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# *Impacts of Climate Change on Tourism in Coastal Areas*

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***Abstract:*** Environmental change is a hot issue in recent years, in addition to environmental protection, biology and other industries, it also has a lot of impact on the economy. For coastal areas, which rely on tourism as their backbone, climate change affects them more intuitively. The starting point of this topic is to quantify impacts of coastal tourism, so as to manage and control them. The study uses official data released by the Hainan Municipal government and the Meteorological Bureau to compare the impact of different climate factors on the local tourism economy and combines data from other studies. The research points out that abnormal precipitation will lead to the decline of tourism revenue. For some special heavy rain caused by the surge in precipitation, it will greatly reduce the income of local tourism. In addition, extreme climate, including typhoons, Qingming wind, extreme high temperature, etc., will affect the decline of the number of local tourism and threatening local tourism industry. Studying the effects of climate change can help coastal areas better plan their economies, help tourists choose when to visit, and protect travelers and tourism workers during special months.

***Keywords:*** climate change, tourism, coastal area

## 1. Introduction

### 1.1. Research Background and Significance

For the last few years, climate change has brought about a lot of direct and indirect problems, such as global warming and precipitation change, while indirect problems include glacier melting, sea level rise and so on. Aside from the energy sector, one of the other sectors affected seriously and directly by climate change is tourism, especially some areas known for their warm weather because of the rising sea level and extreme weather. In the past few decades, researches on tourism flows and seasonality, international tourism, tourism adaptations, and the economic impacts of climate change on tourism have been done, stating that there is not only a positive relationship between the economy and the local climate but also a negative impact of increasing climate problems [1]. By studying the specific coastal tourism example, some local economic impacts can be effectively estimated, and thus help the development of coastal areas based on tourism to grow. At the same time, for these areas, the government can give better advice on the appropriate or inappropriate months for tourism, and the government can predict some economic downturns caused by climate change in advance and formulate countermeasures. This will also facilitate tourists to choose their own travel time and places, improve tourists' travel experience and satisfaction, and will also have a good impact on the reputation

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of such areas. At the same time, for some months that are greatly affected by climate change, but due to some special reasons, the tourist flow is still larger than other months, the government can effectively strengthen some protective measures against such events to protect the safety of tourists and tourism workers.

## 1.2. Literature Review

### 1.2.1. Tourism Climate Indices

The Tourism Climate Index, based on thermal comfort components, includes temperature and humidity, aesthetic components, including sunshine clouds, and physical components, including wind and rain [2]. The Tourism Climate Index uses a very simple index to express all of this, including the following atmospheric parameters: sunshine/cloud cover, and wind speed, and corresponding to different weights, and these weights will be different when analyzing coastal areas and general cities. The Mieczkowski Tourism Climate Index (TCI) is the most universally accepted. Previous research has looked at the link between the tourism climate index and the overnight stays in different tourist regions, demonstrating that despite the uncertainty of the index, it can effectively quantify the suitability of a destination's environment. The Holiday Climate Index is also used to quantify the suitability of the destination environment, which can be differentiated to reduce uncertainty in different areas such as beaches, cities and so on [3]. In this respect, it exceeds the tourism Climate Index and can show more consistent results in the analysis of different areas such as beaches and cities. In conclusion, the Tourism Climate Index has proved to be a feasible and effective index for quantifying the suitability of tourism destinations. At the same time, through this index, the different effects of different climatic characteristics on the suitability of tourist destinations can be distinguished. However, many of the data of this index have the characteristics that cannot be collected in a standardized way. For example, the data of thermal comfort will vary according to different people’s feelings, and it will also differ due to some psychological and behavioral factors or different regions where people come from. Therefore, the tourism climate index can be used as one of the important reference standards, but it is not completely reliable.

### 1.2.2. Tourist-host Exchange Model

This model is mainly used to understand the reaction of residents and tourists to the development of tourism. Basically, three assumption that are made about this model is that there are two types of people involved in tourism that must be involved: residents and tourists; that both groups have their own needs; and that in the negotiation they must reach a consensus and then share the limited resources of the local area [4]. The benefits or costs of the exchange of materials throughout the tourism process allow residents to evaluate their Willingness to Accept for the tourism content (WTA), and allow tourists to evaluate their Willingness to Pay for the tourism content (WTP) [5]. This model is considered to be more general for the judgment of different influencing factors of tourists' choice of tourist destination. Most previous studies on the influence of tourism on residents pay more attention to more specific issues, more specific views and their reasons. Moreover, they only pay attention to a group closely related to tourism, that is, residents, and ignore the analysis of tourists' choices and influences on tourism development. This model is mainly based on a theory called Social Exchange Theory (SET), which is used in the analysis of perspectives from residents towards tourism at large, and combines theories such as carrying capacity, the “Irridex” model and TALC [6]. From different aspects, this paper analyzes the influence of different factors in physical environment and physiological society on the attitude of residents and tourists towards tourist destinations.

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### 1.2.3. Tourisim in Pangandaran

This study focuses on the situation of tourism in Pangandaran Beach, mainly because of its popularity among tourist attractions in West Java, and discusses what results the climate change causes in the country and how does the climate change affect both tourists and tourism practitioners' opinions [7]. The results show that from the perspective of tourism practitioners, climate change will affect coastal natural resources, which are themselves one of the biggest attractions of coastal tourism; from a tourist perspective, climate change will affect how tourists travel to the areas they visit.

Studies have shown that the number of tourists visiting Banggandaran has fluctuated. The decline over the past five years was mainly caused by tsunamis, which related with the climate change, in Aceh and Banggandaran. In protecting against natural disasters, the government can focus on managing the disaster-prone areas and take this factor into account in spatial planning. At the same time, the government needs to integrate disaster risk factors more effectively into sustainable development. In addition to climate disasters, although the severity of climate change and its effects is not yet intuitively felt by both tourists and tourism practitioners, adaptation plans should be proposed in advance.

### 1.2.4. Numerical Climate Models

Numerical models and observations of climate are very important for those who analyze environmental problems and decide policy, and through this model the Intergovernmental Panel on Climate Change (IPCC) addresses some more specific problems already faced and potential problems that may occur in the future [8]. Numerical models of climate can not only predict the weather, but even analyze the effects of climate change. Recently, the Coupled Model Comparison Project (CMIP), supported by the World Climate Research Programme (WCRP), has predicted climate change in the 21st century, and these results have provided basis for some of these analyses.

However, there are some problems with the model, such as the inability of the model to provide researchers, stakeholders and decision makers with the necessary high-resolution regional climate information in areas with complex terrain or coastal areas, which leads to the application of the model being more general than precise. So even though this model solves most of the climate estimation problems and the model has been widely used, it leaves some problems that need to be solved for coastal areas and other complex areas, and some new research techniques have been developed. To avoid these problems, dynamic downscaling techniques are now more widely used. Due to better surface topography, vegetation and land and sea distribution, RCM is able to better reproduce the climate characteristics of these regions [9].

## 1.3. Research Content and Framework

This research will analyze how specific climate changes affect Hainan's local tourism, a typical coastal tourism region in China, through the climate and economic data, and combine with other papers related to this specific climate impact, deduce how general climate change relates with coastal tourism, and give some solutions.

## 2. The Case of Hainan

Similarly, Hainan Province in China is an area with tourism as a supporting industry. According to statistics, the tertiary industry led by tourism is the main supporting industry of Hainan Province. In 2022, the number of tourists in Hainan Province exceeded 60 million, and the total tourism income reached 105.476 billion yuan, of which the tourism income in February, July and January accounted for the top three. The climate change in Hainan Province is mainly reflected in three aspects:

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temperature change, precipitation change and sea level change, and has a significant impact on Hainan's tourism industry.

In 2022, Hainan Province was affected by Qingming wind twice in April, resulting in extremely low temperatures. In May, there were 4 light to medium heavy rains, which were more than the usual. In July, there were three phases of large-scale high temperature processes; In August, Typhoon Mulan No. 7 and Typhoon Masadda No. 9 were tropical storm and typhoon respectively. It was affected by Typhoon Olu in September. The above months, except July, are all months with low annual tourism revenue. Considering a series of reasons such as the special time of July, the unified summer vacation of students, and the more extreme weather in July 2021, the possibility of extreme weather affecting the tourism industry in July cannot be ruled out. In addition, there are also studies focusing on the analysis of Taiwan Maolin national scenic area, to explore threats of weather disaster to local tourism. The study assessed the subsequent impact of Typhoon Morakot on the region and found that in the 18 months after the disaster, the number of visitors to the park decreased by more than 700,000, resulting in a total loss of NT $1.39 billion in tourism [10]. In addition, research has shown that tropical cyclones have a huge impact on coastal tourism from different angles, including damage to infrastructure, business disruption, tourist evacuation, and damage to the image of the destination. In Florida, for example, the study estimated an average loss of about $10 million per county immediately, $12 million in the first month after the disaster, and $7 million in the second month after the disaster. The average damage to coastal counties during the month of the hurricane was estimated at about $12.5 million and continued to be felt for the next two months. These results suggest that coastal areas of Florida will be hardest hit by the climate disaster, if only tourism losses are taken into account [11].

## 3. Analysis on the Problems

Precipitation has a negative effect on tourism. In the data released by the Hainan provincial government in 2022, the three months with the lowest tourism revenue are April, August and September. From Table 1, the author can see the characteristics of the following aspects: First of all, the average temperature in April was 24.9 degrees Celsius, and the precipitation was 101.0 mm. The average temperature was relatively low compared with previous years, with slightly more precipitation and large fluctuations in weather, and the total revenue of tourism in the month was only 6.035 billion yuan. The average temperature in August was 27.8 degrees Celsius, and the precipitation was 308.5 mm. Although the temperature was normal compared with previous years, the precipitation was higher. The total revenue of tourism in the month was 2.894 billion yuan, the lowest in the whole year. The average temperature in September was 27.4 degrees Celsius, and the precipitation was 285.5 mm, which was 0.5 degrees lower than previous years, and the precipitation was low. The total revenue of tourism in the month was 3.01 billion yuan, which was the second lowest in 2022. It can be seen that in the three months with the lowest tourism revenue in Hainan Province in 2022, there are abnormal precipitation compared with previous years. At the same time, a study found that the Djukar and Segura basins in the Spanish Mediterranean region recorded a total of 239 extreme rainstorms (≥200 mm/24 h) between 1950 and 2016, and as the impact of extreme rainstorms extended into November, it posed a huge challenge to increase the number of tourists there [12]. This information indicates that too much or too little precipitation will have a negative impact on tourism.

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Table 1: T statistics of average monthly temperature, precipitation, number of tourists received and total tourism revenue in Hainan Province in 2022.

| Month (2022) | Average temperature (Celsius) | Precipitation (mm) | Number of passengers received (tens of thousands) |
|---|---|---|---|
| 1 | 20.9 | 22.9 | 665.42 |
| 2 | 19.1 | 53.2 | 1103.21 |
| 3 | 24.5 | 25.5 | 465.11 |
| 4 | 24.9 | 101 | 312.65 |
| 5 | 26.3 | 326.6 | 432.43 |
| 6 | 29.1 | 127.2 | 490.34 |
| 7 | 28.8 | 321.1 | 604.16 |
| 8 | 27.8 | 308.5 | 158.2 |
| 9 | 27.4 | 285.5 | 183.79 |
| 10 | 25 | 304 | 449.67 |
| 11 | 24.8 | 108.7 | 486.35 |
| 12 | 18.9 | 25.7 | 652.69 |

Moreover, climate disasters, including typhoons, tropical cyclones, torrential rain, drought, cold dew wind, Qingming wind, low temperature rain, hail, tornadoes and so on, have a great impact on tourism. These natural disasters will lead to crop production and the closure of tourism-related facilities, which will directly affect people's lives and property safety. These disasters also affect people's health and quality of life, with high temperatures leading to water shortages and air pollution, and humidity increasing the risk of infectious diseases.

## 4. Suggestion

In response to some of the problems related to tourism brought about by climate change, here are some suggestions for improvement.

Firstly, reducing greenhouse gas emissions for retarding global warming and the climate change caused by global warming should be included in the policy. For example, voluntary agreements are instruments of interaction, usually legislative processes, between industry and government in which there is a voluntary partnership on environmental and other matters. In theory, if companies have more expensive legal controls, they will be forced to take steps to reduce greenhouse gas emissions. At the same time, if the general direction of the policy is to reduce greenhouse gas emissions, through the formulation of an overall comprehensive policy, it can help reduce greenhouse gases [13].

Secondly, in view of crop damage and closure of tourism facilities caused by extreme weathers, mainly unusually heavy rainfall in the spring and summer, the drainage efficiency after encountering extreme precipitation can be effectively improved through strategies such as waterway maintenance and increasing the availability of waterways, so as to reduce crop losses.

Thirdly, some survey results show that due to the lack of air-conditioning systems, some tourism related workers who work outdoors cannot adapt to working in extreme temperatures, which is very bad for their physical and mental health and safety. The government can protect the health of workers by making reasonable and effective shift plans and providing work or rest periods [14].

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## 5. Conclusion

The impacts of climate change on tourism in coastal areas are very typical, extensive and complex, and the analysis of coastal areas can well cover some environmental problems that most tourism industries will face under the general trend of global warming. For the government, tourism workers and tourists, this paper will play a role in helping to formulate policies, protect their own safety and facilitate the choice of travel time. At present, global warming is an irreversible natural condition for the time being, and tourism, which is greatly affected by climate, is being used as a pillar industry in a large part of coastal areas. With the intensification of climate change, tourism will face the need to change and adapt to the environment, and this study mainly focuses on which climate change is the primary problem that these coastal areas need to pay attention to and solve. In this paper, climate data of Hainan, including precipitation data, temperature data, and economic data of tourism, are compared and analyzed, so as to find and quantify the problems. Finally, it is concluded that no matter the precipitation is too high or too low and the extreme weather conditions have a great negative impact on the tourism industry. However, this conclusion must be compared with data from other coastal areas, including some coastal areas that are not supported by tourism. For example, the Andaman Nicobar Islands in India, because the tourism industry is generally undeveloped, the increasing climate problems will not have the same impact on the tourism industry in this place as Hainan. In the future, more specific economic utility or tourism index can be used to distinguish different influencing factors from the relationships that lead to results, so as to judge which or which of such complex factors have the greatest impact, so as to facilitate regional response and improvement.

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