ANALYSIS AND DETERMINATION OF TOURISM CLIMATE INDEX (TCI) IN EAST NUSA TENGGARA

Hidayat, N.M.[1]*

[1]Indonesian Agency for Meteorology Climatology and Geophysics (BMKG), Jakarta, Indonesia, 10610
*E-mail: nmanarul@gmail.com

ABSTRACT

The development of tourism is quite rapid in several parts of Indonesia. No exception in East Nusa Tenggara which offers beautiful part of the beach. Most tourists will use this information in the form of the Climate Comfort Index (CCI) to determine the right travel time. The Climate Comfort Index can be searched using the Tourism Climate Index (TCI) method including weather parameters such as maximum air temperature and minimum air humidity (Daytime Comfort Index), average air temperature and average air humidity (Daily Comfort Index), rainfall, length of sunshine and average wind speed. Monthly data for the years 1991 - 2015 were provided from eight BMKG meteorological stations. The results showed that the Rote and Maumere regions were in the 'Very Good' category in the summer (June to July). Meanwhile, Sabu and Rote had the most comfortable for seven months. In general, during the summer (June to August) the TCI value (≥ 70) has increased so as to provide comfort condition for beach tourism destinations. The best time for travelling is best visited during the peak of the dry season (June to August) while in the rainy season (November to February) is the worst time to travel.

1. Introduction

The tourism industry is one of the fastest growing industries in Indonesia. This is evidenced by statistical data on the achievements of tourism development throughout 2016 which exceed the target. The cumulative number of foreign tourist arrivals to Indonesia (January to December 2016) was recorded at 12,023,971 visits, with a growth of 15.54%. Based on statistical data for the period January - November 2016, countries that are members of the Association of South-East Asian Nation (ASEAN), such as Thailand (9.7%), Singapore (7.9%), and Malaysia (4.4%). Visits of foreign tourists have a positive impact on foreign exchange earnings of Rp. 176-184 trillion rupiah, from the 2016 target of 172 trillion rupiahs [1].

The Indonesian government, through the Visit Indonesia program, has had a significant influence in increasing the number of foreign tourists in 2012. The number of foreign tourists who came reached 8.04 million, up 5.16 percent compared to 2011 [2]. Forecasts by the World Tourism Organization (UNWTO) show that by 2030 international tourists will reach 1.8 billion with an estimated growth rate of 3.3 percent per year. Meanwhile, the Asia and Pacific region is estimated to control 4.9 percent [3].

Increasing the number of tourists can affect the Gross Regional Domestic Product (GRDP). Through the measurement of variables in the tourism sector (number of tourists, hotels, objects, investment, and restaurants) shows a positive and significant contribution to the GRDP of East Nusa Tenggara Province [4].

East Nusa Tenggara has various tourism destinations and various tourist attractions, ranging from natural resources, cultural festivals, customs, to culinary delights. According to BPS data 2015 [5], tourists visiting NTT mostly choose natural and coastal destinations as tourist destinations. Of the 458 tourists who visited in 2015, 115 people chose natural destinations and 104 people chose beach destinations as their tourist destinations.

The aspect of tourism development is influenced by various factors. One of the significant factors is weather and climate [6]. Climate factor is an essential factor in determining tourism development planning, so it needs to be measured and evaluated [7]. Areas, where the level of comfort are unknown will be at risk of stroke, asthma and other disorders due to the significant difference in climate with the region of origin of tourists [8].

Seasonal analysis using TCI for tourist attractions in Ethiopia uses climate parameter data to TCI calculations from 170 weather stations throughout Ethiopia. The results show that the climatic conditions in Ethiopia are very good for tourists coming with a range of Marginal to ideal results in each region in Ethiopia [9]. Investigated the variability of tourism climate comfort in Bali Province from 1981 to 2014 on a spatial and temporal

ANALYSIS AND DETERMINATION OF TOURISM CLIMATE INDEX...Hidayat, N.M.

57

scale. The data used in the study is combined data from bmkg station observations in Bali Province, CHIRPS, and ECMWF as well as ONI data for the analysis of ENSO's influence on tourism comfort levels in Bali province. The results showed that Bali Province has the highest level of comfort in the dry season (June - July - August) with a good comfort level for traveling while in the rainy season has the lowest average but is still in a good period for traveling. In addition, in the extreme analysis of the level of comfort of the tourism climate in Bali Province, the minimum extreme analysis has the comfort level of the tourism climate in the range in tolerance to quite good. While in the maximum extreme analysis has a level of comfort tourism climate in the comfortable range for travel [10].

Research on TCI is developed in Hungary. Kovacs et al. (2017) developed research on the current climate conditions of tourism in Hungary and future assessments. The data are observational data from the CarpatClim project of 1961–1990 and projection data from the two periods 2021-2050 and 2071–2100 from Aladin-climate set by the Hungarian meteorological service [11].

The use of TCI has been used for analysis in various areas such as the Ancol, Bogor Botanical Garden, and Cibodas Botanical Garden. The results show that daytime is the minimum climatic comfort condition for doing tourist activities [12]. TCI information can also be submitted on a monthly basis, such as tourist areas in Magelang (Borobudur Temple) which shows that the convenience of traveling is from June to August [13].

This research aims to analysis and determination the comfort index of tourism in NTT. We know that NTT is very possible to be developed as one of the strategic areas in priority scale national development because NTT is a National Strategic Area (KSN) and a Special Economic Zone (KEK) for the Eastern Indonesia region [14].

2. Methods

The location of the object of research is precisely in the Province of East Nusa Tenggara (NTT) which is astronomically located at 8 ° - 12 ° south latitude and 118 ° - 125 ° east longitude. NTT is one of the provinces whose territory is united by the Savu Sea and the Sumba Strait. The area reaches 47,349.9 km2. With a large enough area, this study uses monthly climate data (maximum air temperature, average air temperature, wind speed, solar radiation and precipitation) for the period 1991 - 2015 obtained from seven Meteorological Stations (Waingapu, Sabu, Maumere, Alor, Rote, Larantuka, and Eltari) and one Climatology Station (Lasiana Kupang).

Climatic conditions and one's physical comfort are closely related to one's condition in an area [15]. The method to determine the comfort level of a tourism area is used the Tourism Climate Index (TCI). The formula for finding the TCI value uses equation:

$$TCI = 8\,CI_d + 2\,CI_a + 4\,R + 4\,S + 2\,W \quad (1)$$

with:
CI_d = maximum daily air temperature (°C) and minimum daily relative humidity (%)
CI_a = mean daily air temperature (°C) and mean daily relative humidity (%)
R = total precipitation (mm)
S = total hourss of sunshine (hourss)
W = average wind speed (km/h or m/s)

The ranges given for all the parameters used in the TCI method range from 0 to 5. A rating close to the value 5 indicates that these parameters are ideal for forming a comfortable environment. The weight value of each TCI parameter can be seen in Table 1.

Table 1. Table of Tourism Climate Index (TCI)

Sub- Index	Weighting (%)
Daytime Comfort Index (CI$_d$)	40%
Daily Comfort Index (CI$_a$)	10%
Precipitation (R)	20 %
Sunshine (S)	20 %
Wind (W)	10 %

**Table 2. Table Rating Scheme Effective Temperature and Mean Monthly Precipitation**

Rating	Effective Temperature (⁰C)	Mean Monthly Precipitation (mm)
5	20 – 26.9	0 - 14.9
4.5	19 – 19.9 and 27 - 27.9	15- 29.9
4	18 - 18.9 and 28 - 28.9	30 – 44.9
3.5	17 - 17.9 and 29 - 29.9	45 – 59.9
3	15-16.9 and 30 – 30.9	60 – 74.9
2.5	10 – 14.9 and 31 - 31.9	75 – 89.9
2	5 – 9.9 and 32 – 32.9	90 – 104.9
1.5	0 – 1.9 and 33 – 33.9	105 - 119.9
1	-5 – 0 and 34 – 34.9	120 – 134.9
0.5	35 – 35.9	135 -149.9
0.25	>36	-
0	-9.9 - -5	>150
-1	-14.9 - -10	-
-2	-19.9 - -15	-
-3	< -20	-

Table 3. **Table Rating Scheme Mean Monthly Sunshine and Wind Speed**

Rating	Mean Monthly Sunshine (hrs/day)	Wind Speed (km/h)
5	>10	< 2.88
4.5	9 – 9 hours 59 minute	2.88 – 5.75
4	8 – 8 hours 59 minute	5.76 – 9.03
3.5	7 – 7 hours 59 minute	9.04 – 12.23
3	6 – 6 hours 59 minute	12.24 – 19.79
2.5	5 – 5 hours 59 minute	19.8 – 24.29
2	4 – 4 hours 59 minute	24.30 – 28.79
1.5	3 – 3 hours 59 minute	28.8 – 38.52
1	2 – 2 hours 59 minute	-
0.5	1 – 1 hours 59 minute	-
0	< 1 hours	>38.52
-1	-	-
-2	-	-
-3	-	-

Table 4. **Table Rating Categories of Tourism Climate Index (TCI)**

Value of Index	Description
90 -100	Ideal
80- 89	Excellent
70 – 79	Very good
60 – 69	Good
50 – 59	Acceptable
40 -49	Marginal
30 - 39	Unfavourable
20 -29	Very unfavourable
10 -19	Extremely unfavourable
-3 - 9	Impossible
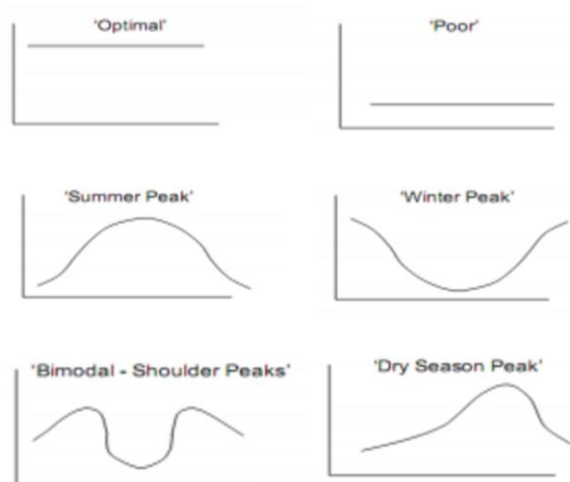
Figure 1. **Six Conceptual Tourism Climate Distribution**

The next TCI value is calculated using the equation (1) by using the variable rating scheme (sub-index) in Table 3 as a reference.

After that, the TCI value is processed statistically simple, and the final output results are spatial descriptions to display areas based on the level of comfort of the tourist climate.

The climate comfort level in the tourism sector can be classified into six annual distributions (Figure 1). The distribution of the tourism climate in Scott and McBoyle's [16] model can represent seasons caused by climate conditions.

3. Result and Discussion

Spatial Distribution of Monthly TCI Values. TCI scores in January at several points in the NTT region were in the range of 40 - 59 (marginal to acceptable). It can be seen that the Waingapu Meteorological Station, Maumere Meteorological Station, Larantuka Meteorological Station, Mali Meteorological Station, and its surroundings have TCI scores that fall into the 'marginal' category. Meanwhile, for the area of the Lasiana Climatology Station, El Tari Meteorological Station, Tardamu Sabu Meteorological Station, Lekunik Rote Meteorological Station, and its surroundings have the TCI value category 'acceptable'.

In February the TCI value at several points in the NTT region was in the range of 40 - 59 (marginal to acceptable), but several areas in NTT experienced an increase in TCI values, such as the Mali Meteorological Station and its surroundings. The TCI value in March was still in the range of 40 - 59 or in the 'marginal to acceptable', but the spread areas where the TCI value increased. There was an increase in the TCI value in April to reach an 'acceptable' value of 59. Value of TCI in May go on high increase from the previous month, which in the range of 60-79 (good to very good).

The TCI values from June to August are in the range 70 - 79 (very good). From the explanation, it is known that from June to August all destinations in NTT can be visited very safely and comfortably because they have a 'very good' level of climate comfort. This shows that June to August is the best time to visit NTT to be used as a recommendation for tourists who want to visit NTT.

In the regions of Iran, spring and autumn have a comfortable climate for tourism activities. Spatially during the baseline period, the comfort level of tourism in Iran falls into the marginal category – very good. While in the Future period entered into a period of comfort level can be received - very good [17].
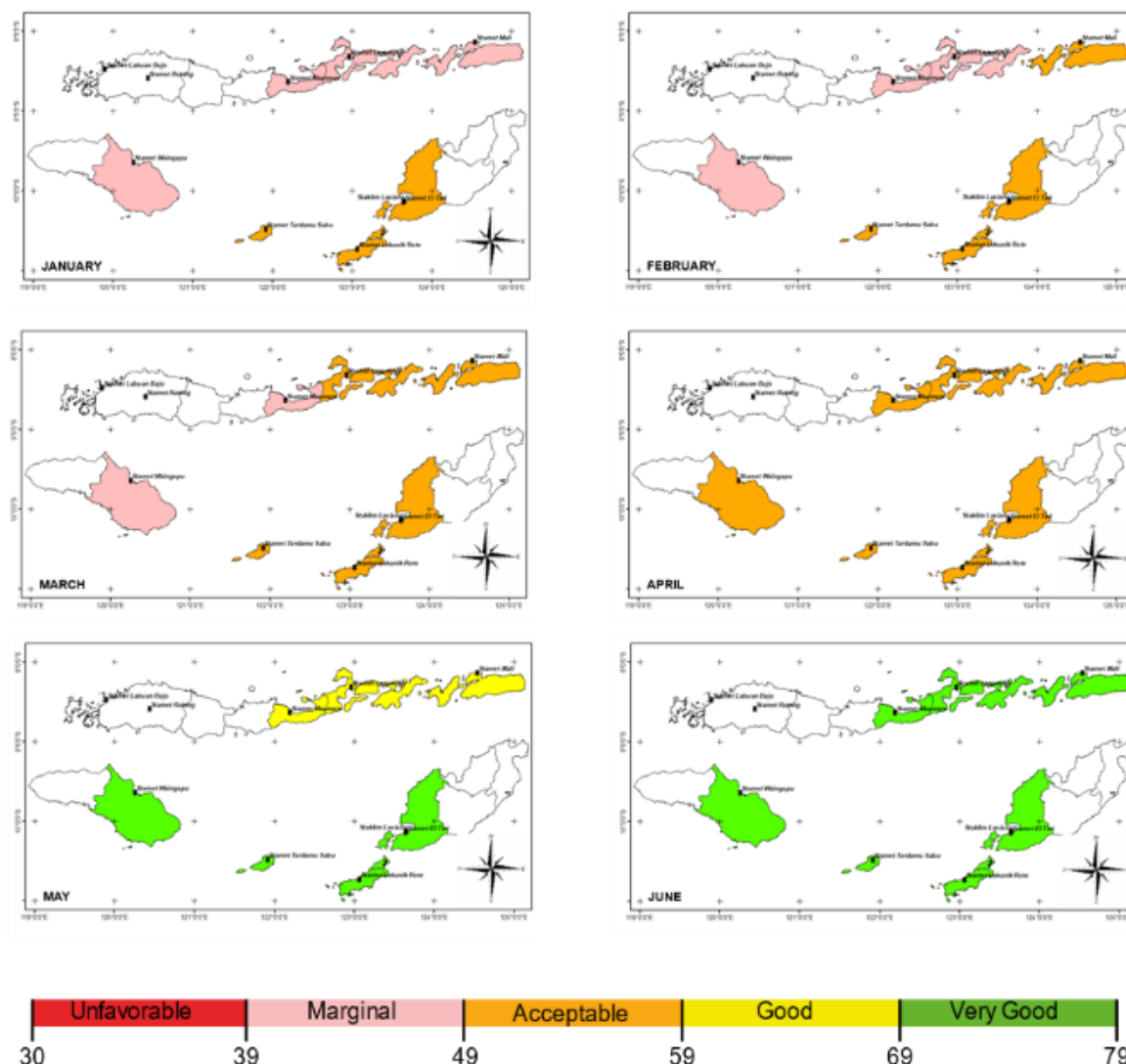
ANALYSIS AND DETERMINATION OF TOURISM CLIMATE INDEX..Hidayat, N.M.

59

Figure 2.   Spatial Distribution Pattern of Monthly TCI Values (January – June) period 1991-2015

From September to December, the TCI index value decreased. The TCI score is relatively good except for the Maumere Meteorological Station which has a TCI value that falls into the 'acceptable' category in October. Meanwhile, the month of November shows similarities to January, which is "marginal to acceptable". In general, December has a 'bad' climate comfort level.

As a result temporally, the comfort level of the tourism climate in Iran has a bimodal curve pattern. The research was developed by Cheng and Zhong. (2019). The research is on the evaluation of the comfort of the tourist climate in the Grand Shangri – La region. from 1980 to 2016 obtained through china's national meteorological information service. The results of such processing in the Grand Shangri – La region in the research period, the best comfort level was in the period of May - October. The ideal comfort level is extraordinary in June – September.In the study, the Grand Shangri – La region divided

eight comfort level areas based on heat mapping of the Grand Shangri-La region [18].

Temporal Distribution of Monthly TCI Values. After processing climate data for 24 years from 8 observation station, the monthly TCI value from each observation can be shown detail in Monthly Tourism Climate Index Graph of Tourism Destination Areas and Table 4.

Based on the calculation results of the TCI index in January, February, and March, it ranges from 42-55. The results of the TCI value in April showed that Sabu and Rote (TCI> 60) (Figure 2).

Judging from the pattern of monthly TCI value movements, all NTT areas have a pattern 'Summer Peak'. Based on the calculation of the TCI, it shows that the climate in each tourist destination has a dry season peak distribution pattern. NTT is best visited during the peak of the dry season (June to August).
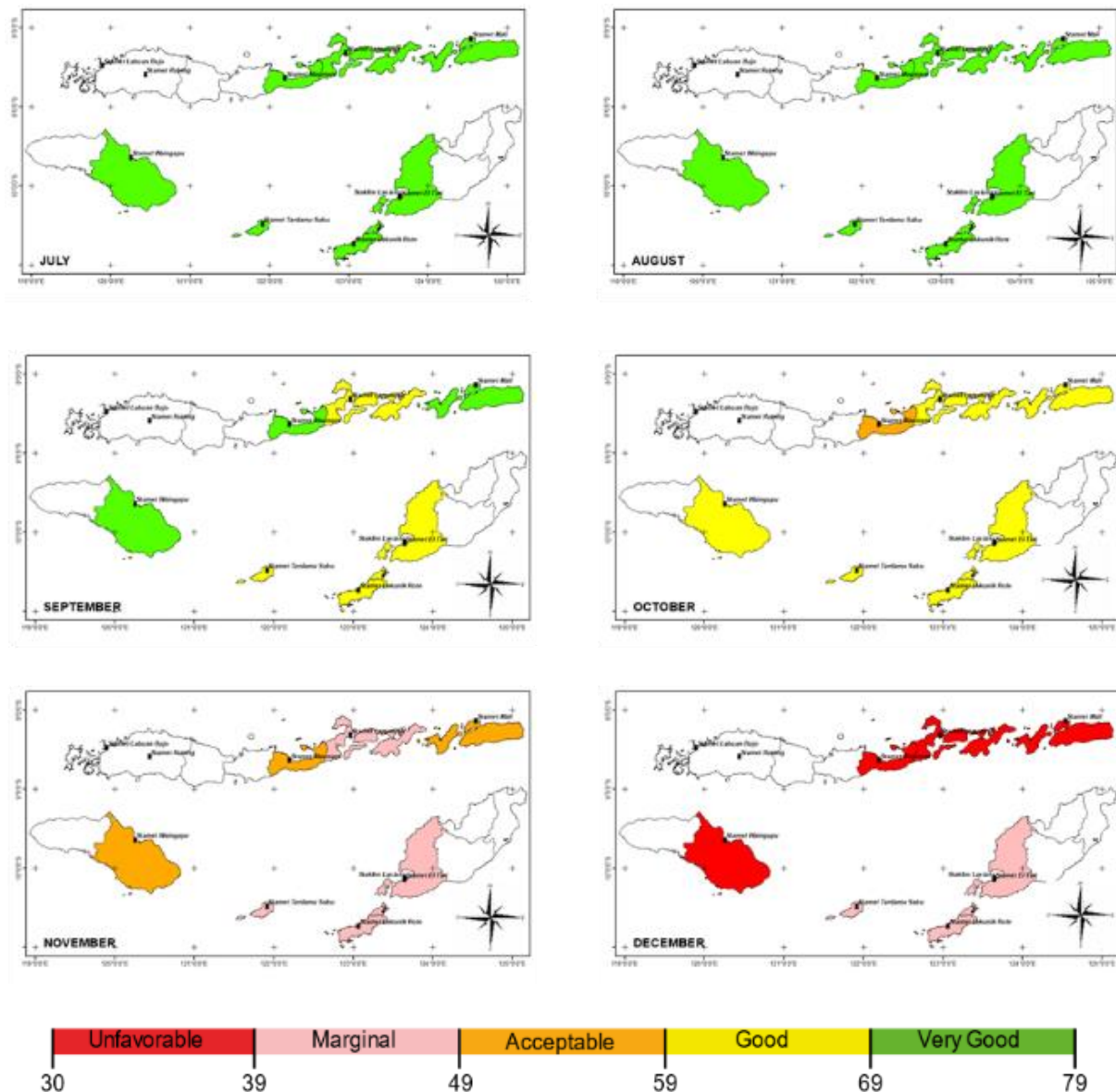
Figure 3. Spatial Distribution Pattern of Monthly TCI Values (July – December) period 1991-2015

Table 5.   Table Value of TCI (January-June)

No	Destination	J	F	M	A	M	J
1.	Waingapu	42	47	51	57	73	71
2.	Sabu	48	49	50	62	75	79
3.	Maumere	47	48	49	56	64	82
4.	Alor	46	50	53	59	68	73
5.	Rote	46	49	49	60	72	80
6.	Lasiana	50	50	55	57	69	76
7.	Larantuka	48	48	55	51	68	70
8.	Eltari	51	51	51	57	70	78

Table 6. Table Value of TCI (July-December)

No	Destination	J	A	S	O	N	D
1.	Waingapu	79	75	71	66	55	39
2.	Sabu	82	76	75	64	53	38
3.	Maumere	73	75	70	59	51	36
4.	Alor	79	79	75	69	56	38
5.	Rote	80	76	75	70	51	41
6.	Lasiana	76	72	72	63	51	42
7.	Larantuka	75	74	67	62	48	39
8.	Eltari	76	72	68	59	47	41
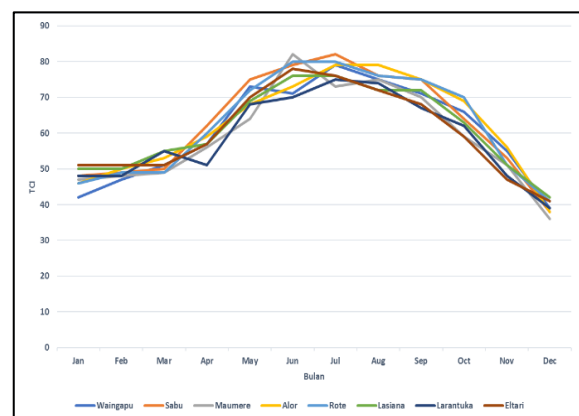
Figure 4.   Monthly Tourism Climate Index Graph of Tourism Destination Areas for 8 observation station

ANALYSIS AND DETERMINATION OF TOURISM CLIMATE INDEX...Hidayat, N.M.
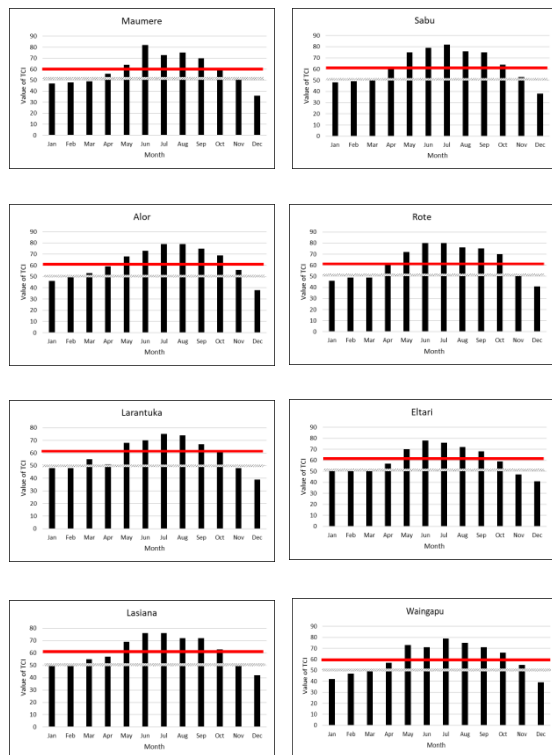
Figure 5. **Monthly Tourism Climate Index Graph of Tourism Destination Areas**

Scott and McBoyle's Model of TCI Value. Figure 4 shows the distribution graph of each region. The distribution of TCI shows that the TCI value ≥ 60 occurs from May to October while TCI ≤ 50 occurs in January and December.

Meanwhile, Waingapu, Maumere, Alor, Lasiana, Larantuka, and Eltari (TCI 51-59). Continuing in May, all NTT areas had TCI values above 60. Sabu has the highest TCI value, which is 75. On the other hand, the lowest TCI value occurs in Maumere with a TCI value of 64. In general, from June to September it has a TCI value of ≥60.

4. Conclusion

Climate can also affect the comfort level of tourists so that they can determine the time and place of interest they want. Climatic factors affect tourists' interest in determining tourist times and places, because climate affects the comfort level of tourists. The level of tourism comfort is a representation of the climatic conditions in a tourist spot those are related to the health risks of tourists. From the previous discussion, it can be concluded that when traveling in East Nusa Tenggara is best visited during the peak of the dry season (June to August) while in the rainy season (November to February) is the worst time to travel.

Acknowledgement

References

[1] Ministry of Tourism and Creative Economy. *Ministry of Tourism's Performance Accountability Report.* Jakarta, 2016.

[2] Ministry of Tourism and Creative Economy. *Data Collection of Foreign Tourist Profiles* Jakarta, 2019.

[3] United Nations and World Tourism Organization. *International Recommendations for Tourism Statistics*. Madrid, 2008.

[4] Rachmawati Ninda Annisa, *Essay Tourism Sector's Contribution To Gross Regional Domestic Products (Grdp) Province Of East Nusa Tenggara Province.* Surakarta: Muhammadiyah Surakarta University, 2019.

[5] Badan Pusat Statistik. *Number of Tourist Attractions by Tourism Themes and City agencies.* Jakarta, 2015.

[6] Matzarakis, *Weather and climate related information for tourism*, Tour Hosp Planin Dev 3: 99115, 2006.

[7] Bakhtiari, B., Bakhtiari, *A Determination of Tourism Climate Index in Kerman Province*. Journal DESERT 18. 113-126. 2013.

[8] Nemeth, Akos. *Estimation of tourism climate in the lake Balaton Region*, Hungary. Journal of Environmental Geography 6, 49-55, 2013.

[9] Behaylu, Ayele,. G. T. *Seasonal Analysis Using Tourism Climate Index of Major Tourist Places of Ethiopia*. Journal Of Humanities And Social Science, 23, pp. 1 – 13, 2018.

[10] Utami, M. A. D. *Analisis Variabilitas Iklim Terhadap Tingkat Kenyamanan Iklim Pariwisata Berdasarkan Holiday Climate Index (HCI) di Provinsi Bali*. Sekolah Tinggi Meteorologi Klimatologi dan Geofisika. 2019.

[11] Kovács, A., Németh, Á., Unger, J. dan Kántor, N., *Tourism climatic conditions of Hungary– present situation and assessment of future changes. Időjárás/Quarterly Journal Of The Hungarian Meteorological Service*, 121(1), pp.79-99, 2017.

[12] Sudiar NY., Koesmaryono Y., Perdinan, Arifin H.S., *Characteristics and Climate Comfort on Nature-Based Tourism Area at Ancol Eco-Park, Bogor Botanical Garden and Cibodas Botanical Garden*. EnviroScienteae Vol. 15 Number. 2, 240-248, 2019.

[13] Hasanah N.A.I., Maryetnowati D., Edelweis F.N., Indriyani F., Nugrahayu Q., *The climate comfort assessment for tourism purposes in Borobudur Temple Indonesia*. Journal Heliyon 6. 2405-8440, 2020.

[14] Deputi Bidang Ekonomi, Badan Pembangunan Nasional. *East Nusa Tenggara Province Tourism and Creative Economy Development Policy.* Jakarta, 2016.

[15] Mieczkowski, Z. *The tourism climatic index: a method of evaluating world climates for tourism*. The Can Geogr, 29 (3): 220-233, 1985.

[16] Scott, D., G., McBoyle. *Using a 'tourism climate index to examine the implications of climate change for climate as a natural resource for tourism*. In: Matzarakis, A., de Frietas, C.R. (eds.) Proceedings of the First International Workshop on Climate, Tourism and Recreation, 69-98, 2001.

[17] Bakhtiari, B., Bakhtiari, A. dan Afzali Gorouh, Z., *Investigation of climate change impacts on tourism climate comfort in Iran*. Global NEST Journal, 20(2), pp.291-303, 2018.

[18] Cheng, Q.P. dan Zhong, F.L, .*Evaluation of tourism climate comfort in the Grand Shangri-La region*. Journal of Mountain Science, 16(6), pp.1452-1469, 2019.

ANALYSIS AND DETERMINATION OF TOURISM CLIMATE INDEX...Hidayat, N.M.

63