Chapter 5
Tourism Climate Indicators (TCI) Applied in Moc Chau District (Son La, Vietnam)

Hoa Thu Le, Khanh Nguyen Ngoc, and Nhung Nguyen Thu

Abstract Climate is an important resource of tourism industry; climate indicators can be measured and assessed. The determination of the right time for tourism activities contributes to the orientation of making investment plans for managers and advising vacation time for visitors. To determine the right time, the researched team used 7 climate parameters: total precipitation, monthly average temperature, relative humidity, average maximum temperature, average temperature of dark temperature, minimum average of relative humidity, and daily average of sunshine hours and wind speed to calculate TCI model in Moc Chau. The TCI calculation results based on 10-year climate data (2008–2018) show that Moc Chau is a place with favorable conditions for year-round tourism activities, preferably from October to April next year.

Keywords Tourism climate indicators (TCI) · Tourism industry · Moc Chau · Vietnam

1 Introduction

Tourism is an important economic sector of the global economy. In 2018, the tourism industry achieved 1451 million visitors and achieved a total turnover of $ 1401 billion, creating an average of $ 5 billion per day for the world economy (World Tourism Organization (UNWTO), 2019). Tourism has been improving the quality of life for millions of people, changing the lives of communities in many countries,

H. T. Le
Tay Bac University, Son La, Vietnam
e-mail: hoale@utb.edu.vn.com

K. N. Ngoc
Vietnam Geography Association, Hanoi, Vietnam

N. N. Thu (✉)
VAST - Institute of Geography, Hanoi, Vietnam

not only in developed countries but in developing countries also that have benefited from the tourism industry. Therefore, the development of the tourism industry is the object of many scientific studies with many different perspectives, including studies on the relationship between human health and climate, creating an application platform for studying the linkage between climate and tourism industry.

Climate and weather are considered a country's tourism resources, having profound impact on human health and tourism. During the past nearly 100 years, many researches on climate index with human health and resort activities have been conducted (Landsberg, 1972; McMichael, Woodruff, & Hales, 2006). Many studies have even shown that climate affects the tourism industry as deeply as agriculture, namely: climate decides the location selection and tourism experience (Hamilton, Lau, & Lau, 2006; Hu & Ritchie, 1993). From the perspective of organizers, Scott and McBoyle (2001), Matzarakis (2006), Kozak, Uysal, and Birkan (2008), Scott and Lemieux (2010), and Gómez-Martín, Armesto-López, and Martínez Ibarra (2017) point out that climate affects crop length, quality, and profitability of tourism industry. Meanwhile, Matzarakis (2006) and Gómez-Martín et al. (2017) suggest that climate and weather affect tourism dynamics and activities. In line with the above viewpoint, Ayscue, Curtis, Hao, et al. (2015) and Gómez-Martín et al. (2017) have pointed that: The climate influences the decisions of investors, managers, and tour operators. Therefore, climate is an important criterion in assessing the image of a destination for tourism and is considered a tourism development resource of a locality. Climate parameters need to be specifically quantified to assist travelers in planning a vacation, managers in exploiting and making their own decision in investment.

In recent years, there have been many studies on climate index for tourism such as tourism climate index (TCI) (Mieczkowski, 1985), beach climate index (BCI) (Morgan, Gatell, Junyent, et al., 2000), and developing tourism climate index (TNDT) (De Freitas, Scott, & McBoyle, 2008). However, from its birth to the present, the TCI proposed by Mieczkowski is the most widely used indicator to assess the suitability of climate for tourism. The purpose of TCI is to provide a comprehensive measure to quantify and assess the world climate for tourism activities in general by integrating all climate-related variables into a single indicator; this indicator has three advantages: firstly, TCI determines the appropriate time to conduct tourism activities at a specific time in any locality when meteorological parameters are available; secondly, quantifying TCI uses data stored for many years, so it is possible to show the change of TCI at different stages, thereby quantifying the local climate change, this is significant in assessing the impact of climate change on tourism as currently (Amelung, Nicholls, & Viner, 2007; Hein, Metzger, & Moreno, 2009; Nicholls & Amelung, 2008; Scott & McBoyle, 2001); thirdly, identifying TCI helps compare climate potential in different localities, allowing comparison of destination climate differences among different regions. Because of the diversity and integrated climate indicators for tourism, TCI is applied to the research in many countries around the world (Amelung et al., 2007; Cheng & Zhong, 2019; Kozak et al., 2008).

Our study selects the mountainous district of Moc Chau to assess the tourism climate index because of the importance of the district in the Moc Chau national tourist area, in particular, and the Northern Vietnam tourism, in general. According

to development planning, Moc Chau has been identified as one of the 10 National Tourist Areas, a driving force for tourism development for the whole region. Although in many reports and studies, it is always confirmed that climate resources played the most important role in the tourism attractions in Moc Chau, no studies have yet quantified the local tourism climate index. Determining tourism climate index in Moc Chau creates scientific basis and creates decision-making tools for tourists, in particular, and the tourism industry, in general, for Moc Chau district.

2 Methodology

2.1 Study Area

Moc Chau is a mountainous plateau district of the limestone plateau in the Northwest region of Vietnam, with an average altitude of more than 1050 m above sea level, with a natural area of 1081.66 km^2 ranked eighth among 12 city districts of Son La province. The whole district has 2 towns (Moc Chau and Moc Chau Farm) and 13 communes (Dong Sang, Muong Sang, Long Sap, Chieng Khua, Chieng Hac, Tan Lap, Chieng Son, Tan Hop, Phieng Luong, Quy Huong, Na Muong, Hua Pang, and Ta Lai).

Overall, Moc Chau has a very cool climate, the average annual temperature is only about 18.7 °C; in the hottest month, the average temperature reaches 23.2 °C and reaches 12.3 °C in the coldest month. Moc Chau has two distinct rainy and dry seasons: the dry season from November to March next year, the average rainfall is about 20-40 mm/month; rainy season is from April to October, the average monthly rainfall ranges from 100 mm/month to 330 mm/month. According to the observed data, the number of sunny hours at Moc Chau station is very moderate, reaching 1665 hours/year (Table 5.1).

Thus, Moc Chau is located in the tropical monsoon climate but due to the impact of the high belt, it brings both the characteristics of the subtropical and temperate highland climate, which is very convenient to develop tourism for whole years.

Table 5.1 Temperature, rainfall, average monthly sunshine hours in Moc Chau district, period 2008–2018

Month	1	2	3	4	5	6	7	8	9	10	11	12	Average in year
Average tem (°C)	12.3	13.6	17.0	20.5	22.4	23.2	23.1	22.6	21.3	19.0	15.9	13.0	18.7
Average rainfall (mm)	21.8	21.4	42.1	103.2	188.2	231.5	286.3	326.7	254.6	132.9	37.9	18.5	1665
Average monthly sunshine hours	118	138	165,9	192,8	153,1	148,0	147,7	148,7	143,4	134,6	146,0	127,7	1665,4

Source: Calculation based on data provided by the National Center for Meteorology and Hydrology

2.2 Methodology

For this study, we collect and use monthly average data on climate factors at Moc Chau station, Son La province, for 10 years from 2008 to 2018.

The process of determining climatic indicators is determined as follows:

1. Collect data.
2. Calculate the comfort index daytime (CID) on the basis of average maximum temperature and monthly average minimum humidity (°C).
3. Calculate the average daily comfort index (CIA) (°C) which is a combination of daily average temperature (°C) and average daily relative humidity (%).
4. Determination of monthly rainfall (R)(mm).
5. Determination of monthly sunshine hours (S)(h).
6. Determine the average wind speed W (km/h).
7. Calculate tourism climate index using the following relationship:
   TCI = 8CID + 2CIA + 4R + 4S + 2 W. (Table 5.2)
8. Determine the appropriate time for taking place tourism activities at local area (Table 5.3).

3 Results

Through the research steps, we have the results of the subindex and tourism climate index in Moc Chau district as follows (Table 5.4).

Table 5.2 Additional parameters/indicators in tourism climate index

Parameters	Climate change	Effect on TCI	Contribution level (%)
CID	Daily maximum temperature and daily minimum relative humidity	Description of thermal comfort when tourist activity takes place at its maximum	40
CIA	Average daily temperature and daily relative humidity	A description of thermal comfort within 24 h including when sleeping time	10
P	Amount of rain	Reflecting the negative effects of outdoor activities	20
S	Number of sunny hours	Making a positive contribution to tourism, but there is a potential risk of sunburn and discomfort on extremely hot days	20
W	Wind speed	Being positive in nature because of the cooling effect in hot areas	10

Table 5.3 Classifying tourism climate index according to comfort level

NO	Tourism Climate Index	Comfort level
9	100–90	Ideal
8	90–80	Excellent
7	80–70	Very good
6	70–60	Good
5	60–50	Acceptable
4	50–40	Normal
3	40–30	Unexpected
2	30–20	Very undesirable
1	20–10	Extremely undesirable
0	10–0	Imposed

Table 5.4 Results of sub-indicators and tourism indicators in Moc Chau district, Son La province

Month	1	2	3	4	5	6	7	8	9	10	11	12
CIA	3	4.5	5	5	3.5	3	3.5	3.5	4.5	5	5	4
CID	2.5	2.5	3.5	4.5	5	5	5	5	5	4.5	3	2.5
R	4.5	4.5	4	2	0	0	0	0	0	1	4	4.5
S	1.5	2	2	2.5	3	2.5	2	2	2	2	2	2
W	5	5	5	5	5	5	5	5	5	5	5	5
TCI	**63**	**77**	**81**	**77**	**60**	**54**	**56**	**56**	**64**	**71**	**80**	**73**

In general, Moc Chau district has a favorable climate to develop tourism in whole years. During the year, there are 2 months with excellent tourism climate index (March and November); 4 months have a very good tourist climate index (February, April, October, December); 3 months have a good TCI (January, May, September); 3 months tourism climate index reached the lowest level (May, June, July) but still acceptable in the general classification (Fig. 5.1).

Because Moc Chau is located on a plateau with an average elevation of 1050 m, the daily comfort index (CIA) and the minimum to maximum temperature threshold (CID) show that Moc Chau climate is cool throughout the day and night, favorable for traveling vacation. This is also a district with a moderate number of hours of sunshine and wind speed, which brings a pleasant feeling to visitors, without the feature of being sunburned or too strong wind obstructing the movement so it is very convenient for outdoor activities (hiking, camping, cycling…). Especially, March and November are the best climate months for visitors to Moc Chau, all of the meteorological elements are ideal for human health and safe for visitors' travel (Fig. 5.2).

From May to August, the district's CTI reached the lowest level of the year (54–56%). The reason is that the district is located in the tropical monsoon climate zone; during this period, the district is influenced by the southwest monsoon combined with the tropical convergence band, so the rainfall is much higher than other
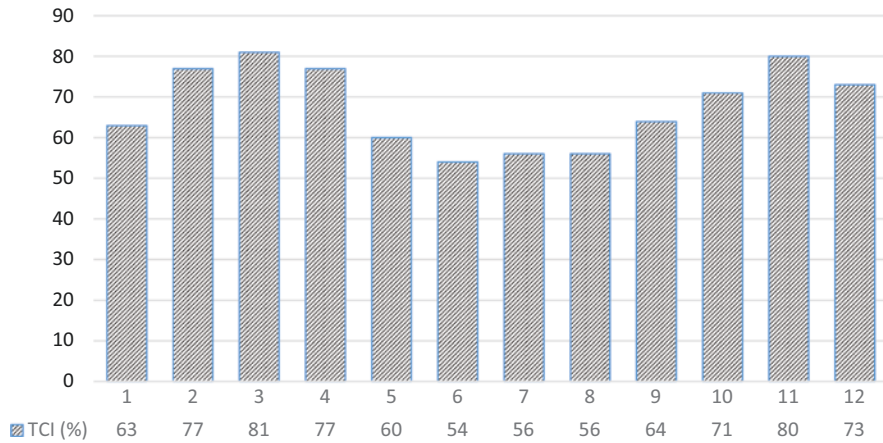
Fig. 5.1 Changes in tourism climate index of Moc Chau district in months of the year

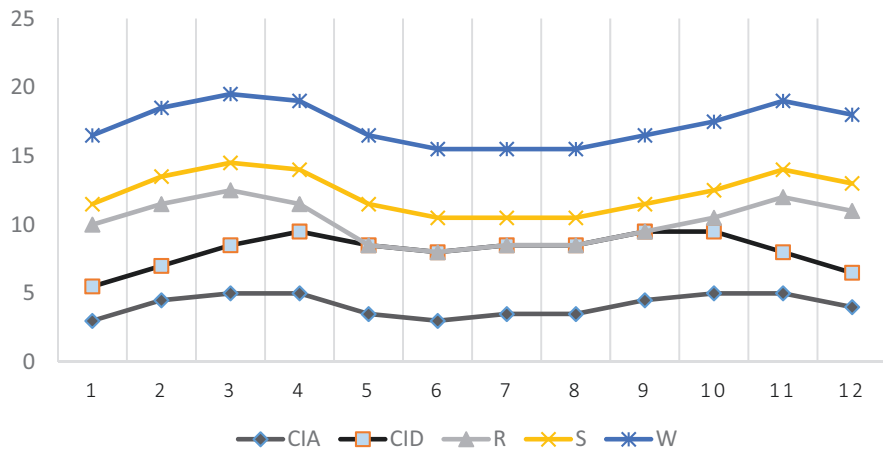|	1	2	3	4	5	6	7	8	9	10	11	12
TCI (%)	63	77	81	77	60	54	56	56	64	71	80	73

Fig. 5.2 Variation of sub-indicators related to tourism climate index in months of the year in Moc Chau district

months of the year (Table 5.1). It rains making travel activities difficult, especially affecting the travel and outdoor experience activities of visitors.

In addition, CTI in January dropped sharply to 63% compared with December at 70% and February to 77%. The main reason is due to the impact of the polar air block, brought by the northeast monsoon, making the temperature here reach the lowest level of the year; at the same time, the number of sunny hours is also sharply reduced because of heavy fog this month.

4 Conclusions and Discussion

The application model of the tourism climate index (TCI) of Mieczkowski in Moc Chau district, Son La province, Vietnam, once again confirms that tourism activities are not only affected by the heat element of the atmosphere but also by other factors: rain, sun, and wind. Research results show that Moc Chau can organize tourism and recreation activities all year round because all months of the year have an acceptable climate index for tourism activities. The study also provides travelers with the best time to visit Moc Chau from September to April next year. Especially, March and November are the two best climate months to relax and experience here. In addition, the TCI in Moc Chau provides a scientific basis for tourism managers and travel agencies to plan investments and establish appropriate businesses to achieve the highest efficiency.

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