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# **Analysis of Climate Resources Impact on Guilin International Resort Tourism Development**

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**Abstract:** Guilin is trying to be an international tourist destination. Climate resources development and utilization can play a catalytic role in the sustainable development of tourism. By analyzing the climatic resources of tourism in Guilin, the climate conditions, meteorological disasters and climatic comfort of 13 stations in Guilin were studied. The city has clear four seasons, with short winter cold and summer heat, and the accumulated temperature conditions, rainfall, sunlight, wind is proper for tour; all of these bring a high human comfort. Guilin's climate is very beneficial to the ecological environment, biological species and picturesque scenery, which is very suitable for living and tourism. While, meteorological disasters also occur from time to time, so in the tourism project development we need to pay great attention for it.

**Keywords:** Guilin City, Tourism Resource, Climate Analysis

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## **1. Instructions**

With the rapid development of national economy, people's living standards improved, people's demand for travel is higher and higher. The regions tourism climate resources has been attention more and more. Relevant scholars began to pay much attention to research in tourism climate resources, tourist climatology is gradually mature [1]. Wei Fengyun monograph review the studies of tourism climate of China from 2001 to 2007 [2], the paper summarized the research progress on the current situation of study on tourism climate of China. Yang Shangying [3] in detail discussed the influence of climate on tourism activities. She considered that the tourism climate resources is a very important tourism resources, escape cold tourism climate resources, avoid summer heat tourism climate resources, recuperate tourism climate resources, these tend to have larger attraction to the tourists. Zhang Fuqing [4] basis on the theory of tourism climatology, gave a comprehensive analysis of features of the tourism climate resources in Nanchang and the impact on the tourism industry, put forward make full use of the seasonal variation characteristics and climate advantages, development of tourism resources and climate resources rationally, promote the sustainable development of tourism industry of Nanchang. Guo Jie [5]

think that the weather or climate is an important component of the tourism environment, it is also a kind of important tourism resources. Climate and human tourism activities have a direct or indirect relationship, which influence the development of tourism. Cao Hui [6] and so on thought that climate affect all outdoor tourism activities, its influence can be divided into two basic aspects: First, the climatic conditions affected the tourism environment and the tourism quality for tourists to participate, either positive or negative influence of tourist's activities, for example rain, hail etc. weather disaster can destroy the natural scenery and affect tourists travel experience effect; Second, climate conditions directly affect the person's physiological process, which affect tourists' subjective body feeling comfortable, wind, humidity, temperature can lead to tourists feeling warm, cold, comfortable etc. physiological reaction. Liu Qingchun [7] thinks that the climate has an important influence on the human body, climate is an important factor influencing people's tourism activities. So the evaluation of tourist area climate comfort is particularly important. Besides influence of climate on human health, as one of the important content of tourism resources evaluation, it has relation on the sightseeing place quality and the time

length of the tourist season, the evaluation of tourist area climate comfort not only can offer scientific meteorological basis for the development of tourism, but also help tour operators to arrange activities, to help tourists choose appropriate time and place, so can achieve better economic benefit and social benefit.

Climate conditions is a prerequisite factor for development of regional tourism, and also is a main problem that tourism management departments to carry out tourism activities plan that must considered. The pros and cons of climate conditions directly affect people's activities. Tourists always select the best tourist season, and most comfortable environment for tourism, therefore tourism climate comfort degree is a main factors which affect passenger flow volume seasonal change, and climate change also help to formed tourist low and peak seasons. There are more study of tourism climate comfort, they used comfort calculation methods are not same [8-12], but everybody thought that across different climate condition, climate comfort algorithm should consider the local climate characteristics and considering the local climate adaptability of the crowd.

Full evaluation and development of climate resources, it is an important work for the development of tourism reasonable. Guilin is a famous international tourist destination, study of Guilin tourist climate resources is very important.

## 2. Guilin Climate Resources

Guangxi belongs to subtropical monsoon climate zone, four seasons distinct, abundant climate resources. Guilin is located in the northeast of Guangxi, Xiang-Gui railway corridor is the main channel for cold air invasion to Guangxi. Where surrounding mountains and hills ups and downs, rivers crisscross, it formed the unique local climate. Lian Lishu etc. [13-16] study of tourism climate resources, and put forward that the various regions should according to its local climate characteristics, rational utilization of the tourism climate resources, to development of tourism projects.

### 2.1. Temperature

Guilin city and counties annual average temperature is 16.2~19.9°C. Ziyuan county annual average temperature is minimum, Pingle county annual average temperature is highest. Temperature seasons change is obvious, four seasons are distinctive. The temperature in January is lowest, extreme minimum temperature, in Ziyuan county, is -8.4°C, in central and southern of Guilin, extreme minimum temperature is 0°C or so. In July, the highest temperature was 38.3~40.4°C, in Ziyuan and Longsheng mountain area the extreme maximum temperature seldom appears exceed 38°C, extreme maximum temperature in Quanzhou, GongCheng and Pingle county are about 40°C. But the cold or high temperature weather days is not very long.

### 2.2. Humidity

Relative humidity in all counties is between 67% to 84%, it is lower in autumn and winter season. The humidity of Guilin city is lower than the surrounding county. The relative humidity will be close to 100% at the south wind weather in March and April. Because of south wind brings a lot of water vapor, so doors, windows, and walls are all very wet. But from September to December, influenced by the north dry cold air, or controlled by the subtropical high pressure, the air humidity of Guilin can reduce to 10% or less, the weather is very dry.

### 2.3. Precipitation

The Guilin's average annual rainfall between 1300~2000mm, is one of the heavy rain center of Guangxi. Southern four counties precipitation is fewer, north-central counties precipitation is bullish, Yongfu county annual precipitation is at most of all city. Rainfall in the whole city are abundant in general, but because of Guilin are influenced by monsoon climate, dry and wet seasons is very obvious. From May to July, it is the Guilin's precipitation peak month. Heavy rains and a few days heavy rain weather process is the main cause of city flood. There are about 3-4 times each year distinct flood weather process of Guilin. From autumn to winter season, Guilin's precipitation is reduce obviously and will appear different degrees of drought.

### 2.4. Sunlight

Guilin's sunlight variation is obvious in four seasonal, the sunshine can reach more than 2000 hours for some maximum years, the minimum only 1200 hours for some other years, the difference are nearly 800 hours from maximum year to minimum. From February to April, Guilin is less sunlight, July to September, the sunshine are bullish. The sunshine times is fewer at mountainou area and bullish at the flat country.

### 2.5. Wind

The average wind speed of various counties of Guilin is 1.3- 2.9m/s, between north-central of Guilin, wind speed is bigger, at south of Guilin the wind speed is smaller. Guilin has a lot of mountains about 1500 m high above, these mountains less block for wind because of the high elevation, wind speed is larger all the year round, where can provides a good geographical conditions for wind power. From late spring to early summer and early autumn also often set the combined impact of a short-term thunderstorm winds in Guilin, the wind speed can achieve the largest 15-20m/s, or even close to 30m/s. Due to the rapid development of the city, high buildings and large mansions continuously appears, the city has played a certain role in blocking wind, reflected the trend of wind speed in the smaller.

### 3. Tourism Meteorological Disasters

Guilin's main severe weather are: low temperature of spring and autumn; storms, floods, hail, thunderstorm winds and thunderstorms in the spring to summer; south wind wet weather in the spring; drought in the autumn and winter; cold wind, frost, frozen and cold wave in the winter, etc. Other disasters caused by hail, wind, high temperature, fog and haze etc. this also a certain influence on the local tourism activities. Guilin is a high incidence zone of thunderstorm, with an average of thunderstorm days are 76 days, up to more than 100 days some year, the loss caused by lightning is more and more large. These meteorological disaster affect to Guilin tourism activities.

#### 3.1. Rainstorm

The rainstorm is mainly occur in April to July, there are 4-10 days heavy rain in Guilin every year, the maximum heavy rain day number is appeared 20 days in 2015. One day strongest rainfall is 420.2 mm, on June 22, 1966, at Yongfu county. Heavy rains often cause the geological disasters such as landslides, mud-rock flow, especially in both sides of the road of Guilin to the Ziyuan, to Longsheng mountainous area, every year some section of landslides caused by the heavy rain, affect the normal traffic of the tourist road.

#### 3.2. Drought

Drought is a meteorological disasters that happened in Guilin area almost every year, drought distribution is more in the south part, fewer in north part. It will occur in summer, autumn and winter, but it will not happen in the spring almost. After the middle of July, precipitation decreased significantly in Guilin, it is very prone to drought. The worst appeared standing was three consecutive months without precipitation, production and living water appeared serious difficulties, it also suffered serious destruction of ecological environment, ecological tourism is affected.

#### 3.3. Wind

Spring and summer thunderstorm winds often cause trees down and billboards blown over, it also severely affected on tourist boat in the Li-river of Guilin. Winter cold winds, often bring about cold wave, that can make the tourists feel uncomfortable. At the same time wind easy to cause some upper air tourism projects unsafe.

#### 3.4. Thunder and Lightning

Guilin area belongs to the high incidence of the thunder and lightning, lightning disasters happened every year. Late spring to autumn is the season of lightning prone to. Because urban building lightning protection measures are more strict requirements, lightning mainly damage to the harm of urban household electrical appliances, but in the rural due to lightning protection measures does not reach the designated position, plus farmers often working in the mountains and open paddy field, villagers suffer lightning casualties

accidents almost in every year. Guilin's thunder and lightning was happened from April to August mainly, it is rare in winter to early spring.

#### 3.5. Cold Wave

Affected by the cold wind from northern in Winter, Guilin will appear cold weather. Cold wave mainly affect the northern mountainous area of Guilin, but southern area happen less. Cold wave will cause the loss of comfort, the northern mountainous area because of cold wave can often cause icy roads, serious impact on road traffic safety.

#### 3.6. High Temperature

Midsummer season, the hot weather will also visit Guilin, the average numbers of high temperature day ( $\geq 35^{\circ}\text{C}$ ) are 4-20d per year. In 2013, it is a year that the hot weather is most, Guilin from May to September are high temperature appeared, high temperature days in south county reached to 66d, villages and towns of automatic weather station records to extreme maximum temperature is  $42.1^{\circ}\text{C}$ .

#### 3.7. The South Wind and Continuous Cloudy Rain

March to April, more south wind or continuous cloudy rain weather often happened, this cloudy and wet weather, easy to cause rock tumbled, pedestrian falls, also easy to cause food mildew, affect the daily life of tourists.

#### 3.8. Haze

Since haze is serious atmospheric pollution characterization, in recent years people's attention are more and more to haze, Guilin has appeared more haze weathers in 2010-2014, it maximum reached nearly 100d in urban areas. Since Guilin's government strengthen the management, haze weather has dramatically reduced after 2015, it is only 30 d per year. In addition to the northeast Xingan county haze slightly more, the rest of the county, township is rarely haze.

## 4. Comfort Index of Climate

Climate comfort reflect the climate of a place on the human body feel comfortable degree. There are lots of discussion about climate comfort. Wu Dui [17] specializes compared of variety of algorithms and think of each algorithms have its advantages and disadvantages. He claims various regions should according to its local actual climate situation, to carry out comprehensive research and establish their own algorithms.

#### 4.1. Method Selection

Refer to Guangxi [8] and Nanjing [10] algorithm, the method they used had been corrected in this paper, the calculation months of climate comfort around Guilin is show as below.

$$\text{ssd}=1.8t-0.55(1-f / 100)(1.8t-26)-3.2V^2 \quad (1)$$

The  $ssd$  for human comfort index,  $t$  for the average temperature,  $f$  for relative humidity,  $v$  for average wind speed.

#### 4.2. Various Counties Comfort Level Calculation Results in Each Month

Use the average temperature, humidity, wind speed of Guilin 13 stations of 12 months, plug (1), the results are shown in the table below:

Table 1. Guilin counties climate comfort degree in each months.

Sta./Mon.	1	2	3	4	5	6	7	8	9	10	11	12
Ziyuan	6	9	16	26	34	40	43	43	37	28	19	10
Quanzhou	6	9	16	27	36	42	47	46	39	30	20	11
Longsheng	10	13	20	30	37	42	45	44	39	31	22	14
Xingan	7	10	16	28	36	42	45	46	40	31	21	12
Guangyang	8	10	17	28	36	43	46	45	39	31	21	12
Lingchuan	9	12	18	29	37	44	47	46	41	33	23	14
Guilin	9	12	19	29	37	44	47	47	41	33	23	14
Lingui	11	14	20	31	39	44	47	47	73	34	25	16
Yongfu	11	14	20	30	38	44	46	46	42	34	24	15
Gongcheng	12	15	22	32	40	45	48	48	43	35	26	17
Yangshou	12	15	22	32	39	45	48	48	43	35	26	17
Pingle	14	17	24	33	40	46	48	48	44	36	27	18
Lipu	13	16	23	33	40	45	48	47	43	36	26	18

According to Guilin's actual climate situation, calculate results can divided as 9 levels:  $ssd \leq 10$ , the feeling is cold, very uncomfortable; (10, 15], feeling cool, uncomfortable; (15, 20], feeling slants cool, more comfortable; (20, 25], slightly cool, comfortable; (25, 30], the most comfortable; (30, 35], partial hot, comfortable; (35, 45], feel hot, more

comfortable; (45, 47], feel hot, uncomfortable;  $ssd \geq 47$ , the feeling is very hot, the most uncomfortable.

#### 4.3. Comfort Degree Analysis

It can be seen from table 1 that from December to February is cold uncomfortable in north-central of Guilin, south is less comfortable, From July to August it is hot uncomfortable in south-central of Guilin, north is less comfortable, the rest time is basically comfortable. These climate is very beneficial to tourism.

## 5. Climatic Impact Assessment

Over the past 20 years, Guilin's climate was overall to warming, after high temperature anomalies since 1998, all stations temperature has been in a state of high and volatile. Precipitation change is not obvious. Wind speed is diminishing. Haze weather is increasing. Meteorological disasters caused by climate change is aggrandizing.

Climate change will transform the farmland fertilizer rate, will further intensify the development of crops diseases and insect pests, it can increase the pollution of ecological environment; It affect the surface state and water resources, It can make the soil surface desertification, glacial recession, permafrost melting, degradation of grassland vegetation, it can speed up the desertification, It affect the forest ecosystem carbon cycle; Climate warming, extreme weather and climate events increases, the frequency and intensity of meteorological disaster are augmented.

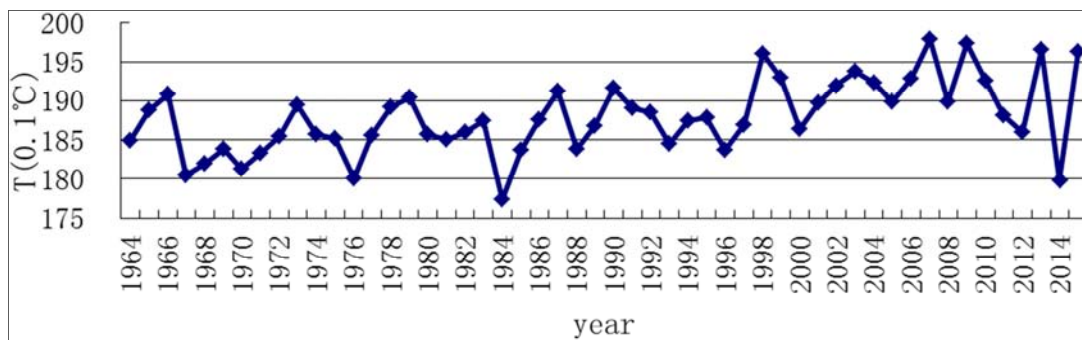


Figure 1. The annual average temperature change of Guilin in every year.

#### 5.1. Effect on Ecological Environment

Climate warming can make the arid development and advancing deserts; Climate warming caused the ash haze weather increased, it serious impact on the ecological environment and Li-river water quality. Farmers' heavy use of chemical fertilizers, pesticides, it has aggravated the ecological environment of Li-river.

#### 5.2. Effects on Biodiversity

According to some study of Guilin's specialists in biology, Guilin diversity degradation is very serious, it had 10 plant species in the Li-river alone has nearly become extinct.

Dominant plant population changes, plant community reduced and its structure simplification, the diversity of plant landscape of Li-river had been influenced. Due to the Li-river water quality is eutrophication, water plants lush spread in the river, but the species composition and community types is simple, the river bank is mainly maple Yang ling and Bamboo. Species and genetic erosion run off at a staggering rate.

#### 5.3. Influence on the Development of the Tourism Industry

Climate has plays an important role for local tourist attraction. Climate change will affect the change of tourism landscape, for example the drought or rainstorm can causing

rivers tourism projects be affected. The weather such as high temperature, precipitation, has a very big impact on tourism activities. Due to climate warming, Guilin winter snow viewing time has decreased significantly, and some south's ornamental plants has introduction to Guilin. It added new attractions for Guilin tourism, such as the introduction of galsang flower, it can flowering in Guilin from spring to autumn, the sea of flowers become a new place for citizens to leisure. Meteorological disasters had a great influence on tourism activities, affect the tourists travel, safety and comfort.

## 6. Brief Summary

- (1) Local climate has play the importance role for tourism landscape formation, climate change will affect the change of tourism landscape, people choose a good climate to arrange travel has become a kind of common practice.
- (2) Guilin has a pleasant climate, little cold or heat weather, ecological beauty, has become an important destination that tourists choose to travel at home and abroad, Guilin is building international tourism resort. According to the climate characteristics, draw on advantages and avoid disadvantages, we can reasonable exploitation and utilization of local climate resources to development of new tourism projects. It can play a positive role of health, sustainable development of Guilin's tourism.
- (3) Major tourist meteorological disasters of Guilin are: heavy rain, wind, drought, high temperature, thunder, cold wave, south wind and continuous rain days, haze etc..
- (4) Guilin climate comfort degree is suitable for human survival and living as a whole. December to February north-central of Guilin will appear as uncomfortable cold weather, from July to August south-central of Guilin will be a hot uncomfortable weather, besides of these, most of the time for the whole year of Guilin basically is a more comfortable or comfort.

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