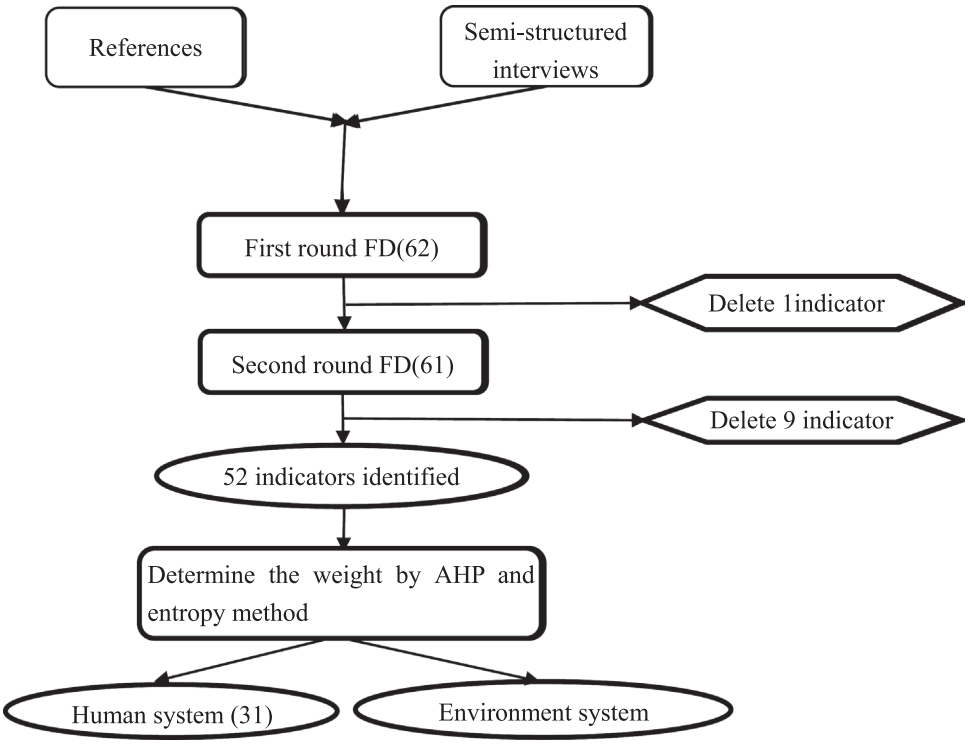


Fig. 3. Index development processes. Note : FD means the fuzzy Delphi method.

approaches. Following previous sustainable PA tourism studies (i.e., Ashok et al., 2017; Blancas et al., 2010; Jitpakdee and Thapa, 2012; Lee and Hsieh, 2016; Perez et al., 2013; WTO, 2004; Yu, 2006), other indicators were obtained through personal semi-structured interviews with visitors, local inhabitants and specialists from Qinghai Lake Protection and Utilization Administration of Qinghai ProvinceNational Forestry and Grassland Administration, and Ministry of Culture and Tourism in China. Sixty-two candidate indicators were obtained.

As shown in Fig. 3, here, a fuzzy Delphi method was used to select the indicators. Delphi has been widely used in tourism literature to build consensus for establishing sustainable tourism indicators (e.g., Lee and Hsieh, 2016; Ocampo et al., 2018). Despite its ambiguity and uncertainty, the Delphi method remains a useful investigative technique. Fuzzy set theory can correct some of its shortcomings by shortening the questionnaire survey time, avoiding the distortion of individual expert opinions, clearly capturing the semantic structure of prediction items, and considering the fuzziness of the interview process (Lee and Hsieh, 2016). Therefore, we used the fuzzy Delphi method to obtain a decentralized consensus with controlled opinion feedback when evaluating each indicator.

Table 1 lists the qualification of the experts who were asked to fill in the survey questionnaire. According to Ocampo et al. (2018), there is no strong relationship between the number of experts and the quality of the decisions made by the panel. In contrast, adding inexperienced experts could weaken result accuracy (Saaty and Özdemir, 2014). Hence, we invited 15 experts, 8 of whom agreed to participate. The panel members seemed fair and representative because they were selected from three different groups: scholars in the PA tourism domain (3), recreation managers from Qinghai Lake Protection and Utilization Administration (2), and Officials in PA tourism-related government departments (3).

During the two fuzzy Delphi survey rounds, 11 indicators that failed to reach consensus thresholds were deleted. Fifty-two PA tourism sustainability indicators were identified (Appendix A).

To determine the indicators' weights, the analytical hierarchy process (AHP) method was applied because it provides a way to systematize PA tourism's complex problems, is easy to operate, and may incorporate the opinions of various stakeholders (Deng et al., 2002). The AHP is widely used to assess interviewees' views on the relative importance of sustainability indicators in the form of hierarchical data (Lee and Hsieh, 2016; Ocampo et al., 2018). Therefore, to determine each indicator's weight, we used the AHP method to conduct the expert questionnaire survey on the above-mentioned eight members of the expert group from June to July 2020. For the quantitative indicators of the environment system, we combined the entropy weight method to compensate for the lack of subjective weight obtained by the AHP. The calculation formula for the entropy weight is introduced in the "data analysis methods" section. See Appendix A for index weights.

3.3. Data

The social system index data were obtained from the questionnaires. Respondents rated each indicator on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Three versions of the questionnaires were designed for managers, local residents, and tourists so that each stakeholder group could assess the other two stakeholders' relationships with the PA. The survey was completed during August and September of 2020, both online (powered by https://www.wjx.cn/) and in person. In order to ensure that the visitors had enough time to complete the questionnaires, the questionnaire for tourists was completed at fast food restaurants near the Erlangjian attraction, the most visited spot in the reserve. Regarding the questionnaire for managers, as the Qinghai Lake Protection and Utilization Administration of Qinghai Province (the management organization) had a total of 152 managers, 61.2% of them completed the questionnaire. For local residents, since most of them can only speak Tibetan, questionnaires were completed with one-to-one help from translators. The survey was conducted in two towns (Heimahe and Jiangxigou) that were more closely related to tourism development. Finally, 700 valid questionnaires were obtained from managers (93), tourists (299), and local residents (308).

Environmental system index data were obtained from the Monitoring Report of QLNR, Tourism Statistics of Qinghai Lake Protection and Utilization Administration of Qinghai Province, China County Statistical Yearbook (County Volume), and China County Statistical Yearbook (Township Volume) from 2009 to 2019.

3.4. Data analysis methods

The equation for the score of the *i*th dimension of the human system is

$$g_i = \sum_{j=1}^{m_i} r_j y_{ij} \tag{1}$$

Table 1
Qualifications of the experts.

Office	Number
Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences	2
Northwest Plateau Institute of Biology, Chinese Academy of Sciences	1
Tourism Administration Office of Qinghai Lake Protection and Utilization Administration of Qinghai Province	2
Department of PAs Management, National Forestry and Grassland Administration in China	2
National Parks and PAs Management Division, Qinghai Forestry and Grassland Bureau	1

where m_i (i = 1, 2, 3, 4, 5, 6) is the number of indicators of the ith dimension, and i = 1, 2, 3, 4, 5, and 6 represent community on PA, tourism on PA, PA on community, tourism on community, PA on tourism, and community on tourism, respectively; r_j and y_{ij} represent the weight and the score of the jth indicator in the ith dimension, respectively.

The equation for the weighted human system scores is:

$$G = \sum_{1}^{n} gi \tag{2}$$

where n (n = 6) is the number of dimensions of the human system.

Data analysis methods for the environment system are as follows:

(1) Standardization of indicator data

We used formulae (3) and (4) to standardize the original data. For a positive index (Zhang et al., 2011)

$$x'_{ij} = \frac{x_{ij} - \min\limits_{1\le j\le n} x_{ij}}{\max\limits_{1\le j\le n} x_{ij} - \min\limits_{1\le j\le n} x_{ij}} \tag{3}$$

and for a negative index

$$x'_{ij} = \frac{\max\limits_{1\le j\le n} x_{ij} - x_{ij}}{\max\limits_{1\le j\le n} x_{ij} - \min\limits_{1\le j\le n} x_{ij}} \tag{4}$$

where x'_{ij} and x_{ij} indicate the standardized and original value of index j in year i (i = 1,2,3…9,10), respectively; $\max\limits_{1\le j\le n} x_{ij}$ and $\min\limits_{1\le j\le n} x_{ij}$ represent the maximum and minimum value of index j over ten years. When x'_{ij}= 0, use 0.0001 instead to avoid the occurrence of null value in the subsequent entropy method algorithm.

(2) Combination of entropy and the AHP weights

The weight obtained through the entropy weight method is an objective weight, which is complementary to the subjective weight obtained by AHP method. Therefore, we combined them on the environment system indicators. The entropy weight method mainly uses the entropy value in information theory to represent the uncertainty of the information, calculates each evaluation attribute's ability to transmit decision information, and calculates the relative weight among attributes (Chen, 2020). The formula is:

$$y_{ij} = x_{ij}' \Big/ \sum_{i=1}^{m} x_{ij}' \tag{5}$$

$$d_j = 1 + \frac{1}{lnm} \sum_{i=1}^{m} y_{ij} ln y_{ij} \tag{6}$$

$$w_j'\prime = d_j \Big/ \sum_{i=1}^{m} d_j \tag{7}$$

$$w_j = \frac{w_j' \times w_j'\prime}{\sum\limits_{i=1}^{m} \left(w_j' + w_j'\prime \right)} \tag{8}$$

where $w_j'$is the weight obtained by the AHP, $w_j'\prime$is the weight obtained by the entropy weight method, $w_j$is the final weight of indicators of the environment system.

(3) Calculation of each dimension score

The dimension scores were calculated based on standardized data. The equation for the ith dimension score is

$$f_i = \sum_{j=1}^{k_i} w_j x_{ij} \tag{9}$$

where k_i (i = 1, 2, 3) represent the index number of the i-th dimension, and i = 1, 2, and 3 indicate the economic, sociocultural, and ecological dimensions, respectively.

(4) Coupling coordination degree model

To study the coupling coordination degree between the three environment system dimensions—economy, society, and ecology—a coupling coordination evaluation model (Li et al., 2012) was built as follows:

$$D_{ij} = \sqrt{C_{ij} \times T_{ij}} \quad , (i,j = 1,2,3) \tag{10}$$

$$C_{ij} = \left(\frac{f_i \times f_j}{\left[(f_i + f_j)/2 \right]^2} \right)^2 , (i,j = 1,2,3) \tag{11}$$

$$T_{ij} = q_i f_i + q_j f_j , (i,j = 1,2,3) \tag{12}$$

where D_{ij} is the coupling coordination degree, which reflects the positive coupling degree and coordination state of the two dimensions, and $D_{ij} \in [0,1]$. 1, 2, and 3 represent the economy, socioculture, and ecology, respectively. C_{ij} is the coupling degree reflecting the degree of the ith and the jth dimensions' influence on each other and $C_{ij} \in [0,1]$ (Tang, 2015). The greater the coupling degree, the stronger the interplay between the two dimensions, and vice versa. T_{ij} reflects the overall level of the ith and jth dimensions (Tang, 2015). q is the weight of the corresponding dimension. It is worth noting that compared to coupling degree, coupling coordination degree further emphasizes inter-dimensional coordination and the positive role between dimensions (Cheng et al., 2019).

The coupling coordination degree among the three dimensions of the environmental system was calculated via the following equations (Sun and Cui, 2018):

$$\mathrm{D} = \sqrt{C \times T} \tag{13}$$

$$\mathrm{C} = \left\{ f_1 \times f_2 \times f_3 | [(f_1 + f_2 + f_3)/3]^3 \right\}^3 \tag{14}$$

$$\mathrm{T} = l_1 f_1 + l_2 f_2 + l_3 f_3 \tag{15}$$

where D is the coupling coordination degree of the environment system. C is the coupling degree, and T is the coordination degree. l is the weight of each dimension.

4. Results

4.1. Results of the social system

Table 2 shows the respondents' sociodemographic characteristics. The tourists gender distribution is balanced (males or females percentages do not exceed 60%). However, there were fewer female respondents among local residents and managers for the following reasons: (i) among the communities around Qinghai Lake, most of whom are Tibetans, males generally have a higher level of education and participate more in public affairs on behalf of their families; (ii) more than 70% of managers in the Qinghai Lake Protection and Utilization Administration of Qinghai Province are male.

Table 2
Respondents' profiles.

		All respondents (700)		Local residents (299)		Tourists (308)		Managers (93)	
		Frequency	%	Frequency	%	Frequency	%	Frequency	%
Gender	Male	445	63.57	202	67.56	177	57.47	66	70.97
	Female	255	36.43	97	32.44	131	42.53	27	29.03
	Total	700	100.00	299	100.00	308	100.00	93	100.00
Age	18 or below	4	0.57	0	0.00	4	1.30	0	0.00
	18–25	55	7.86	28	9.36	24	7.79	3	3.23
	26–30	119	17.00	32	10.70	81	26.30	6	6.45
	31–40	265	37.86	103	34.45	123	39.94	39	41.94
	41–50	167	23.86	91	30.43	48	15.58	28	30.11
	51–60	82	11.71	43	14.38	22	7.14	17	18.28
	60 or above	8	1.14	2	0.67	6	1.95	0	0.00
	Total	700	100.00	299	100.00	308	100.00	93	100.00
Education	Junior high school or below	177	25.29	160	53.51	14	4.55	3	3.23
	Senior high school	111	15.86	57	19.06	53	17.21	1	1.08
	Undergraduate	314	44.86	77	25.75	157	50.97	80	86.02
	Postgraduate or above	98	14.00	5	1.67	84	27.27	9	9.68
	Total	700	100.00	299	100.00	308	100.00	93	100.00
Average monthly income (¥)	3000 or below	170	24.29	132	44.15	32	10.39	6	6.45
	3001–5000	196	28.00	100	33.44	85	27.60	11	11.83
	5001–8000	149	21.29	39	13.04	88	28.57	22	23.66
	8001–10000	92	13.14	13	4.35	44	14.29	35	37.63
	10001–15000	50	7.14	6	2.01	32	10.39	12	12.90
	15000 or above	43	6.14	9	3.01	27	8.77	7	7.53
	Total	700	100.00	299	100.00	308	100.00	93	100.00

The 26–50 years age range was dominant (exceeding 70%), ensuring the respondents' ability to understand and fill-in the questionnaire. Most of the tourists and managers (over 70%) who participated in the survey had received undergraduate education or above. However, over half of the local residents only had a junior high school education or below. Most residents' (over 78%) average monthly income was less than 5000 yuan, which is significantly lower than that of tourists and managers. The low income and low education level of the community further informs us that they possibly lacked sufficient capacity to participate in tourism development and decision-making.

The sum of the weights for the social system was set to 1. The influence of PA on community and community on PA had the same highest weight (0.28), followed by tourism on the community (0.20), tourism on resources (0.13), PA on tourism (0.08), and community on tourism (0.04). The experts considered the PA–local communities relationship the most important factor for developing sustainable PA tourism.

The social system's assessment result is 3.59 (out of 5). As presented in Fig. 4, tourism on community (TC, 3.95) and PA on community (PA, 3.94) are the best performers, followed by community on PA (CP, 3.54), PA on tourism (PT, 3.20), community on tourism (CT, 3.12), and tourism on PA (TP, 2.77). This reflects PA managers' dissatisfaction with the negative effects of tourism on QLNR resources and environment.

4.2. Results of the environment system

The ecological environment had the highest weight (0.53), followed by the economic environment (0.33), and sociocultural environment (0.14), showing the importance of the ecological environment in ensuring sustainable PA environment systems, consistent with the principle of nature conservation.

Based on existing studies (Zhao et al., 2020; Zhou et al., 2016), the coupling coordination degree (D) of the environmental system was divided into five classes (Table 3).

As shown in Table 4, among the three environment system dimensions, the coupling coordination degree (D) was barely balanced (0.47). The coupling coordination degree between economy and socioculture was highest (D_{12}=0.89), followed by that between socioculture and ecology (D_{23}=0.47). However, between economy and ecology, it was slightly unbalanced (only 0.25) and very close to the seriously unbalanced development scale. Clearly, the ecological environment assessment index (f_3) is much higher than the economic index (f_1). This should draw attention to the economic–ecological environments relationship.

4.3. Results of Qinghai Lake tourism system

The BTS proposed by Ko (2001) provides a systemic way of combining the system quality of environment and that of humans into a sustainability index without tradeoffs, followed by the barometer of sustainability (Prescott-Allen, 1997). As shown in Fig. 5, many different combinations of human and environmental sustainability can illustrate each system's level of sustainability. Thus, BTS

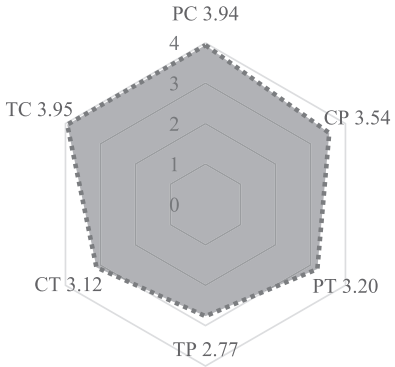


Fig. 4. Evaluation results of the social system.

Table 3
Discriminating standard of coordinated coupling of the environment system.

Class of coordinated coupling	D
Seriously unbalanced development	0.0 <D≦ 0.2
Slightly unbalanced development	0.2 < D≦ 0.4
Barely balanced development	0.4 < D≦ 0.6
Favorably balanced development	0.6 < D≦ 0.8
Superiorly balanced development	0.8 < D≦ 1.0

Source: Adapted from (Zhao et al., 2020; Zhou et al., 2016).

Table 4
The assessment results of the environment system.

Assessment index	f_1	f_2	f_3	T
Score	0.10	0.23	0.35	0.25
The coupling coordination degree	D_{12}	D_{13}	D_{23}	D
Score	0.89	0.25	0.47	0.47

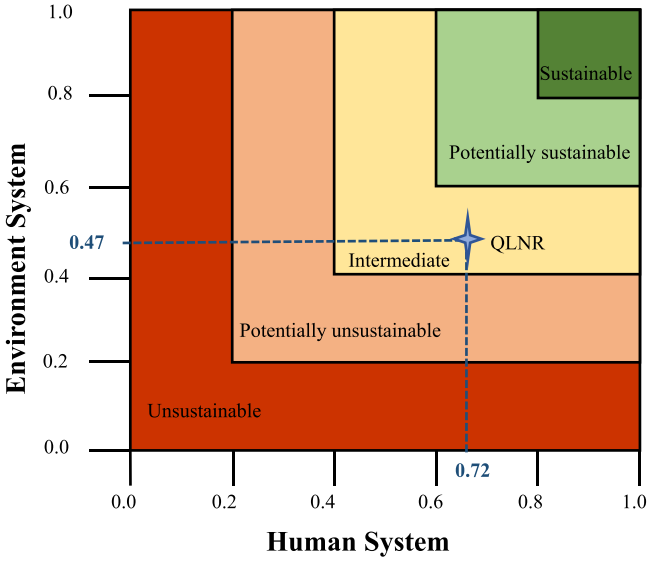


Fig. 5. BTS of Qinghai Lake tourism system.

regards humans and the environment as one system, evaluates not only parts but also the whole system, considers human beings and the environment equally important, and adopts the most appropriate methods and indicators to analyze each problem (Ko, 2005, 2001).

If each system's evaluation results were converted to a full scale of 1, the sustainability of the Qinghai Lake tourism system would be intermediate. In contrast, the sustainability of the human system (0.72) was better than that of the environmental system (0.47). The former belongs to the intermediate interval, whereas the latter is in a potentially sustainable interval.

5. Discussion

5.1. Indicators and weights

The rapidly expanding demand for PA tourism emphasizes the need to provide system sustainability indicators that will contribute toward sustainable tourism, consistent with the primary PA conservation goals. Leung et al. (2018) specified that best practices for sustainable tourism of PA should follow these principles: conserve nature (the fundamental principle), safeguard the environmental and/or cultural qualities, respect the special needs of local communities, ensure viable, long-term economic operations, and provide appropriate opportunities to facilitate meaningful and high-quality visitor experience that aims to build a conservation ethic. The indicators cover the above four aspects and fully consider the fundamental principle and key stakeholders' informed participation (WTO, 2004).

Here, the ecological environment had the highest weightage among the environment system, consistent with other research results (Li, 2004; Yu, 2006) and following the principle of giving priority to the nature protection for tourism in PAs (Leung et al., 2018). Previous studies included economic, social, and ecological environmental indicators on sustainable tourism, but few focused on the inter-dimensional relationships, which, however, can often provide useful information about sustainability (Asmelash and Kumar, 2019; Schianetz and Kavanagh, 2008; Zhang et al., 2017). For example, the evaluation results of the coupling coordination degree of the environmental system remind that we must pay attention to the economic development of the Qinghai Lake tourism system.

In the social system, the weight of the community–PA relationship was the highest. Moreover, it was higher than those in Tsaur et al.'s (2006) and Bhuiyan et al.'s (2016) studies. This reflects the universality of PA–community conflict (Zhang et al., 2020b) and the importance of reducing conflicts to ensure sustainable PA tourism development (Wang et al., 2019) in contrast to the West—there are many residents living in or around PAs in China (Wang et al., 2019; Zhou and Grumbine, 2011).

It should be noted that our aim is to provide a practical sustainability management tool and help managers and other decision makers achieve sustainable PA tourism. However, since there are many types of PAs and tourists' preferences, and surrounding

communities vary greatly in different countries (Zhong et al., 2020), when applied to other types of protected areas, the index system proposed in this study should be modified according to the actual situation to truly reflect the characteristics of case sites.

5.2. Stakeholders

Although there is cooperation in the form of public–private partnerships in the governance of PA tourism in China (Su et al., 2007), tourism operations in most PAs are effectively controlled by the government (e.g., QLNR). This is because natural scenic resources in China are publicly owned (Su et al., 2007; Zou, 2013). Therefore, here, PA managers, local communities, and tourists are the core stakeholders of the social system assessment. However, for some PAs, including private ones, where the government does not actually run tourism, tourism operators, NGOs, and other core stakeholders should participate in the sustainability evaluation of PA tourism.

Tourists should be considered important stakeholders in sustainable tourism research as their feedback provides valuable information for improving visitor behavior and sustainable tourism management (Rasoolimanesh et al., 2020). As for the Qinghai Lake tourism system, only by understanding the attitudes and preferences of tourists can the economic benefits of tourism be improved. Ultimately, tourists pay for their destination experience.

Furthermore, community participation assessment in the current study is also necessary for the following reasons: (1) their livelihood is directly or indirectly related to resources in PAs, (2) communities firstly bear the tourism–related development costs, and (3) participation enhances communities sense of belonging and ownership (Wondirad et al., 2020).

5.3. Qinghai Lake tourism system

The Qinghai Lake tourism system requires further improvements to reach a sustainable level, especially regarding the environmental system. The coupling coordination degree between economy and ecology is only 0.25 (slightly unbalanced), suggesting an urgent need to improve the lake's tourism economic efficiency than its ecological environment.

The social system is potentially sustainable based on BTS. Evidently, local communities, managers, and tourists are satisfied with their mutual relationship. Tourists awarded lower scores for environmental education indicators (B211) and interaction between residents and tourists (B314), expressing their desire for an interpretation service and interaction with the local community, both of which they expressed during our interviews. This supports Chinese tourists' view of PA tourism as not only nature tourism, but also as a cultural experience (Xu et al., 2014); environmental education programs are still few in many PAs in China (Xu et al., 2013).

The managers' lower indicator scores (B222, B223, B123, B124) expressed their frustration with the negative impact of tourists and local residents on the biophysical environment and wildlife. Although illegal construction has been stopped and the ecological environment effectively improved, tourist and community management remain a challenge for managers.

According to the evaluation results, we put forward the following suggestions for sustainable tourism management in QLNR:

(1) First, accommodation and catering services should be set up in towns around the reserve and recreational activity in or visits to specific areas in different seasons should be restricted to reduce the negative impact on the wetland and wildlife. The key is to develop diverse cultural experiences and ecotourism programs to attract visitors to these areas.
(2) Second, a variety of friendly environmentally recreation services should be provided to enable tourists to acquaint themselves with environmental education and the mysterious Tibetan culture, encouraging them to spend more money locally. In this way, local communities and PAs can earn more tourism revenue. Simultaneously, the economic environment would become more sustainable.
(3) Third, communities should be empowered by education and training, and they should be provided with more opportunities to participate in tourism services, planning, and decision-making. For example, local communities can be trained to participate in environmental interpretations. This will not only increase the community's environmental awareness and provide them with a new way of living, but also tourists will have more opportunities to communicate with the local community.

6. Conclusion

PA tourism is a complex human-environment system. Sustainable development requires not only harmonious relationships among stakeholders, but also coordinated development among the economy, socioculture, and ecological environment. Although previous studies have proposed indicators for the sustainability of tourism in PAs related to the human system or the environment system, these have rarely paid attention to both systems simultaneously, and the relationships between the internal elements of the system have usually been ignored. To fill these gaps, this paper makes the following contributions: (i) it establishes an evaluation framework for sustainable PA tourism including stakeholders and the environmental system based on the human-environment system framework from the perspective of the complex adaptive tourism system; (ii) it applies the relationship framework of PA–community–tourism and the coupling coordination theory to reflect the relationships among stakeholders and different dimensions of the environmental system; (iii) it identifies a set of indicator systems in accordance with characteristics of tourism in PAs, which combine the advantages of subjective indicators to evaluate stakeholder perceptions and objective indicators to reflect environmental changes.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.gecco.2022.e02074.

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