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Identifying conflicts tendency between nature-based tourism development and ecological protection in China

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ABSTRACT

Developing spatial regulation strategies is important for nature-based tourism, and this procedure could be more rational and scientific with the understanding of the spatial distribution of conflicts tendency between tourism development and ecological protection. In this study, we developed an Indicator of Conflict tendency between nature-based Tourism development and ecological Protection (ICTP), based on the combination of landscape attractiveness and ecological sensitivity. By integrating land cover, topography, climate and other datasets, this paper presents the spatial distribution of the ICTP in the study area in China. The results show that most areas of China have a low or medium ICTP. Areas with very high ICTP account for 13.79% of the studied areas, including the central part of the Inner Mongolia Plateau, northern part of the Loess Plateau, southwestern part of the Northeast Plain, north and south sides of Tianshan Mountains, coast of Bohai Bay and coastal areas of Jiangsu and Zhejiang Province. These areas are mainly confronted with problems of desertification, salinization and soil erosion. 11.09% of studied areas have very low ICTP, mainly located in the Tarim Basin and western part of Inner Mongolia Plateau, characterized by low landscape attractiveness and low ecological sensitivity. Our results can inform decision makers with regard to where are most likely to suffer from ecological problems caused by nature-based tourism activities, and to which types of problems that are likely to arise. Such information can help decision makers forecast the developmental trend of the relationship between nature-based tourism development and ecological protection, further determine the degree of control on nature-based tourism. The study developed the basic framework for measuring the conflict tendency of nature-based tourism development and ecological protection, which can inspire researchers to think about factors that should be considered when measuring such tendency.

1. Introduction

Nature-based tourism has experienced a rapid growth in many countries and regions in recent years (Balmford et al., 2009), bringing economic benefits to local communities, and thus contributing to poverty alleviation. However, nature-based tourism also caused several ecological problems (Hall and Härkönen, 2006; Monz et al., 2013). These problems can be attributed to complex reasons, such as unreasonable tourism planning, excessive construction of tourism facilities, and poor management of tourism flows (Tang, 2015). As a result, the quality of natural tourist attractions could be negatively affected by these ecological problems, and such deterioration is detrimental to the sustainable development of nature-based tourism.

China also experiences the same problems during the rapid development of nature-based tourism. A study carried out from 2009 to 2010 with the support of the Ministry of Environmental Protection of the People's Republic of China[1] and the China National Tourism Administration[2], showed that at least 1033 protected areas in China have developed nature-based tourism activities. Among them, 53% suffer from garbage pollution, 23% suffer from damage of protected objects, and 22% suffer from air pollution (Zhong and Wang, 2011). Moreover, according to the summary report of the "Green Shield 2017[3]", over

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[1] Later renamed the Ministry of Ecology and Environment of the People's Republic of China.

[2] Later renamed the Ministry of Culture and Tourism of the People's Republic of China.

[3] The "Green Shield 2017" is a special action of supervision and inspection focusing on national nature reserves launched in 2017 jointly organized by 7 departments: The Ministry of Environmental Protection, the Ministry of Land and Resources, the Ministry of Water Resources, the Ministry of Agriculture, the Forestry Bureau, the Chinese Academy of Sciences, the Oceanic Administration, of the People's Republic of China.

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20,000 clues of ecological problems involving national nature reserves were detected in China. These ecological problems are mostly caused by unreasonable exploitation of resources, including but not limited to unreasonable tourism development.

Under ideal circumstances, nature-based tourism development and ecological protection could be able to reach a balance situation in which economic profit and ecosystem conservation can be sustainable optimized (Fadafan et al., 2018). However, ecological problems will occur when the intensity of the tourism activity exceeds ecological carrying capacity, leading to conflicts between nature-based tourism development and ecological protection (Shi et al., 2015; Lu et al., 2009; Wu, 2005; Yang and Wang, 2000).

The word "conflict", originated from sociology, originally referred to the contradiction between different interest groups on usage of certain resources (Owens, 1985). A conflict is a process of confrontation between two or more individuals (or groups) in one space. This kind of confrontation usually comes down to the divergence and competition of interests. The competition objects include natural resources and social resources. Conflicts between social groups include economic conflicts, political conflicts, etc., and such conflicts often target items with clear property rights. For instance, the conflict caused by the different interests on tourism resources among local residents, tourist companies, financial investors, different departments of governments like the bureaus on environment and the bureaus on economic development, bureaus of agriculture and/or forestry, poverty alleviations, etc. Such conflicts will cause certain damage to the social structure, but they will also stimulate social progress to some extent. Another type of conflict occurs between human society and natural ecosystem (Gundersen et al., 2019; Fang and Liu, 2007; Liu et al., 2006). The occurrence of such conflicts is often attributed to overuse or destructive use of natural resources by human, particularly of those resources with unclear property rights. For instance, the vigorous exploitation of oil or gas in a national park (Rabanal et al., 2010), the excessive construction of a railway in national park (Murray et al., 2017), the over-presence of industrial manufacturing enterprises along cost lines (Tian et al., 2016), the construction of a dam that damaging wildlife habitats (Czerniawski et al., 2010), the overharvesting on species that leading to a sharp decline in populations (Borowik et al., 2018), deforestation in the national park that negating the effect of sustainability (Phumee et al., 2018). In such cases, natural resources suffer from over-used or destructive-used, resulting in problems such as resources reduction and quality degradation which will inhibiting the further development of human society, thus creating a conflict between resource utilization and environmental protection.

Conflicts between nature-based tourism development and ecological protection belongs to the category of conflict between man and nature, which may bring serious negative impacts on tourism-ecological systems. Therefore, managers need to adopt strategies to control the development of tourism in order to prevent the occurrence of conflicts, such as the restriction to the number of visitors in specific areas (Gundersen et al., 2019). However, the excessive control may limit regional development as tourism is a profitable industry that providing numerous opportunities for economic development (Engelhardt et al., 2004). Thus, determining the proper control degree on tourism activities according to conflict tendency between nature-based tourism development and environmental protection becomes a feasible method to manage such conflicts.

Conflict tendency is a predictable indicator of the possibility of conflict (Chu et al., 2016), which is dependent on the degree of competitiveness between different natural resource utilization, or on the difference in the value orientation of resource utilization (Barrow, 2010; Brody et al., 2004): the greater the difference, the greater the likelihood of a conflict and the greater the control degree that needs to be taken. Recently, the concept of conflict tendency has gradually been employed in tourism research (Chu et al., 2016). Previous studies have shown that conflicts tendency may have spatial variations, mainly because different areas have different environmental characteristics and are therefore subject to different degree and type of pressures from tourism activities. For example, in areas where nature-based tourism activities are frequent, vegetation destruction and soil compaction are more serious (Wolf and Croft, 2014; Rankin et al., 2015). In addition, nature-based tourism activities carried out in sensitive and fragile environments are more likely to trigger ecological problems (Leman et al., 2016). Nahuelhual et al. (2013) identified tourism hotspots in Ancud, Chile, by using a combination of land cover, vegetation coverage and other indicators. They found that these areas are widely overlap with areas of high ecological sensitivity and thus suggested specific control measures to prevent the occurrence of ecological problems in these areas.

Although several studies have noted that some regions are more likely to experience conflict than others, e.g. areas where nature-based tourism activities are frequent, areas with sensitive and fragile ecosystem (Wolf and Croft, 2014; Rankin et al., 2015; Leman et al., 2016), few have attempted to quantitatively measure the conflict tendency between nature-based tourism development and ecological protection, nor to spatially express the results. Our present study aims to fill this gap, by focusing on two issues: i) constructing an indicator to present the conflict tendency between nature-based tourism development and ecological protection spatially explicit; ii) exploring the spatial pattern of the ICTP and its influencing factors in the study area of China (excluding Hong Kong, Macao, Taiwan and part of the ocean and island territory due to missing data). Specifically, we used theories related to ecology, tourism, and sociology to construct a conceptual framework to measure conflict tendency between nature-based tourism development and ecological protection, and consequently explored the spatial distribution of conflict tendency in the study area of China by using statistical methods. After that, the feasibility of the proposed ICTP has been verified with the analysis of several recent ecological events, followed by the discussion about the implications of the ICTP for practice.

This study aims at providing decision makers with an indicator leading to reasonably determination on the degree of control on tourism development on a large spatial scale, thus reducing the occurrence of ecological problems caused by nature-based tourism activities, and further formulating a more comprehensive strategy for the sustainable development of tourism through the utilization of this indicator. The presented framework could inspire researchers to identify critical factors when measuring conflict tendency between nature-based tourism development and ecological protection, and to get a profounder cognition of how these factors will affect the evaluation results. This framework is expected to scale well with large numbers of spatial data and to be easily transferable to different regions.

2. Methodology

2.1. Study area

The present study focused on most areas of China (excluding Hong Kong, Macao, Taiwan and part of the ocean and island due to missing data), involving 31 provinces (Fig. 1). The study area is located between 3°N-53°N, 73°E-135°E, with an area of approximately 9.57 million km^2. The study area has a good basis for nature-based tourism development. On the one hand, the study area has a rich and diverse natural ecosystem, including forests, grasslands, wetlands, deserts and other ecosystems. These constitute the resource base for nature-based tourism development; on the other hand, the study area has a large population. In 2017, the population of the study area was about 1.3 billion. With the development of economy, the per capita GDP in the study area in 2017 has exceeded 8000 dollars. This has created good market conditions for nature-based tourism development. In recent years, tourism in the area has developed rapidly. In 2018, the number of domestic tourist trips increased 10.76 percent to 5.539 billion and tourism revenue increased 12.3 percent to 513 million in the study

Fig. 1. The study area (excluding the grey areas, i.e. Hong Kong, Macao, Taiwan and part of the ocean and island).

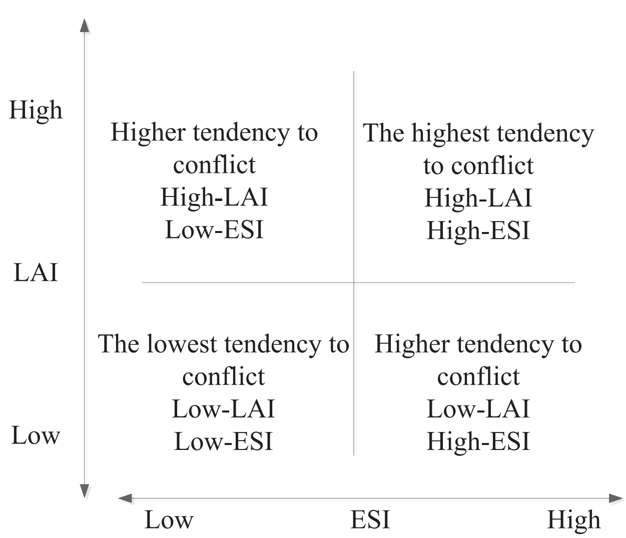

Fig. 2. Conceptual framework of conflict tendency between nature-based tourism development and ecological protection.

area, compared with 2017.

2.2. Conceptual framework and calculation procedure

Previous studies have found that although nature-based tourism activities have some adverse impact on environment, this does not mean that all areas in which such activities occurs will suffer from ecological problem (Willian and David, 1998). Whether nature-based tourism activities would cause ecological problems or not also largely depends on tourism intensity, such as the degree of tourist crowding and the construction of tourism facilities. People will choose space with specific characteristics for nature tourism activities. In the general case, a higher landscape attractiveness results in a higher intensity of tourism activities for a single spatial unit.

However, ecological problems may not be explained only by the intensity of tourism activities. In areas exhibiting a strong anti-interference ability and high resilience, high-intensity tourism activities are less likely to cause ecological problems (Fadafan et al., 2018). Therefore, in order to fully understand the mechanisms underlying ecological problems, we must also consider ecological sensitivity—that is, the possibility that the ecological status of the environment will be depart from the equilibrium due to disturbances. It can be inferred that high ecological sensitivity, combined with a high influence of tourism activities on the environment, resulting in a greater possibility of ecological problem.

Thus, it can be deduced that the region has both a high landscape attractiveness and a high ecological sensitivity is more prone to conflicts between nature-based tourism development and ecological protection. Based on this assumption, this study proposes an Indicator of Conflict Tendency between nature-based tourism development and ecological Protection (ICTP), which aims to measure the possibility of conflict between nature-based tourism development and ecological protection (Fig. 2). The ICTP is calculated using the following formula:

$$ICTP_i = LAI_i \times ESI_i \tag{1}$$

where $ICTP_i$ is the conflict tendency indicator of grid *i*; LAI_i is the landscape attractiveness indicator of grid *i*; and ESI_i is the ecosystem sensitivity indicator of grid *i*. ITCP across the study area was calculated based on the approach presented in methodology section, and then normalized through the Min-Max Normalization technology (Westers et al., 2017). In order to clearly describe the spatial distribution of ICTP, a hierarchical classification description of ICTP is required. The classification approach including Equal Sequence Method, Jenks Natural Breaks and so on. Among these, Jenks Natural Breaks is a method of grading data sets based on the discontinuity of data sets as a basis for grading. It can effectively deal with the problem of hierarchical classification, thereby is often used in evaluation research (Peña et al., 2015).

2.2.1. Landscape attractiveness index

Following the previous study on landscape attractiveness, we selected eight spatial explicit indicators as the contributing factors of ICTP, they are naturalness (NL); water proximity (WP), protected area proximity (PA), landscape diversity (LD), vegetation coverage (VC), altitude suitability (AS), relief suitability (RS) and climate comfort (CC) (Hernández-Morcillo et al., 2013). These eight indicators are used to calculate the Landscape Attractiveness Index, using the following formula:

$$LAI_j = \sum_{i=1}^{n} \alpha_i x_{ji} \tag{2}$$

where LAI_j represents the LAI of grid *j,* and α_i represents the weight coefficient of factor *i*. Jenks Natural Breaks is used to classify the types of areas with different LAI. Due to the large area on which the study focus, the equal weight method (i.e., setting weight = 1) was used to strengthen the applicability of the results across the study area. This method was used also by Peña et al. (2015) in the relevant study on EU region. x_{ji} represents the value of the single factor *i* of grid *j*, $n = 8$. The explanation of these factors and their assignment are briefly presented below (Table 1).

NL is the extent to which the Earth's surface has not been disturbed by humans (Wrbka et al., 2004). The higher the naturalness, the higher the landscape attractiveness. Naturalness is closely related to the land use and land cover (LULC). In general, forests, swamps, glaciers, and snow have a high naturalness, and farmland and construction land have a low naturalness (Peña et al., 2015). According to the LULC database provided by the Chinese Academy of Sciences Resource and Environment Data Center (http://www.resdc.cn/first.asp), the LULC in China could be group into 24 types, e.g. paddy fields, dry land and urban land (Table 1). Based on remote sensing satellite image data originated from Landsat 8 OLI and GF-2, among others, we adapted according to the Chinese LULC remote sensing mapping classification system designated by Liu et al, and then applied combined technical system including high-resolution remote sensing, drone and ground observation as well as human–computer interaction interpretation method based on geoscience knowledge. This resulted in a LULC vector data set of 2015 and eventually resulted in the LULC data of 2015 with a resolution of 1 km. The comprehensive evaluation accuracy of the first-level classification is over 93%, and the comprehensive accuracy of the second-level classification is over 90% (Ning et al., 2018). Using the classification for naturalness of different land cover types proposed by Peña et al.(2015), combined with China's Land Use and Land Cover (LULC) classification system, we assigned the NL of each evaluation unit a score from 1 (lowest) to 7 (highest).

WP reflects the spatial proximity of the grid cells to a water body (i.e. lakes, swamps). Water bodies not only have a high aesthetic value, but also provide people with many recreational opportunities, such as fishing and swimming. Therefore, landscape attractiveness is higher in the vicinity of a water body (Sievänen and Neuvonen, 2011; Jensen, 2003; Sen et al., 2011). We calculated the Euclidean distance between

Table 1
Classes of the proxy variables of landscape attractiveness in China.

Assessment indicators	Assigned score						
	1	2	3	4	5	6	7
Distance to the protected area (PA)	> 46.73 km	(155.33 km, 246.73 km]	(89.28 km, 155.33 km]	(41.48 km, 89.28 km]	≤41.48 km	–	–
Landscape diversity (LD)	> 47.21 km	(34.93 km, 47.21 km]	(23.17 km, 34.93 km]	(14.02 km, 23.17 km]	≤14.02 km		
Distance to water (WP)	> 9.85 km	(5.72 km, 9.85 km]	(2.86 km, 5.72 km]	(1.14 km, 2.86 km]	≤1.14 km		
NDVI (VC)	≤0	(0, 0.3]	(0.3, 0.5]	(0.5, 0.7]	> 0.7		
RDLS (RS)	> 8	(6–8]	(4–6]	[0, 0.5)&(3–4]	[0.5, 3]		
Elevation (AS)	> 5.5 km	(4 km, 5.5 km]	(3 km, 4 km]	(2 km, 3 km]	≤2 km		
TCS (CC)	< −1.5	[−1.5, −1.0)	[−1.0, −0.5)	[−0.5, −0.2)	[−0.2, 0]		
LULC (NL)	Paddy fields, dry land, urban land, rural settlements, other construction land	Bare land, bare rock texture	Gobi and Sandy Land	Beach land, other woodland	Low-coverage grasslands, saline-alkali lands, reservoir pits, sparse woodlands, river channels	Medium Coverage Grassland, Shrubbery	Forest lands, high-coverage grasslands, permanent glaciers, mudflats, lakes, swamps

Note: when "Distance to the protected area > 246.73 km", the "PA" index will be assighed "1", the rest can be done in the same manner.

the evaluation unit and the nearest water body (extracted from the LULC database) and used the natural breakpoint method to assign the WP of each unit a score from 1 (lowest) to 5 (highest) (Onaindia et al., 2013).

PA refers to the spatial proximity of an unit to a protected area. Protected areas are defined as a concentrated area of unique natural landscapes. Space units located in or near protected areas often have a high natural tourist attraction (Maes et al., 2012). We calculated the Euclidean distance between the grid cell and the protected area, and used the natural breakpoint method to assign the PA of each unit a score from 1 (lowest) to 5 (highest). The protected area data was extracted from The China Database on National protected area constructed by Research Center for Eco-Environmental Sciences of Chinese Academy of Sciences (http://www.ecosystem.csdb.cn/cnnr/index.jsp) and The World Database on Protected Areas built up by International Union for Conservation of Nature (https://www.protectedplanet.net/c/world-database-on-protected-areas). As of April 2017, there are 3294 national protected areas, including 225 national scenic areas, 447 national nature reserves, 718 national water conservancy scenic spots, 826 national forest parks, 242 national geological parks, and 836 national wetland parks in China. Using Google Maps and ArcGIS software, we extracted the geographical coordinates of the centers of gravity of each protected area (Zhu et al., 2017) to create 3294 map points.

LD refers to the number of landscape types present in a certain spatial range. The greater the number of landscape types, the more opportunities for tourists to appreciate diverse natural landscapes, and the more attractive the landscape. Following the method developed by Nahuelhual et al. (2013), landscape diversity was evaluated as the mean value of the shortest Euclidean distance between the grid and the nearest protected area. The smaller the mean, the higher the landscape diversity. Using the natural breakpoint method, the LD of each unit was assigned a score from 1 (lowest) to 5 (highest).

VC is a strong indicator of the ecological status of a region (Lamchin et al., 2015). The higher the vegetation coverage, the higher the landscape attractiveness (Perren, 2014). Vegetation coverage can be expressed using the Normalized Difference Vegetation Index (NDVI). NDVI weakens the influence of the atmosphere and of terrain shadows, and is very sensitive to surface vegetation coverage (Pettorelli et al., 2005). Therefore, it is a commonly used indicator of the status and dynamics of vegetation coverage. NDVI data used in this research were derived from MOD13Q1, NASA's MODIS vegetation indicator product provided on Geospatial Data Cloud (http://www.gscloud.cn/sources/?cdataid=265&pdataid=10). These data were geometrically and atmospherically corrected, and synthesized every 16 days using the maximum synthesis method, at a spatial resolution of 250 m. We selected images covering the period from April to October 2015; then, we used the Envi5.3 software to pre-process the original image, and used the ArcGIS software to perform projection rastering, resampling, and other processing. Following the vegetation status corresponding to the NDVI, the VC of each unit was assigned a score from 1 (lowest) to 5 (highest).

AS refers to the degree of altitude that is suitable for nature tourism. Altitude is closely related to the oxygen content of the air. As the altitude rises, the oxygen content of the air decreases, and the human body can experience a phenomenon of hypoxemia resulting in a sense of discomfort, which is not conducive to the carrying out of nature tourism activities. Based on the classification criteria proposed by Chang et al. (2007), we assigned the AS of each unit a score from 1 (lowest) to 5 (highest). The elevation data used in this study have been taken from the Chinese Academy of Sciences Resource and Environment Data Center (http://www.resdc.cn/first.asp).

RS refers to the relief degree of land surface (RDLS) that is suitable for nature-based tourism. A certain amount of relief can increase aesthetic quality, but the Earth high RDLS will hinder the development of tourism activities. Therefore, there is a nonlinear correlation between RDLS and landscape attractiveness. The calculation of RDLS is based on the method proposed by Feng et al. (2007) and Hao and Ren (2009). The specific formula used is:

$$R = \{[max(H) - min(H)] \times [1 - P(A)/A]\}/500 \tag{3}$$

The dependent variable R is RDLS; max(H) and min(H) respectively represent the highest and lowest elevations in the area (in m); P(A) represents the flatland area (in Km^2), i.e., the area with a slope of less than 5°; A represents the total surface area. The setting of the window size in the neighborhood analysis is based on the research of Tang and Yang (2012). Following the relationship between relief and tourism attractiveness mentioned above, we assigned the RS of each unit a score from 1 (lowest) to 5 (highest).

CC comprehensively considers the principle of heat exchange between the human body surface and the near-surface atmosphere. Climate comfort is directly proportional to the attractiveness of the landscape. We used the Tourism Climate Suitability indicator (TCS) proposed by Ma et al. (2009) to express climate comfort. This indicator combines the temperature and humidity indicator (THI), the wind-cold indicator (WCI), and the clothing indicator (ICL). Studies on the eastern coast of China, southwest China and other regions have confirmed the validity of this index (Cao et al., 2012; Pan et al., 2011). Its formula is as below:

$$TCS = 0.6 \times THI + 0.3 \times WCI + 0.1 \times ICL \tag{4}$$

$$THI = T - 0.55 \times (1 - F) \times (T - 14.4) \tag{5}$$

$$WCI = -10\sqrt{V} + 10.45 - V \times (33 - T) + 8.55 \times S \tag{6}$$

$$ICL = (33 - t)/0.155H - (H + aRcos\alpha)/(0.62 + 19.0\sqrt{V})H \tag{7}$$

where T represents temperature (in °C); F represents relative humidity (%); V represents wind speed (in m/s); S represents daily sunshine hours (h/d); H represents the 75% of the body's metabolic rate (in W/m^2), for which we considered the metabolic rate of light activity, with $H = 87\,W/m^2$; a represents human body's absorption of solar radiation, for which we took the value of$a = 0.06$; R indicates the solar radiation received by the unit area of vertical sunlight (in W/m^2); and α is the solar elevation angle. Following Cao et al. (2012), the CC of each unit was assigned a score from 1 (lowest) to 5 (highest). The meteorological observation data (i.e. temperature, relative humidity, wind speed, and sunshine hours) in this study were taken from the National Weather Information Center (http://data.cma.cn/data/cdcindex/cid/6d1b5efbdcbf9a58.html). The monthly data of 829 meteorological stations nationwide were used, covering the period from June to September 2016. We used the ANUSPLIN software to generate spatial data through meteorological interpolation.

2.2.2. Ecological sensitivity

Ecological sensitivity refers to the extent to which ecosystems respond to disturbances from tourism activities and reflects the degree of likelihood of regional ecological environmental problems (Pan et al., 2011): the more ecologically sensitive a region, the more likely it is that human tourism activities will cause ecological problems.

Numerous studies have shown that tourism activities have an impact on the state of vegetation, soil, hydrology, and biodiversity (Hall and Härkönen, 2006; Cao et al., 2016; Hammitt and Cole, 2011), trigger different kinds of ecological problems. For example, the state of soil and vegetation have a direct impact on desertification, the state of lithology and vegetation have a direct impact on soil erosion, the state of geology, landforms, and climate affect the possibility of soil salinization. All these show that tourism activities may cause ecological problems like soil erosion, desertification, rocky desertification and salinization. Therefore, this study mainly considers desertification sensitivity, soil erosion sensitivity, rocky desertification sensitivity and salinization sensitivity.

Generally, once an ecological problem hits a region, no matter what kind of the problem, the whole ecosystem of this region will suffer from serious damage (Chen and Wu, 2018). Therefore, the short board method is usually adopted when assessing ecological sensitivity (NDRC, 2015) at national and regional scales. This method is generally considered to be applicable and scientifical (Xiong et al., 2018). The short board method takes the maximum value of the results of different types of sensitivity assessments. Therefore, we used the following formula for the calculation of the Ecological Sensitivity Index:

$$ESI_i = max\{DS_i, RDS_i, SES_i, SSS_i\} \tag{8}$$

where ESI_i represents the ecological sensitivity indicator of the grid i; DS_i represents the desertification sensitivity; RDS_i represents the rocky desertification sensitivity; SES_i represents the soil erosion sensitivity; andSSS_i represents the soil salinity sensitivity. The ecological sensitivity data were collected from the Ecological Center of the Chinese Academy of Sciences (http://www.ecosystem.csdb.cn/ecoass/ecoassess_list.jsp?func=mgx). All these parameters were assigned a score from 1 (lowest sensitivity) to 5 (highest sensitivity), and divided into five categories: least sensitive, less sensitive, averagely sensitive, very sensitive, and particularly sensitive, respectively. According to Eq. (8), ESI of the study areas can be divided into five categories: very low (ESI = 1), low (ESI = 2), medium conflict (ESI = 3); high (ESI = 4), and very high (ESI = 5).

The spatial resolution of all raster data was unified to 1 km through adjacent resampling (Tang and Yang, 2012), and using the ALBERS authalic conical projection. It should be noted that, although the observation time of these data is not completely consistent, since the changes of natural elements within decades timeframe is tiny, it is reasonable to use different periods of data to solve a single problem. The same method have been applied in relevant studies, e.g., study on Argentina's recreational potential (Weyland and Laterra, 2014) and on recreational ecosystem services of Region of Magallanes and Chilean Antarctica (Nahuelhual et al., 2017).

2.3. The coefficient of variation (CV)

The Coefficient of Variation (CV) is used to measure the degree of spatial variation of LAI and its influencing factors, ESI and ICTP. The CV is calculated using the following equation:

$$CV = \frac{1}{\bar{Y}}\sqrt{\frac{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}{n-1}} \times 100\% \tag{9}$$

where $\bar{Y}$ is the exponent mean; n is the number of spatial units; and Y_i is the exponent value of each spatial unit: the larger the CV, the greater the relative gap between the indicator values of different spatial units. We divided the CV into three categories: low degree of variation (0–0.5); medium degree of variation (0.5–1); and high degree of variation (1 or more).

3. Results

3.1. The spatial pattern of the ICTP in China

According to the results of Jenks Natural Breaks method, ICTP of the study areas can be grouped into five categories: very low conflict tendency (0, 0.09], low conflict tendency (0.09, 0.27], medium conflict tendency (0.27, 0.42], high conflict tendency (0.42, 0.57] and very high conflict tendency (0.57, 1]. As Fig. 3 shows, the ICTP is low in most areas (33.56%), mainly located in the southeastern region, the Qinghai-Tibet Plateau and the Changbai Mountains. The overall spatial variation coefficient of ICTP is 66.33%, indicating a large difference in ICTP of each evaluation unit.

The areas with very high ICTP account for 13.79%, mainly distributed in the central part of the Inner Mongolia Plateau, northern part of the Loess Plateau, southwestern part of Northeast Plain, north and south sides of Tianshan Mountains, Bohai Bay coast and coastal areas of Jiangsu and Zhejiang. When considering landscape attractiveness only, these areas are suitable for natured-based tourism since the landscape attractiveness of these areas is at a level of high or very high. However, tourism activities in these areas is also prone to ecological problems when considering the ecological sensitivity of these areas. For different areas, the types of ecological problems which likely to be caused by tourism activities are different. For instance, the central part of Inner Mongolia Plateau has high risks of desertification and salinization; the northern part of Loess Plateau and southwestern part of Northeast Plain have high risks of desertification and soil erosion; the north and south sides of Tianshan Mountains as well as Bohai Bay have high risks of salinization and desertification; and the coastal areas of Jiangsu and Zhejiang have high risks of salinization.

High ICTP areas account for 16.14%, mainly distributed in the northern part of North China Plain, northern part of Greater Xing'an Mountains, Qaidam Basin and southeastern side of Tianshan Mountains. Most of the areas have medium to high landscape attractiveness, which could provide the advantageous support for tourism development. However, the ecological sensitivity of most parts of these areas are high to very high, indicating high risks of soil desertification and salinization.

Areas with medium ICTP are around 25.42% in proportion, mainly distributed in the central part of North China Plain, the Xiaoxing'anling and the Northeast Plain. Very low ICTP areas account for 11.09% and are mainly distributed in the northwest region, including the Tarim Basin and western part of Inner Mongolia Plateau. Most of such areas have low landscape attractiveness. Thus, it is not conducive to development of nature-based tourism from the perspective of resources and environment. Meanwhile, the ecological sensitivity of these areas is also very low. Therefore, in those areas, tourism activities are less likely to cause ecological problems such as soil erosion, salinization, desertification or rocky desertification.

3.2. The influencing factors of the ICTP in China

The spatial pattern of the ICTP in China is the result of the interaction effect of both landscape attractiveness and ecological sensitivity. The following sub-sections present the results of the analyses regarding the spatial patterns between these two indicators.

3.2.1. Landscape attractiveness

According to the results of Jenks Natural Breaks, LAI of the study areas can be divided into five categories: very low (0, 0.03], low (0.03, 0.47], medium (0.47, 0.63]; high (0.63, 0.77], and very high (0.77, 1]. Fig. 4 shows the distribution of landscape attractiveness across areas in China. Among the regions, areas that are classified as very high account for 19.45% of the study area. This proportion is greater than the proportion of protected areas within the total area (i.e., about 18%) (China Daily, 2017). In addition, the high LAI areas account for the most of the study area. This indicates that China has still large areas with very high landscape attractiveness yet currently located outside protected areas.

Areas with very high LAI mainly locate in the eastern part of the Northeast and Southern part of China, and the western part of Tianshan Mountains. The eastern part of Northeast have many large rivers, such as the Heilongjiang and Ussuri rivers, and the waters are highly accessible. Moreover, there are old-growth forests, such as the Daxing'anling and Changbai Mountain old-growth forests, resulting in a high vegetation coverage. The Southern part of China enjoys the advantages of several kinds of natural features, such as vegetation and topography, while at the same time they are suitable for human habitation. Therefore, only a few regions have advantages in all the eight aspects of landscape attractiveness discussed in this study, while most regions enjoy only advantages other than naturalness. The western part of Tianshan Mountains is dominated by low-grade gentle slopes, and relief suitability and altitude suitability are relatively high. There are several types of protected areas here, resulting in high values of

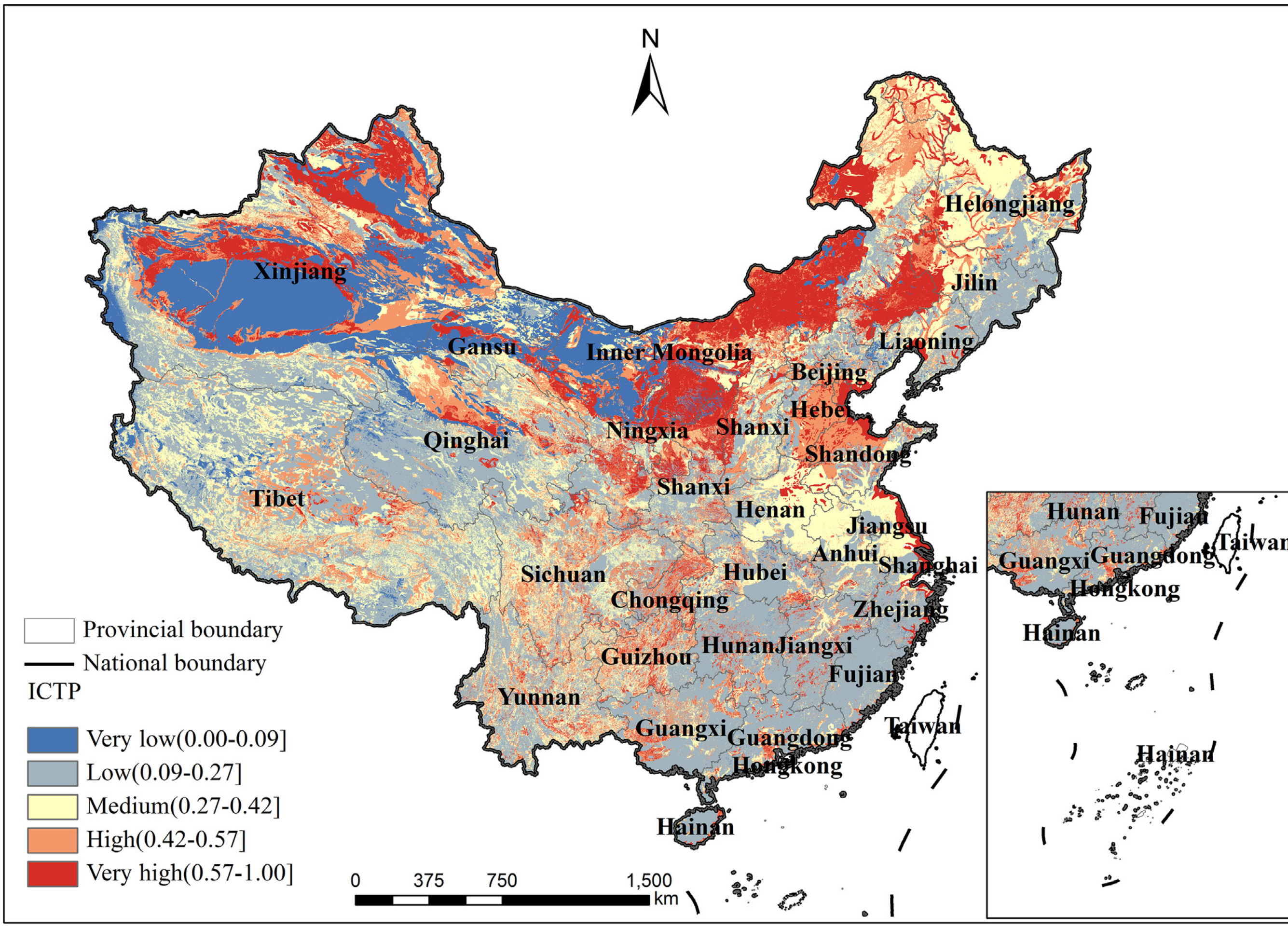

Fig. 3. The spatial pattern of the ICTP.

proximity to protected areas and of landscape diversity, they are also less disturbed by humans and have high naturalness as well as high vegetation coverage due to multiple vegetation types such as mountain grasslands and coniferous forests. And eventually, they have high scores of protected area proximity and of landscape diversity because of a variety of protected areas.

The areas that have been classified as low in attractiveness are concentrated in the western part of Qinghai-Tibet Plateau; their low scores are mainly due to their altitude suitability and climate suitability, which are far below the national average. The elevation of the western part of Qinghai-Tibet Plateau exceeds 5500 m and the climate is very cold. In addition, vegetation coverage and landscape diversity are also low, making this area very inappropriate for nature-based tourism activities.

It can be seen that the spatial variation of LAI in China is relatively small (CV = 27%), with higher values in the southeast and lower values in the northwest. This pattern of spatial differences is formed by the combined effects of eight factors (see Fig. 5). According to their spatial variability, these factors can be divided into three categories: strongly allogenic, moderately allogenic, and weakly allogenic.

Relief suitability is the only strongly allogenic factor (CV = 150%). This reflects the great difference in relief suitability between regions. The low average value of relief suitability (only 1.38) indicates that, for most regions, terrain relief constitutes a constraint factor for nature-based tourism development. From the spatial point of view, the area that is most constrained by topography is the so-called "one-district three-zone" area, i.e., the southeastern Tibet – Hengduan Mountain district, Tianshan Mountains zone, Kunlun Mountains – Qilian Mountains zone, and Daxinganling – Taihang Mountains zone.

Similarly, naturalness is the only moderately allogenic factor (CV = 50%). The average value of naturalness is high, at 4.49, especially in the western region. The western region has a large area, but only accounts for less than 10% of the country's population and GDP. As a result, the vast western region has not been disturbed by human activities. The intensity of land use is relatively low and the naturalness is relatively high, showing a higher advantage over other regions in nature-based tourism development.

All the other factors are classified as weakly allogenic. These factors can be divided into two subcategories. The first subcategory is composed of factors that have a higher average level and can thus promote the development of nature-based tourism in most regions; it includes protected areas proximity, landscape diversity, altitude suitability, and water proximity. The average levels of these four factors are all above 3.8, and showing the above-mentioned spatial pattern with higher values in the east and lower values in the west in terms of spatial pattern. The other subcategory is composed of factors that have moderate mean levels and limit the development of nature-based tourism in some regions; it includes climate comfort and vegetation coverage, both of which show an inward decline from southeast to northwest. Under the strong influence of relief and the moderate effect of naturalness, the landscape attractiveness of the western regions has been improved, but it is still lower than in the eastern regions. Adding all together these factors have led to the formation of the above-mentioned landscape attractiveness pattern in China.

3.2.2. Ecological sensitivity

Fig. 6 shows that most of Chinese regions belong to the low sensitive category. The overall spatial variation of ecological sensitivity is 42%, a

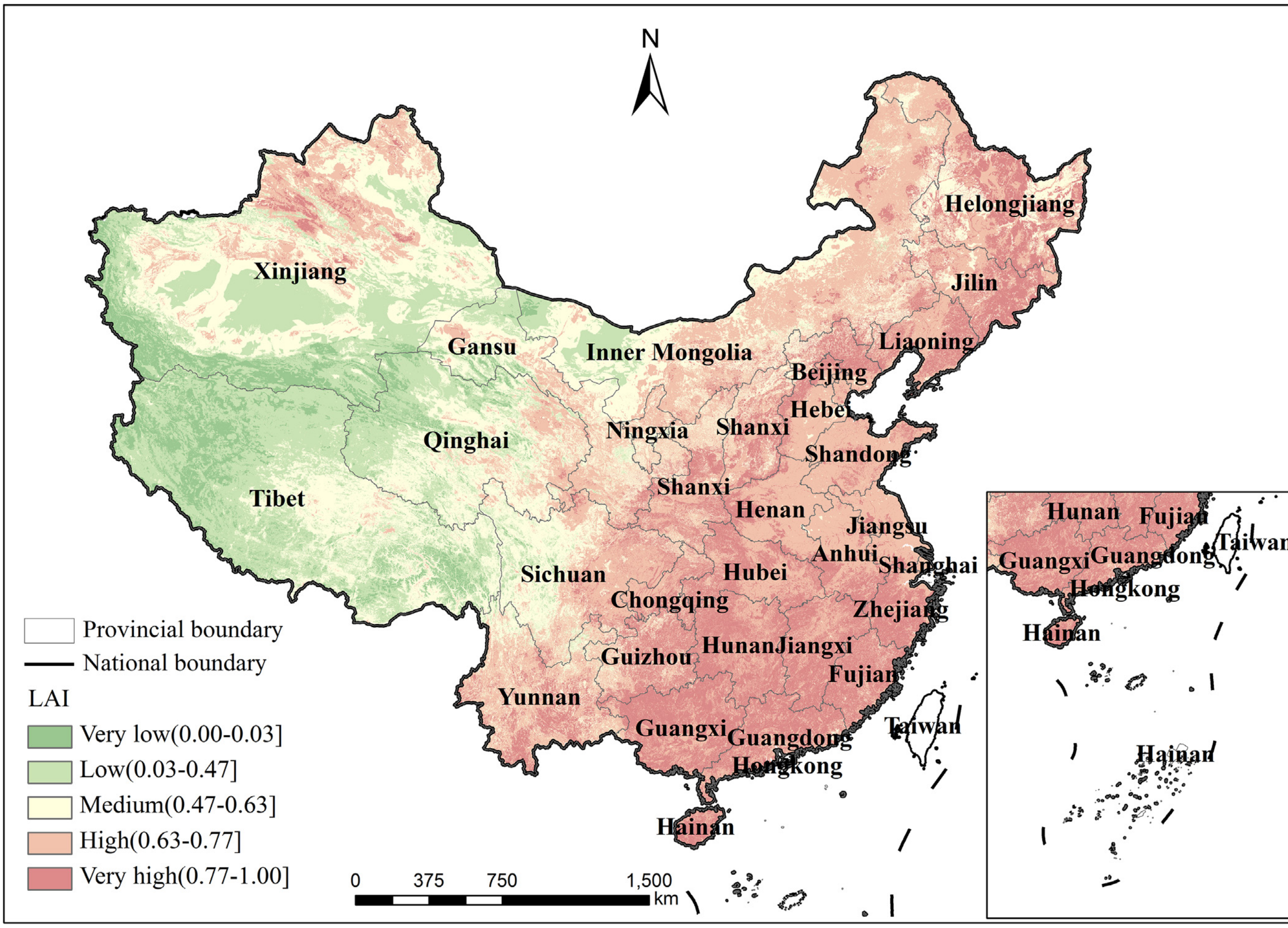

Fig. 4. Spatial distribution of landscape attractiveness and its factors.

value that is higher than the CV of LAI. The very high sensitive areas account for 18.07% of the study area, a value that is lower than the values of the low sensitive area (28.64%) and of the very low sensitive areas (24.29%). Fig. 7 shows that there are differences in the spatial range and in the geographical distribution of types of ecological problems that tourism activities may cause, which can be explained by the combination of natural factors.

Among these types of ecological problems, areas with sensitivity to soil erosion are the largest, accounting for 57.38% of the study area. The areas classified as extremely sensitive account for 2.8% of the study area, mainly located in the Loess Plateau and southwestern mountainous areas. Soil erosion in the Loess Plateau is a long-term geological phenomenon; however, it is mainly caused by the destruction of land and vegetation induced by human activities. The areas with high ecological sensitivity account for 6.4% of the study area, mainly located in the southwest and in the Yanshan, Nuluerhushan and Daxinganling eastern regions. Here, rainfall is more erosive than in other areas; soil is covered mainly with sandy loam or loamy clay, and the topography is undulating (examplified by the Hengduan and Qinba Mountains). Once vegetation in these areas is destroyed, water and soil loss are more likely to occur.

The areas with desertification sensitivity account for 27.61% of the study area, concentrated in the arid and semi-arid regions of northwestern China. Among these, extremely sensitive areas account for 11.58% of the study area, mainly located in the surrounding oases and in the sandy lands of the desert area. The oases of the Gobi Desert have an extremely fragile ecological status, as once desert vegetation is destroyed, sand dunes will be activated, quicksand will resurface, and the oasis will be degraded. Sandy lands are located mostly in semi-humid and semi-arid agricultural-pastoral ecotones, with large annual climate variability and extremely high sensitiveness to human activities. The areas with a high sensitivity to desertification account for 4.48% of the study area, characterized by a dry climate, a high number of wind days, a soil texture that is mostly sandy, and low vegetation coverage, and thus are prone to desertification.

The areas with salinization sensitivity account for 26.42% of the total study area; they are concentrated in the arid and semi-arid regions of northwest China. Extremely sensitive areas account for 8.28% of the total study area, in which usually evaporation is much higher than precipitation. There are also many saline soils in the coastal area and in addition, the intrusion of seawater caused by the human exploitation of groundwater leads to severe salinization problems. The areas with high sensitivity account for 5.26% of the study area, concentrated in the alluvial plains of the southeast of the Junggar Basin and in the Hami region, as well as in the Qinghai-Tibet Plateau.

The areas with rocky desertification sensitivity account for 6.84% of the total study area. Extremely sensitive areas account for 0.37% of the total study area, concentrated in the western and southern parts of Guizhou Province, including the cities of Zunyi and Guiyang; in the downstream areas of the Dadu River in the southwestern Sichuan canyon; and in the lower reaches of the Jinsha River. The areas classified as highly sensitive account for 1.58% of the total study area, intertwined with highly sensitive areas and are mainly distributed in the provinces of Guizhou, Guangxi, Sichuan, Yunnan, and in other southwestern provinces. In addition, there are also flaky distributions in Hunan and Guangdong Provinces, rich in precipitation and rugged terrain and thus are prone to water and soil erosion. Areas with widespread distribution of limestone, thin soil layers, exposed rock

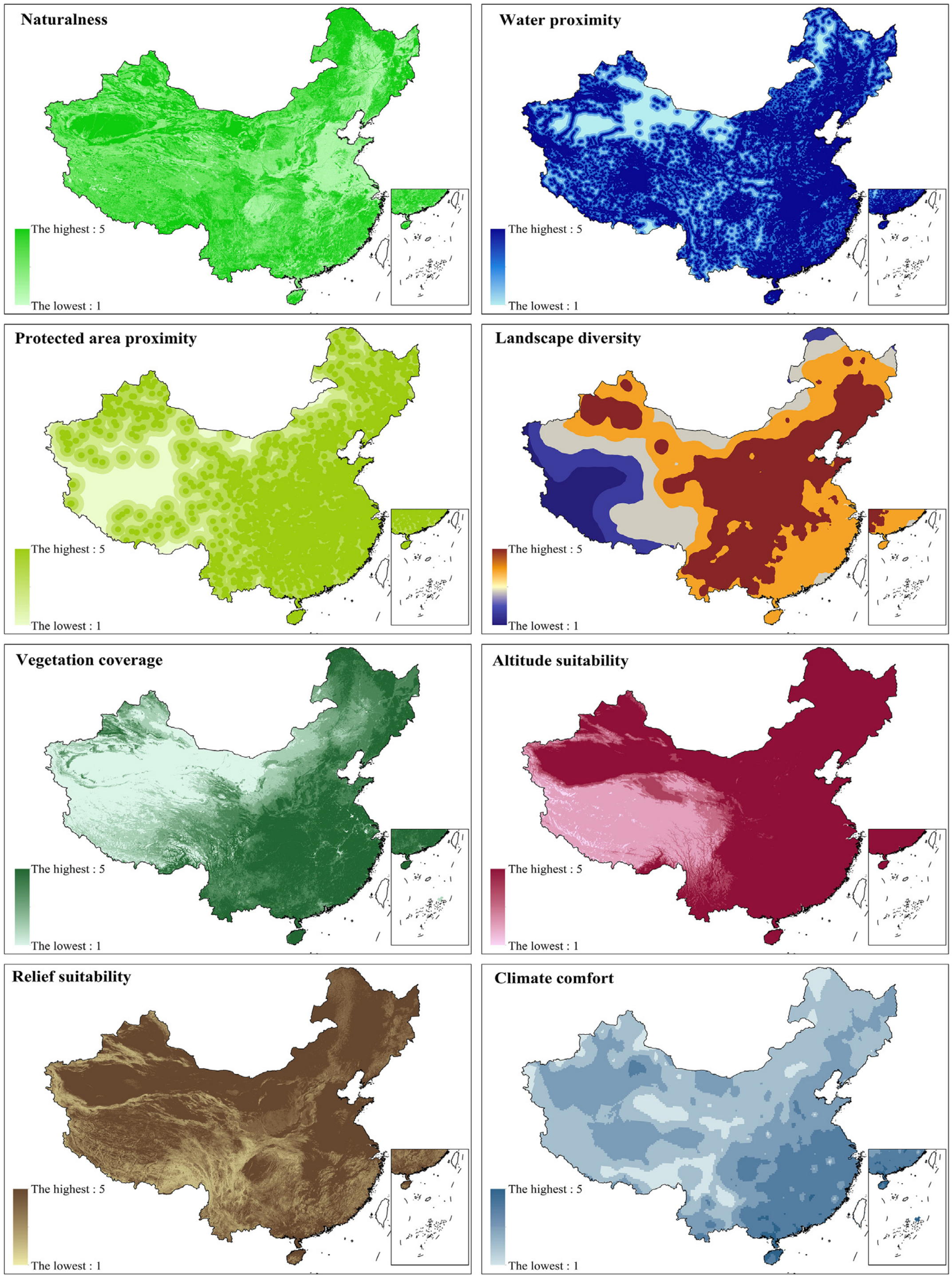

Fig. 5. Spatial distribution of factors of landscape attractiveness.

formations after soil loss and difficult soil formation, are more prone to rocky desertification.

4. Discussion

4.1. The validation of ICTP

This study developed an indicator to measure the conflict tendency between nature-based tourism development and ecological protection, based on the combination of landscape attractiveness and ecological sensitivity. By integrating land cover, topography, climate and other elements, we presented the spatial distribution of the ICTP in the study area of China.

To verify the feasibility of ICTP, we analyzed the distribution of ICTP in several National Nature Reserves. National Nature Reserves are the main areas for developing nature-based tourism in China, and also one type of areas where conflicts between nature-based tourism development and ecological protection occur frequently. They have long been confronted with doubt about whether tourism development and ecological protection could go well simultaneously (Kan, et al., 2018). In recent years, several National Nature Reserves such as the Qilian Mountain and Helan Mountain in the northwestern region, the

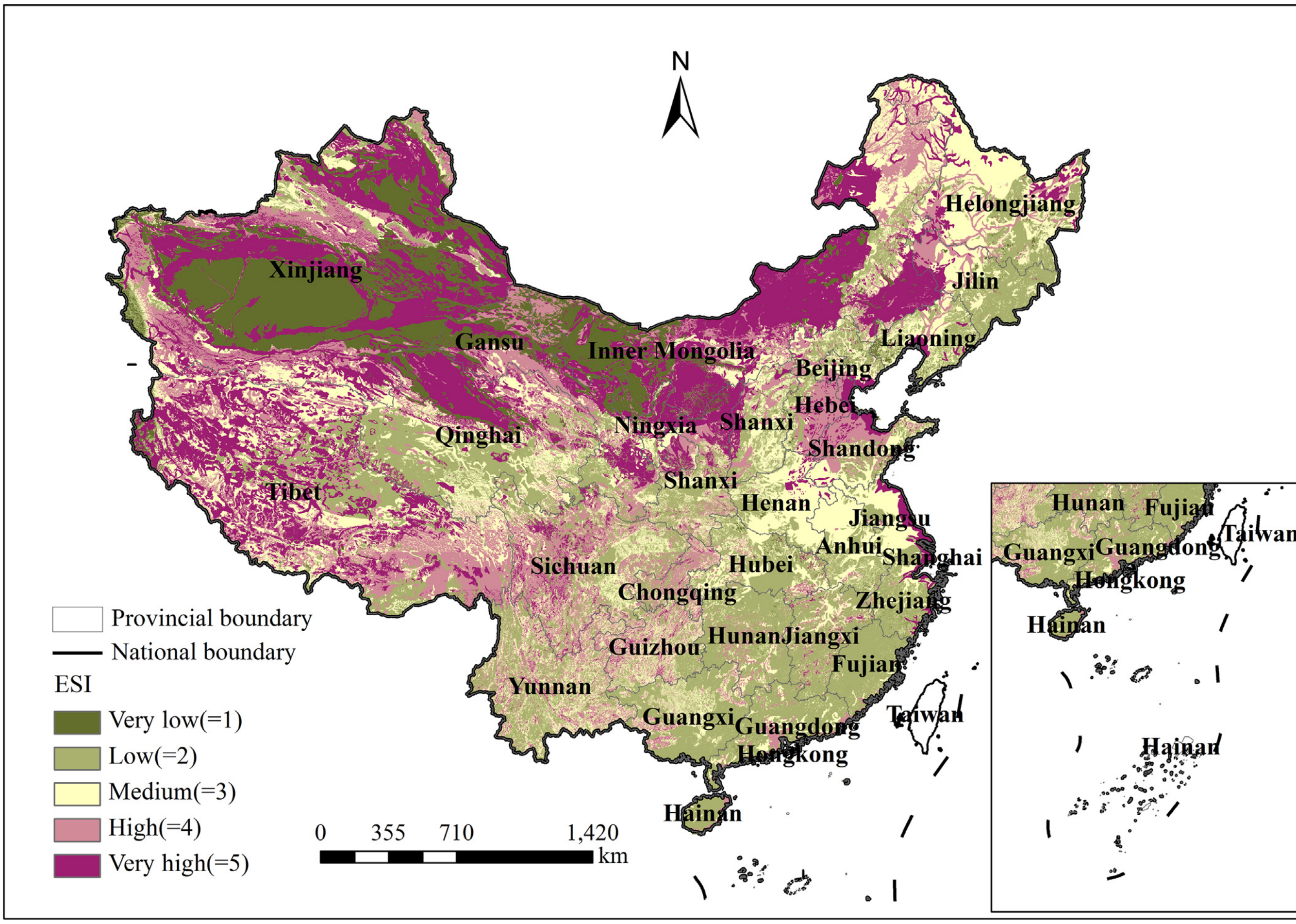

Fig. 6. The spatial distribution of ecological sensitivity and its factors.

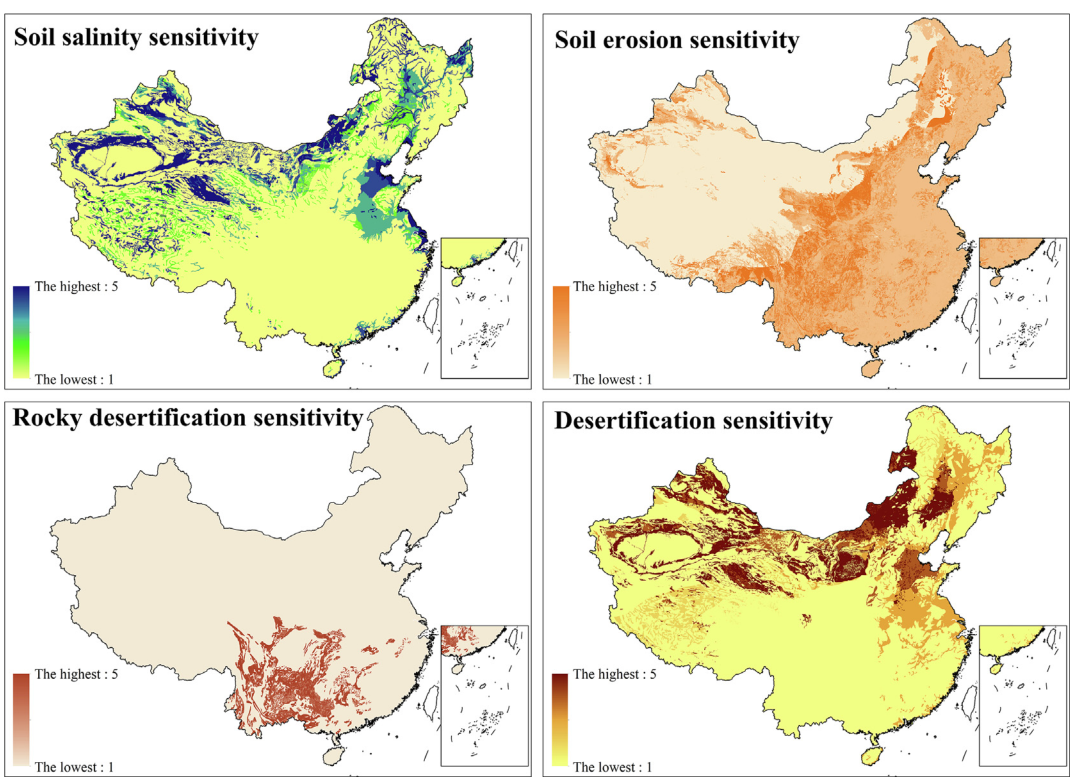

Fig. 7. The spatial distribution of factors of ecological sensitivity.

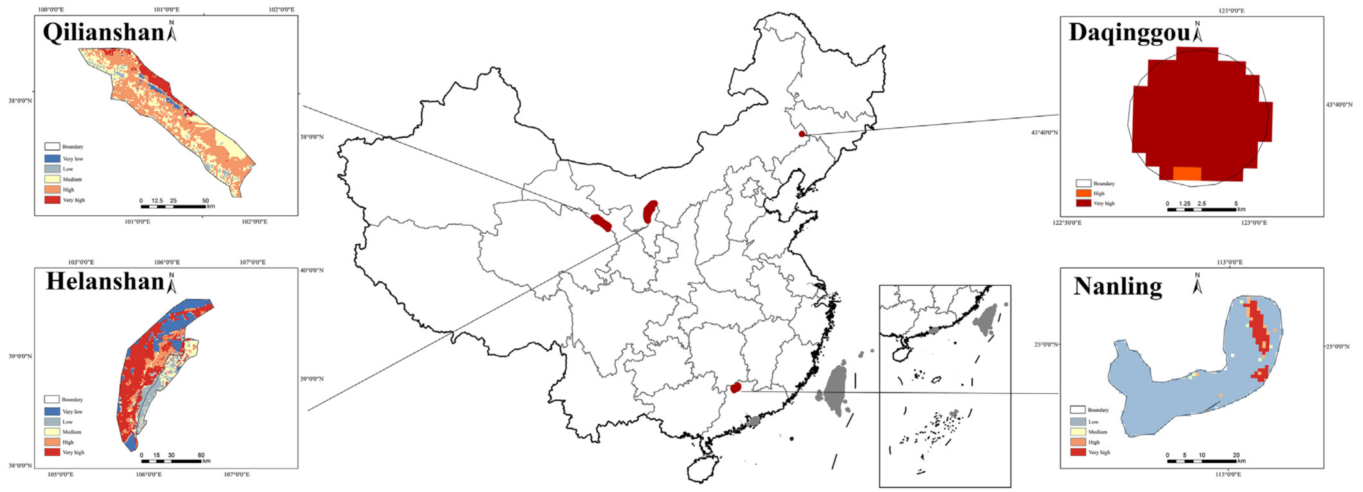

Fig. 8. The ICTP of single protected areas.

Daqinggou in the northeastern region, and the Nanling Nature Reserve in the south of China have experienced different types and degrees of ecological problems. This made it worthful to present the distribution of ICTP in these four National Nature Reserve, and the results were shown in Fig. 8.

Fig. 8 shows that Daqinggou National Nature Reserve has a large number of spatial units with a high conflicts, making up approximately 97.50% of the area. Results of evaluation on landscape attractiveness and ecological sensitivity show that the landscape attractiveness of Daqinggou is high to very high, and the spatial units with very high ecological sensitivity account for 96.25%, indicating high risks of soil desertification and soil erosion. In 1993, the Daqinggou Nature Reserve began to develop tourism. The increase in the number of visitors and income of regional communities also brought great pressures on ecological protection. Particularly, the deteriorating effects on the surface ecology and the environment have become increasingly prominent. For instance, the surface vegetation disappears, mobile sand layer rises, and soil erosion is severe (Cong et al., 2012).

There are also a large number of high conflict tendency units in the Helanshan National Nature Reserve, and the very high conflict-prone space units account for 42.95% of the area. The landscape attractiveness of most areas of Helan Mountain is high (58.90%), and so is ecological sensitivity (51.56%), indicating high risks of soil salinization, desertification and soil erosion. In recent years, with the increasing disturbance from tourism activities and the lack of management, some areas in the Helan Mountain Nature Reserve have shown the occurrence of bare land, habitat fragmentation and biodiversity decline (Zhao, 2015).

Qilianshan National Nature Reserve is dominated by high conflict tendency units, accounting for 52.18%. The space units of high and very high landscapes attractiveness in Qilian Mountain account for 42.39%, while the regions with high and very high ecological sensitivity account for 87.45%, mainly facing the risk of desertification. With the rapid development of tourism, the pressure on Qilian Mountain ecosystem has been greatly aggravated, causing serious pollution to the atmosphere, water and soil, destruction of vegetation, and reduction of the number of wild animals (Ma et al., 2016).

The areas with very high conflict tendency inside some of these protected reserves is few; however, their existence indicates that there are still potential conflicts. This idea could be confirmed in the case of the Nanling National Nature Reserve, where the areas with a very high conflict tendency account for 7.26% of the total area. In 2011, the construction of roads in the core area of the Nanling National Nature Reserve destroyed vegetation and soil layers, such ecological damage does not only required a long recovery time, but also substantially decreased the aesthetic quality of landscape in here (Yang, 2013).

4.2. Influence factor of ICTP

The spatial pattern of ICTP is related to the spatial distribution of landscape attractiveness and ecological sensitivity. As a result, most parts of the study area has a ICTP at a low or medium level. Areas with very high ICTP account for only 13.79% of the total study area, while the areas with very low conflict tendency account for only 11.09% of the total study area.

More than 50% of the study areas have a value of landscape attractiveness that is high or very high, indicating a high nature-based tourism development potential. For a long time, protected areas have been considered as an important space to develop nature-based tourism, and the results of the LAI evaluation show that there are still large areas outside protected area that are suitable for nature-based tourism development in the study area. This phenomenon can also be found in the European Union (Paracchini et al., 2014). Moreover, the study of Paracchini et al.(2014) show that the evaluation results of landscape attractiveness can help decision makers to explore potential tourists hotspots and improve the efficiency of nature resources use.

The spatial variation in landscape attractiveness in the study area are mainly due to relief and naturalness. The average relief in China is above the world average level, having an important influence on China's population distribution and economic structure (Niu and Harris, 1996). Our study shows that relief is the main constraint of nature tourism development in many regions. In addition, naturalness has a great influence on human travel experience since recreation in areas with higher naturalness helps restore autonomy of individuals. The findings of the present research show that the eastern regions of China have a relatively low naturalness, mainly due to the existing land use patterns as most of the land is under human management. Also, the residents in these areas have an urgent need to regain autonomy since the pressures from work, family on them are huge. By taking our results into consideration, policy makers can improve naturalness for nature-based tourism development by establishing restorative spaces and adjusting regional land use patterns.

Although most of the study areas have a high landscape attractiveness, it is important to note that some of these areas are also extremely ecologically sensitive. Hence, spatial layout strategies for the sustainable tourism development should consider both landscape attractiveness and ecological sensitivity. Previous studies proposed that areas with high landscape attractiveness should develop tourism industry, neglecting the ecological problems that tourism activities may cause. For example, Walz and Stein (2018) evaluated the landscape attractiveness in Germany and argued that several types of areas including coastal areas, high mountain areas and lake areas have high landscape attractiveness, thereby recommending tourism development in these areas to maximize economic benefits. However, coastal areas and high mountain areas are usually ecologically sensitive areas, where tourism activities may cause ecological problems (Drius et al., 2019). Therefore, it is difficult to reach sustainable balance between environment and economic characteristics by adopting tourism development strategies only from the perspective of landscape attractiveness.

More than 60% of the study area has an ecologically sensitivity of medium, high, or very high. Areas with soil erosion sensitivity are the largest, followed by areas with desertification sensitivity, while areas with rocky desertification sensitivity are the smallest. These ecological sensitivities are the result of the interaction of natural elements in regions. Under the influence of human activities, the state of these natural elements will change, causing new ecological problems or exacerbating existing ones. Our analysis identified vegetation destruction, excessive tramping, and waste of water resources as important causes of ecological problems in tourist destinations.

Several studies focus only on ecological sensitivity when considering the spatial layout of tourism development (Shi et al., 2015). These studies claim that tourism infrastructure and facilities should not be located in ecologically sensitive areas, and that areas with low ecological sensitivity should be considered as more reasonable locations. However, these studies did not take into account the economic benefits of tourism industry, since low landscape attractiveness may not bring economic benefits, leading to a low efficient spatial structure of tourism development. This highlight the significance of ICTP proposed in this research for sustainable tourism development, which is based on the combination of landscape attractiveness and ecological sensitivity, considering not only the environmental benefits but also the economic benefits, and thus could provide an accurate basis to the increase economic benefits for regional communities, as well as securing the sustainability of natural resources through time.

By combining landscape attractiveness and ecological sensitivity, we found that the spatial units with very high ICTP are mainly distributed in the central part of Inner Mongolia Plateau, northern part of Loess Plateau, southwestern part of Northeast Plain, north and south sides of Tianshan Mountains, Bohai Bay coast and coastal areas of Jiangsu and Zhejiang. These areas are mainly confronted with problems of desertification, salinization and soil erosion. Areas with high ICTP account for 16.14%, mainly distributed in the northern part of North China Plain, northern part of Greater Xing'an Mountains, Qaidam Basin and southeastern side of Tianshan Mountains. These areas are mainly confronted with problems of desertification and salinization. They do have advantages in terms of vegetation, landform and other conditions, and their landscape is attractive; however, these areas have also high ecological sensitivity. This means that carrying out nature tourism activities in these areas is likely to trigger ecological and environmental problems.

The spatial units with very low conflict tendency are concentrated in the Tarim Basin and the western part of Inner Mongolia Plateau. Due to limitation caused by climate, vegetation, and hydrology conditions, landscape attractiveness in these areas is relatively low. Yet the same time ecological sensitivity in these area is also low, resulting in a low probability of conflict between nature tourism development and ecological protection.

4.3. Implication of ICTP for tourism sustainable development

The results of this study stand as a first attempt to map the spatial variations of the conflict tendency between nature-based tourism development and ecological protection. It could be used to help decision makers in four aspects:

)i. determining the extent of nature tourism management in different regions according to the identification of areas that are most likely or unlikely to suffer from ecological and environmental problems due to nature-based tourism development across different regions. According to this study, rigorous restriction to tourism activities should be adopted in at least 13.79% of the studied areas, including the central part of the Inner Mongolia Plateau, northern part of the Loess Plateau, southwestern part of the Northeast Plain, north and south sides of Tianshan Mountains, coast of Bohai Bay and coastal areas of Jiangsu and Zhejiang Province. For another, relative loose strategies could be introduced in 11.09% of studied areas, which mainly located in the Tarim Basin and western part of Inner Mongolia Plateau.

)ii. adopting more effective environmental protection strategies to adapt to tourism development in different type of areas. For example, in areas sensitive to soil erosion, it is necessary to adopt strict measures for vegetation protection and tourist flow control; while in areas that are sensitive to salinization, measures must be taken to conserve water resources in tourism facilities.

)iii. offering a basis to measure conflict tendency between nature tourism and ecological protection at national scale by considering both landscape attractiveness and ecological sensitivity. In the long run, this framework can also be used for regular monitoring. On the basis of the framework proposed in this study, data collection for multiple periods of time can inform on the direction of, and reasons for, changes in conflict tendency, to adopt the appropriate control on these influencing factors in order to reduce conflicts tendency.

)iv. providing a reference framework for the establishment of national parks, a process that Chinese government has launched recently. Specifically, it can provide decision makers with a basis to develop the spatial layout of national parks. National parks have high landscape attractiveness, are ecologically important and fragile area, as well as being also an important vehicle for delivering ecological civilization. National parks must not only ensure ecological protection, but also provide citizens with recreational opportunities, and therefore it is extremely important to consider possible conflicts in these regions. Our results from the conflict analysis show areas in which the construction of national parks is more likely to cause conflicts between nature-based tourism development and ecological protection, as well as the areas that are less likely to experience such conflicts. In addition, these results can inform policy makers on the efforts that should be put to control the development of national parks in different areas.

Just as other mapping methodologies, the mapping proposed in the present study is subject to specific limitations. The first limitation is that the landscape attractiveness evaluation does not consider humanistic amorous feelings. The landscape attractiveness indicator used in in this study mainly refers to the attractiveness of the natural landscape, however, China has a long history of civilization and human elements, such as cultural sites, an important source of tourism attraction. Further research should include element of humanistic amorous feelings.

In addition, the study has a resolution of 1 km as we performed the analysis at national scale, future research could detail the spatial scale with more data, especially when conducting regional studies. Smaller observational scales are needed for regional studies to be able to observe important sources of landscape attractiveness, such as exotic natural resources. In term of generalization of resolution, this study used two methods to unify resolution: the first is to convert high resolution to low resolution, such as the elevation data. In this case, the more detailed information was abandoned, as an alternative to the more cruder and more general information. The goal is to coordinate with other low-resolution data in the data set to facilitate integration analysis. The second is to convert low resolution to high resolution, such as part of NDVI data. The purpose of this is to supplement the unknown properties of the region, with the theoretical basis of the geospatial proximity. Both treatments lead to problems with information deviation at certain observation scales. When the observed object has a large range of space, such as the observation object of this study (i.e., country-level), the degree of information deviation is very small, near negligible; but when the spatial extent of observation is reduced, such as for provincial and municipal areas, information deviation would occur. Future research should aim at collecting source data with uniform resolution and thus enhance the certainty of research results.

5. Conclusions

Although previous studies have noted that some areas are more likely to experience conflicts between nature-based tourism development and ecological protection, few studies have attempted to quantitatively measure the likelihood of such conflicts. In this research, we combined landscape attractiveness and ecological sensitivity, comprehensive considered land cover, terrain, climate and other conditions, to develop an indicator of conflict between nature-based tourism development and ecological protection (ICTP), and the feasibility and attractiveness of the ICTP to forecast and explain the conflicts between nature tourism and ecological protection is demonstrated by the analysis of several Chinese National Natural Reserves presented in this study. It stands as the first attempt to map the conflict tendency between nature-based tourism development and ecological protection in China.

The ICTP is low in most study areas, but there is a large difference in ICTP of each evaluation unit. The spatial pattern of ICTP is related to the spatial distribution of landscape attractiveness and ecological sensitivity. More than 50% of the study areas have a value of landscape attractiveness that is high or very high, indicating a high nature-based tourism development potential. These areas are suitable for natured-based tourism if only the landscape attractiveness is considered, as the landscape attractiveness of these areas is at a level of high or very high. However, due to the high ecological sensitivity, tourism activities in these areas is also prone to ecological problems. More than 60% of the study area has an ecologically sensitivity of medium, high, or very high. Areas with soil erosion sensitivity are the largest, followed by areas with desertification sensitivity, while areas with rocky desertification sensitivity are the smallest.

As a result, the areas with very high ICTP account for 13.79%, for example, the central part of the Inner Mongolia Plateau. Thereby, the rigorous restriction on tourism activities should be adopted in these areas. It worth to note that for different areas, the types of ecological problems which likely to be caused by tourism activities are different, thus environmental protection strategies tailored to areas characteristics would be more effective. For areas with very high ICTP, which located in the central part of Inner Mongolia Plateau, northern part of Loess Plateau, southwestern part of Northeast Plain and so on, mainly confronted with problems of desertification, and soil erosion, strict measures such as vegetation protection and tourist flow control appears to be more necessary. Areas with high ICTP account for 16.14% of the study area, which mainly distributed in the northern part of North China Plain, northern part of Greater Xing'an Mountains and so on, are mainly confronted with problems of salinization. Thus measures such as conserve water resources in tourism facilities need to be introduced in these areas.

The analytical framework presented in this study could help managers not only measuring the conflict tendency between nature-based tourism development and ecological protection, but also monitoring large-scale space regularly. It can inspire researchers to think about factors that should be considered when measuring conflict tendency, and how these factors will affect such conflict tendency, so that researchers can adjust the analysis framework according to local actual situation. This study appears to be important under the background of national parks plans launched recently in China. It can not only provide decision makers with a basis to develop the spatial layout of national parks, but also inform policy makers on the efforts that should be put to control the development of national parks in different areas.

Based on the framework presented in this study, future studies could include the consideration of humanistic amorous feelings, and a detail spatial resolution of data is needed for study on a smaller area.

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