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Article

National Assessment of Climate Resources for Tourism Seasonality in China Using the Tourism Climate Index

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Abstract: Tourism is a very important industry, and it is deeply affected by climate. This article focuses on the role of climate in tourism seasonality and attempts to assess the impacts of climate resources on China's tourism seasonality by using the Tourism Climate Index (TCI). Seasonal distribution maps of TCI scores indicate that the climates of most regions in China are comfortable for tourists during spring and autumn, while the climate conditions differ greatly in summer and winter, with "excellent", "good", "acceptable" and "unfavorable" existing almost by a latitudinal gradation. The number of good months throughout China varies from zero (the Tibetan Plateau area) to 10 (Yunnan Province), and most localities have five to eight good months. Moreover, all locations in China can be classified as winter peak, summer peak and bi-modal shoulder peak. The results will provide some useful information for tourist destinations, travel agencies, tourism authorities and tourists.

Keywords: tourism seasonality; climate resources; Tourism Climate Index; China

1. Introduction

As tourism becomes one of the largest and fastest growing industries, it plays an extremely important role in promoting national and local economic development all over the world. According to Tourism Highlights (2014 Edition), published by the United Nations World Tourism Organization (UNWTO), international tourist arrivals worldwide have increased to 1.087 billion in 2013, bringing in US$ 1.159 trillion in international tourism receipts [1]. Statistics from World Tourism and Travel (WTTC) show that the direct contribution of travel and tourism to the global economy rose by 3.1% in 2013, accounting for 9.5% of total gross domestic product, one in 11 of the world's jobs, 5.4% of world exports, as well as 4.4% of global investment [2]. Notably, China is a major tourism destination, which has made great achievements in tourism over the past three decades. According to the statistics released by the China National Tourism Administration (CNTA), total tourists, which includes the number of domestic tourist and the international tourist arrivals to China, has reached 3.089 billion in 2012, and tourism income was 2.59 trillion yuan, which increased by 15.2% compared to last year [3]. Currently, China has become the largest supplier of tourist resources and the fourth tourism destination worldwide.

It is widely recognized that weather and climate are critical to the tourism sector worldwide [4–11]. Generally, the relationship among climate, weather and tourism has been examined from the perspective of the geography of tourism and climatology [7]. Both show how climate and weather affect the tourism industry. More specifically, climate and weather have a significant impact on the spatial distribution of tourism centers (e.g., the zone for sun and beach tourism or winter sport tourism), tourism resources (e.g., the pattern of tourism climate resources), tourism seasons (e.g., snow cover for snow-dependent activities), tourism supply and demand (e.g., tour schedules of travel agencies and tourists), *etc.* In other words, climate can be characterized as, on the one hand, an asset for destinations and, on the other hand, an important attraction for tourists [12].

Similarly, tourism seasonality is a major issue, which has been noted by tourism researchers for several decades. Butler gave a widely-recognized definition of tourism seasonality: "the temporal imbalance in the phenomenon of tourism, which may be expressed in terms of dimensions of such elements as numbers of visitors, expenditure of visitors, traffic on highways and other forms of transportation, employment and admissions to attractions" [13]. The causes of seasonality in tourism can be put into two categories: one is natural factors, which relate primarily to the climate of a destination (e.g., temperature, sunshine, rainfall, wind speed, humidity); the other one is institutional factors, which reflect social norms and practices (e.g., the schedule of festivals and holidays, the supply of public and private services) [13–16]. The effect of these two factors is found to depend on the types of tourism destinations. For seaside and mountain resorts, natural environments are more important than institutional causes [17], while institutional causes are major factors for destinations with small contrasts in climate, such as Yunnan Province, China [18].

Most previous studies on China's tourism seasonality have primarily explored the characteristics in some provinces or some types of tourist spots [17–21]. More detailed information, such as the tourism seasonality characteristics of the whole country, especially the spatial pattern of tourism seasonality with the effect of climate in China, has not been examined. When discussing the tourism seasonality of climate resources, one must choose a suitable index to assess tourism climate. Several indices have been developed to evaluate climate environments for tourism, including the Tourism Climate Index (TCI) [22], the Beach Comfort Index (BCI) [23,24], the Climate Index for Tourism (CIT) [25], the Modified Climate Index for Tourism (MCIT) [26] and the Physiologically Equivalent Temperature Index (PET) [27–31]. Obviously, the BCI was designed for evaluating the climate conditions of beach holiday resorts, while the PET was used to reflect the thermal properties of tourism climate. TCI is a composite indicator that captures the climatic elements most relevant for general tourism activities, which has been widely used for Europe [32], North America [6], the Mediterranean [33], northwest

Europe [34], European beaches [35], Australia [36] and at the global level [37]. The TCI integrates three essential climatic facets (thermal, aesthetic and physical) into a single index, and it has widespread applicability, because the required climatological data are commonly available. However, its deficiencies can also be noted as follows: (1) the subjectivity of the TCI (e.g., thresholds, weights) is the central weakness of this scheme; (2) weather-sensitive activities, such as beach tourism, cannot be assessed by the TCI without modification. In order to overcome the known limitations of the TCI, a new index for tourism climate assessment, the Climate Index for Tourism (CIT), was proposed by De Freitas *et al.* [25]. However, the CIT specifically pays attention to "sun, sea and sand" (3S) tourism, not general tourism activities. Additionally, Yu *et al.* developed the Modified Climate Index for Tourism (MCIT) using hourly climatic data, which are not available for the macroscopic analysis of tourism seasonality [26]. Therefore, to make the results easily comparable, Mieczkowski's TCI [22] is employed in this analysis due to its comprehensive nature and universal applicability.

This paper assesses the impact of climate on tourism seasonality in China based on the TCI during the period 1981–2010. The structure of this paper is organized as follows: Section 2 describes the research materials and methodological procedures, including the characteristics of the TCI, classification of the annual tourism climate, data requirements and preparation. Section 3 shows the results and discussion, and conclusions are presented in Section 4.

2. Methodology

2.1. The Tourism Climate Index

The Tourism Climate Index (TCI) was developed by Mieczkowski [22] as a composite measure of tourism climate. Initially, 12 climate variables were identified from previous research related to the climate for tourism to represent the TCI; however, seven climatic variables based on monthly means were finally integrated into the TCI, because of meteorological data limitations. These climatic variables are maximum daily temperature, minimum daily relative humidity, daily temperature, daily relative humidity, total precipitation, hours of sunshine per day and wind speed. Furthermore, all of the climate variables were combined into five sub-indices, which are outlined in Table 1.

Table 1. Sub-indices of Mieczkowski's Tourism Climate Index.

Sub-Index	Monthly Climate Variables	Weight
Daytime comfort (CID)	Maximum daily temperature Minimum daily relative humidity	40%
Daily comfort (CIA)	Mean daily temperature Mean daily relative humidity	10%
Precipitation (P)	Total precipitation	20%
Sunshine (S)	Total hours of sunshine per day	20%
Wind (W)	Average wind speed	10%

According to the relative weightings of the incorporated index components, the TCI formula takes on the following expression:

$$TCI = 2(4CID + CIA + 2P + 2S + W)$$

where CID is the Daytime Comfort Index, CIA is Daily Comfort Index, P is the Precipitation Index, S is the Sunshine Index and W is the Wind Index. By using a standardized rating system, each sub-index takes on an optimal rating of 5, and Mieczkowski suggested a classification scheme for the TCI scores. In order to reflect the distribution of the TCI more directly, a simplified rating system combined with the TCI classification scheme of Mieczkowski is presented [6,36,37] (Table 2).

Table 2. The classification scheme of the Tourism Climate Index (TCI).

TCI Categories of Mieczkowski (1985)	A Simplified Rating System for TCI
Ideal (90–100)	Excellent (80–100)
Excellent (80–89)	Good (60–79)
Very good (70–79)	Acceptable (40–59)
Good (60–69)	Unfavorable (Below 40)
Acceptable (50–59)	
Marginal (40–49)	
Unfavorable (30–39)	
Very unfavorable (20–29)	
Extremely unfavorable (10–19)	
Impossible (Below 9)	

2.2. Annual Tourism Climate Classification

A theory was set up by Scott and McBoyle [6] to classify the annual tourism climate of each destination. All destinations can be divided into six types based on the TCI scores (Table 3): optimal, poor, summer peak, winter peak, bi-modal shoulder peak and dry season peak. In addition, Scott and McBoyle found that monthly hotel or resort accommodation costs followed a similar law of annual tourism climate classification rated with the TCI scores by selecting some locations [6], suggesting that the TCI can represent tourism seasonality (e.g., number of visitors, expenditure of tourists) to some extent.

Table 3. The classification of annual tourism climate by Scott and McBoyle.

Category	Description
Optimal	TCI scores ≥ 80 for each month of the year
Poor	TCI scores < 40 for every month of the year
Summer peak	Summer is the best season in terms of climate conditions
Winter peak	Winter is the best season in terms of climate conditions
Bi-modal shoulder peak	Spring and fall months are more suitable for tourism activities in terms of climate conditions
Dry season peak	The dry season is more conducive to tourist activity in terms of climate conditions

2.3. Data Requirements and Preparation

The major dataset required in the analysis is the standard value of the surface climate dataset in China during 1981 to 2010, which was downloaded from the China Meteorological Data Sharing Service System. With 825 meteorological observation stations in China, this dataset includes station attribute information (e.g., station ID, longitude, latitude) and mean monthly climatology data (e.g., temperature, humidity, precipitation, sunshine, wind speed), which have been used extensively in climate-related research across China [38]. Due to the absence of minimum daily relative humidity in the dataset, as an alternative, we collected this data from the standard value of the surface climate dataset in China during 1971 to 2000.

By matching observation stations in these two datasets and removing incomplete and invalid data through strict quality control procedures, including a thresholds' check, extremes' check, consistency check and completeness check, a total of 658 stations, which were found to be homogeneous without any missing data, were finally retained in the analysis, and the data quality can generally satisfy the research requirements (Figure 1). All of the data required by the TCI were obtained by using MATLAB and then exported to text (.txt) format. Furthermore, the meteorological observation stations and the national administrative boundary map (WGS84 geographic coordinate system) were connected through ArcGIS 10.0 software. The stations are evenly distributed throughout China, except in the western Tibetan Plateau. Taiwan province and some remote islands have been excluded from this study due to a lack of long-term monitoring data series in some parts of these regions.

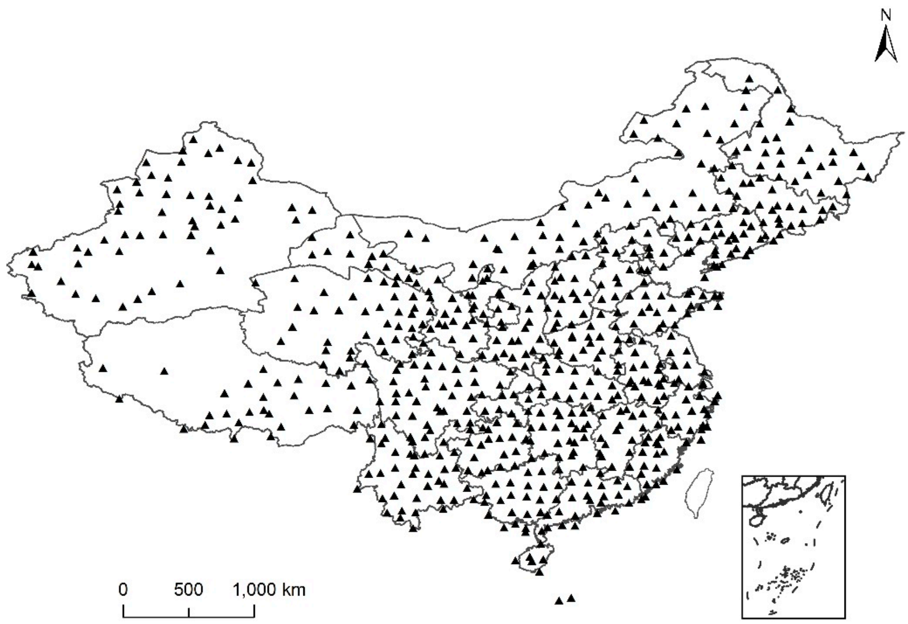

Figure 1. The locations of the 658 meteorological observation stations across China.

3. Results and Discussion

Three sets of analyses were conducted to present the findings and the resulting discussion. First, we calculated the TCI scores for four seasons, while considering the representative characteristic and good stability compared with the TCI scores for each month. Second, the number of good months (TCI $\geq$ 60) is illustrated for each region throughout the year. Third, we classified the TCI values and then described the types of annual tourism seasonality.

3.1. Average Seasonal TCI Scores

Figure 2 presents the TCI values across China for the period 1981–2010 in different seasons. Overall, most of the country has a favorable climate for tourism, such that tourists may visit anytime with many choices available. During spring, most parts of northern and northwestern China are perceived as having good conditions (60 ≤ TCI ≤ 79). The northeastern, eastern and southern regions are classified as having acceptable conditions (40 ≤ TCI ≤ 59). The former areas have higher TCI scores, because of the moderate temperatures and relative dry weather in spring, which are called the spring drought [39]; conversely, the low temperature is responsible for the low scores of the northeast and Tibetan Plateau, while a humid climate with abundant precipitation leads to those for the southern regions. The average TCI map during autumn shows the same categories with good and acceptable conditions during spring, and the essential difference between these two seasons is that the regions characterized as “good” stretch to eastern and southern China during autumn, which can be generally attributed to the decreasing humidity. In summer and winter, China obviously exhibits a latitudinal gradation of tourism climatic attractiveness. Due to the cool climate in summer, the excellent (TCI ≥ 80) and good conditions (60 ≤ TCI ≤ 79) mainly occur in the north of the Qinling Mountains and Huaihe River. In winter, the regions considered as “good” are located in the south of the Five Ridges and Yunnan Province, and regions considered as “unfavorable” are located in the northeast, northwest areas and Inner Mongolia; the other parts are generally categorized as “acceptable”. Whether a region has an attractive tourism climate for tourists in summer and winter, in general, depends on the temperature, which is significantly influenced by the latitude. However, at the local scale, this is likely influenced by the topography and environment compared with the regions at a similar latitude. For example, Shandong Peninsula is affected by a maritime climate and has a cooler summer than other areas at the same latitude. It should be borne in mind that the results in Figure 2 probably cannot reflect the actual tourism activities in each region, because some other factors, such as institutional factors and cultural and historical factors (such as historical sites and scenic spots), have not been considered in the study.

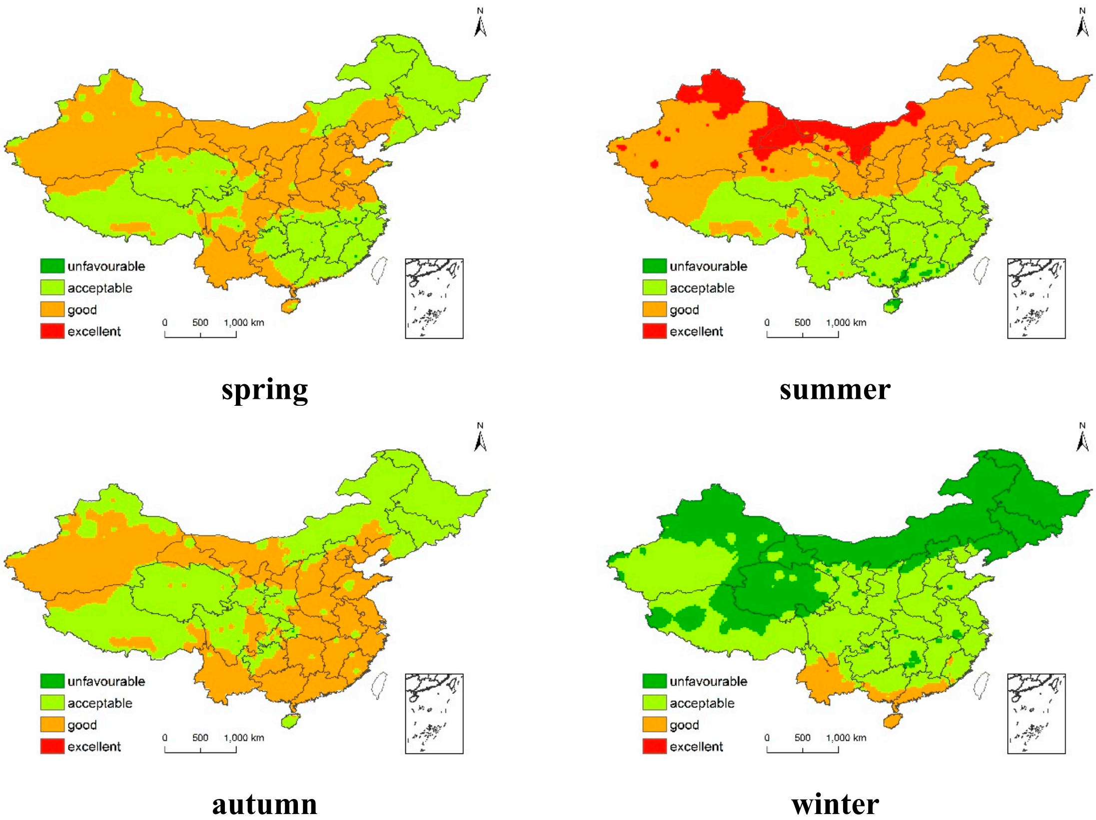

Figure 2. TCI values for China during the four seasons (1981–2010).

A comparison of the average seasonal TCI maps during the four seasons shows that most of China is classified as having "good" or "acceptable" conditions all year, but regions with "excellent" or "unfavorable" ranks only exist in summer and winter, respectively. There is no doubt that the map based on the TCI approach, which describes tourist climatic comfort, performs quite well as an assessment of climate resources for tourism seasonality and a predictor of visitation. Although the map cannot reflect the actual number of tourists due to several causes of tourism seasonality, it helps tourism authorities think about what they should do to increase the number of travelers under an uncomfortable climate or whether they perform satisfactorily with respect to the attraction of visitors in a comfortable climate. Taking Harbin City (the capital of Heilongjiang Province) as an example, it has spared no expense to develop ice-snow tourism in winter (e.g., Harbin International Ice and Snow Festival), transforming the disadvantage of the cold climate into an advantage successfully.

3.2. Numbers of Good Months

The number of good months (TCI ≥ 60) in a whole year, as a picture of current tourism comfort levels throughout China, is presented in Figure 3. In terms of climate resources, China shows notable variation in the number of good months, varying from zero to 10. The regions with the lowest number of good months (less than four), include the Tibetan Plateau area (e.g., eastern Tibet, southern Qinghai) and the most part of southern China (e.g., Jiangxi Province, Hunan Province). It should be pointed out, however, that these areas with less than four good months experience about nine months of acceptable conditions, indicating that although the climate resource is not an advantage in these areas, it would not restrict the development of tourism. Specifically, eastern Tibet and southern Qinghai are classified as having unfavorable conditions only in the winter, while the central areas of China are "good" in fall (Figure 2). As a special alpine-cold zone, the Tibetan Plateau area has low temperatures all year round, because of its high elevation, resulting in low scores in CID and CIA. However, less precipitation, as well as more sunshine duration lead to acceptable conditions during most of the year.

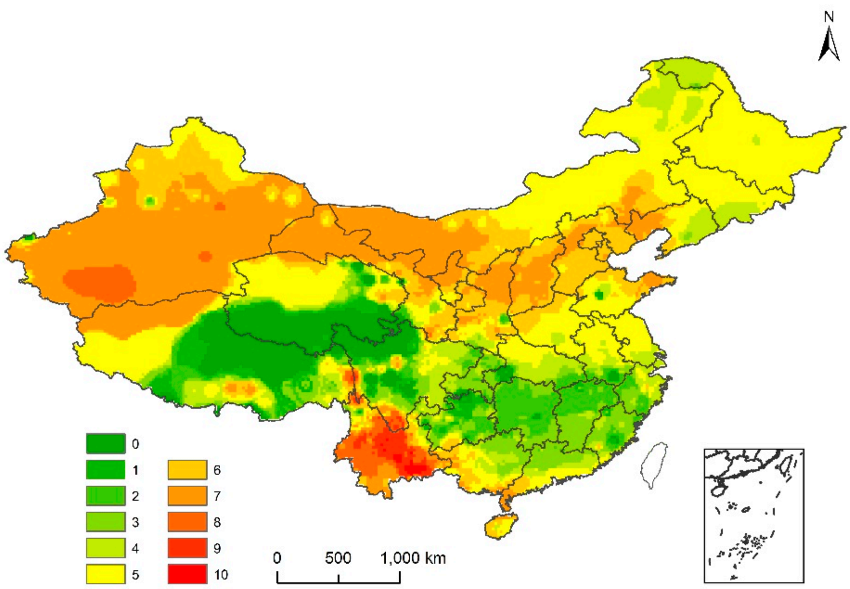

Figure 3. The number of good travel months in China (1981–2010).

The most attractive area with more than eight good months is Yunnan Province. As is well known, the climate of Yunnan Province is mild without a hot summer or a bleak winter because of its special geographic location (low latitude plateau) and the general air circulations. In terms of general air circulations, Yunnan province is controlled by a humid maritime airstream from May to October, while it is controlled by a dry-warm continental airstream from November to April, both of which tend to result in long-term pleasant climates. For example, the suitable period for travelling in Lijiang (a small city in Yunnan Province) is about nine months, from March to November [40]. Moreover, the climatic attractiveness of Lijiang has improved because of the warming-drying trend since 2000. The number of good months in the majority of north China is between five and eight, suggesting that the climates of most areas are comfortable for traveling for about half of the year.

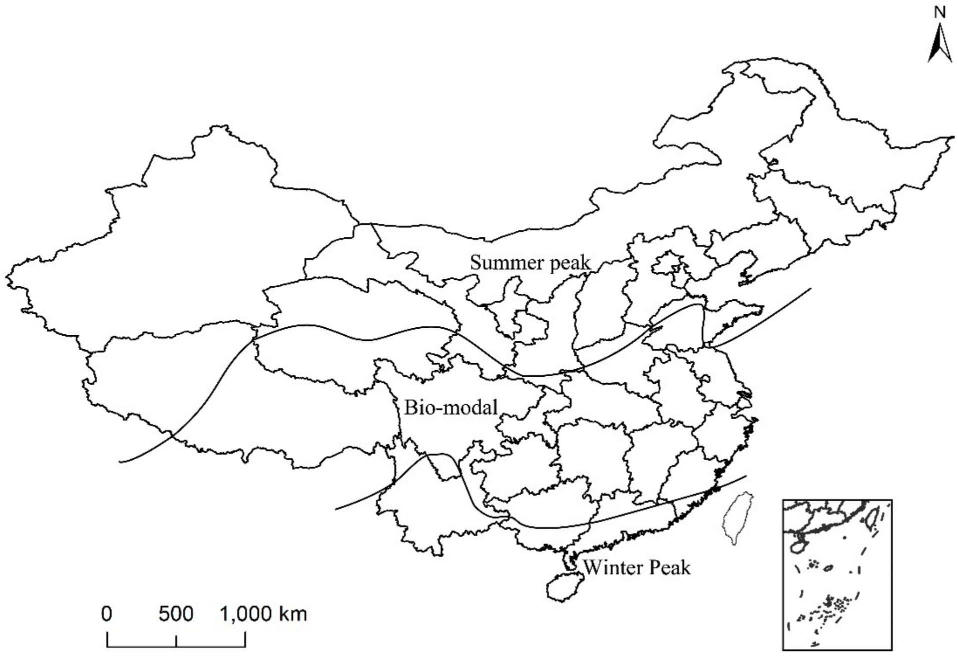

Figure 4. Spatial distribution of annual tourism seasonality (1981–2010).

3.3. Annual Tourism Seasonality Types

Based on the classification scheme of the annual tourism climate suggested by Scott and McBoyle [6] (Table 3), three types, namely the winter peak, summer peak and bi-modal shoulder peak, are identified in China. The spatial distribution of annual tourism seasonality types affected by climate throughout China is presented in Figure 4. Overall, the spatial distribution across China generally shows a latitudinal gradation, with a summer peak, a bi-modal shoulder peak and a winter peak running from north to south. The dividing line between the summer peak and bi-modal shoulder peak approximately follows the boundary of the Qinling Mountains and Huaihe River. As we know, the Qinling Mountains and Huaihe River are important geographic boundaries dividing the north and south parts of China. Therefore, regions to the north of the Qinling Mountains and Huaihe River can be classified as summer peak, except eastern Tibet and southern Qinghai. Regions to the south of the Qinling Mountains and Huaihe River can further be divided into two classes: the southernmost areas of China are winter peak destinations, including southern Guangdong, Guangxi, Yunnan and all areas of Hainan Province; the other areas are bi-modal shoulder peak destinations. As previously suggested (Section 3.2), Yunnan Province has higher TCI scores compared with regions at a similar latitude, leading to the dividing line between bi-modal and summer peak moving southward sharply toward the left.

This classification cannot apply to all destinations perfectly. The TCI values of Yunnan Province are in the range from 60 to 79 all year round; although ratings in the 80s occur in early spring, and 50s occur in late summer. The distribution with high scores lasting for nearly one year would have been labelled "optimal", but its TCI scores are not high enough to be over 80 every month. Yunnan Province, according to the calculated result (Section 3.1), is finally classified as winter peak, because it is distinctly superior to most regions in this season. Poor destinations, moreover, do not exist in China.

4. Conclusions

This paper presents an empirical analysis of the climate impact on tourism seasonality in China during the period of 1981–2010, by combining high quality national meteorological datasets with GIS. The results reveal that the climates of most regions in China are comfortable for tourists during spring and autumn. In summer and winter, the spatial distribution of tourism climates shows a latitudinal gradation. Furthermore, the study suggests that the number of good months throughout China varies from zero to 10, and the most attractive area, with high levels of tourism comfort, is Yunnan Province, whereas the Tibetan Plateau area has the least attractiveness. All regions in China can be divided into three types of annual tourism climate: winter peak, summer peak and bi-modal shoulder peak. The importance of climate resources for tourism seasonality, as well as the spatial distribution of tourism seasonality affected by climate are underlined by analytical results.

All findings of this study can be used as a reference for traveling, planning of destinations, adaptions for reducing seasonality, *etc.* Based on the TCI, travel agencies can create different tour schedules in different seasons. Additionally, a different TCI can be utilized to design different tourism products and even marketing programs. Tourism authorities may make proper readjustments to reduce seasonality by considering climatic attractiveness. What is more, the results of this paper can also be used to promote tourism destinations by local governments (e.g., improvement of existing destinations, development of new destinations). However, the potential effects of climate change will be profound, with temperatures rising and more extreme weather occurring. For example, global surface temperature has risen by 0.8 °C over the last 100 years based on land and marine data [41]. In order to arrive at more robust predictions for future adaptation, additional research is required to compare the results with the actual tourist number and to measure the spatial-temporal distribution of climate resources for tourism seasonality responding to the projected climate change, assessing the effects of climate change in different regional tourism industries, as well as how to deal with these changes flexibly.

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Author Contributions

Yan Fang and Jie Yin conceived the study. Yan Fang gathered the weather data, carried out the caculations and analysis of the results. Jie Yin designed the framework, edited and revised the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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