EVALUATION OF THE SPATIO-TEMPORAL CHARACTERISTICS OF CLIMATE COMFORT FOR TOURISTS IN THE ENCLAVES OF GASHAKA-GUMTI NATIONAL PARK, TARABA STATE, NIGERIA

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Abstract. This research was undertaken to assess the spatial and temporal attributes of the Tourism Climate Comfort Index. The objectives of the study were to classify the climate of the park using rainfall and temperature, and to determine the good, very-good, and excellent-days of visiting the park based on the Tourism Climate Comfort Index. The findings will provide tourists with recommendations regarding optimal times for visiting Gashaka-Gumti National Park in Nigeria. The investigation begins with an assessment of the park's climate over time and across the park enclaves, focusing on the spatial distribution patterns of precipitation and temperature, followed by an analysis of the tourism climate comfort from 1994 to 2024 using the Tourism Climate Index (TCI). Data sources for this research were meteorological stations and remote sensing data (satellite image). These data were processed using the statistical packages for social sciences (SPSS) software and the ArcGIS 10.7 Software. The outcomes of the climate classification for the park indicated a consistent prevalence of high temperatures surpassing 18°C throughout the year, accompanied by elevated air humidity levels averaging 90% and an annual rainfall averaging 270 days. The research identified three distinct categories within the TCI: the good, the very good, and the excellent-days TCI. The study illustrates that the good-days, very-good-days, and excellent TCI were distributed across all enclaves with an average of 210 good-days, 157 very-good-days TCI, and 77 excellent-days TCI. Based on the results of the climatic data analysis, it is concluded that the climate of the study area is characterized by high temperatures and high air humidity of about 90%. The study recommends a cluster heat map analysis that would show the optimal travel period to the park in order to improve visits. The park administration should use the TCI of the Park to increase its marketing strategy and create awareness among their customers.

1. INTRODUCTION

A tourism climate index (TCI) is an effective methodology for the assessment of tourism-related climatic conditions. Such an index can be employed by both tourists and tour operators to identify optimal times and destinations for travel, as well as to organize activities in accordance with projected meteorological conditions (Eugenio-Martin and Campos-Soria, 2010). The tourism comfort climate index functions as a comprehensive metric for evaluating the influence of various climatic factors on the tourism sector. Within this framework, climatic factors including temperature, precipitation, humidity, solar radiation, and wind are systematically integrated.

Several simple tourism climate indexes have been developed; they include the physiologically equivalent temperature (PET), Universal Thermal Climate Index (UTCI), Climate Tourism/Transfer

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Information Scheme (CTIS) and Tourism Climate Comfort Index (TCI), all in an effort to evaluate tourism climate comfort. The climate pertaining to tourism exerts a considerable influence on visitor satisfaction by affecting various determinants including outdoor thermal comfort, the blooming of wildflowers, and the perceptions of climatic comfort. Empirical studies indicate that variables such as mean radiant temperature, moisture levels, and air circulation are pivotal in ascertaining human thermal comfort in tourism regions, as documented by Anna, Maria, and Chiaravalli (2022). The perceived comfort related to climate directly influences tourists' demand for aquatic activities and their spending decisions, thereby highlighting the critical role of weather satisfaction in enhancing the overall tourism experience, as noted by Khalid et al. (2023). Grasping and adjusting to these climate-induced transformations is imperative for sustaining visitor satisfaction and ensuring the viability of tourism practices amid the challenges posed by climate change.

The assessment of tourism climate comfort is essential for comprehending the implications of environmental conditions on tourist experiences and destinations. Research has underscored the relevance of climate indices, such as the Tourism Comfort Index (TCI), Baker's Index (BI), Temperature Humidity Index (THI), and Holiday Climate Index (HCI), in evaluating thermal comfort for tourists, as indicated by José *et al.* (2024).

The aim of this study is to ascertain the climatic conditions relevant to tourism comfort, employing the Tourism comfort index (TCI) to identify optimal periods for tourists to visit the Gashaka-Gumti National Park. Thus, the objectives were to identify rainfall and temperature patterns and characteristics, as well as the good, very-good and excellent-days with respect to the TCI.

2. DESCRIPTION OF THE STUDY AREA

The Gashaka–Gumti National Park (GGNP) is a national park co-owned by two states in Northeast Nigeria which border each other (Taraba and Adamawa States). The Gashaka section of the park is in Taraba State, while the Gumti section is in Adamawa State. The park is located between latitudes 6°56′16.116″ N and 8°5′22.341″ N of the Equator, and longitudes 11°11′5.859″ E and 12°13′14.087″ E of the Meridian. It is situated at the foot of the Mambilla Plateau, Taraba state, in Northeast Nigeria, and covers a land area of about 6,411 km^2. The park was initially gazette as Gumti, Gashaka and Serti Game sanctuaries by the defunct Northeast Government of Nigeria in the 1970's. The three game sanctuaries were merged and upgraded to the status of National Park by the Nigeria National Park Decree of August 26, 1991 which was repealed by Decree 46 of 1999.

The Park occupied parts of the two states, Taraba and Adamawa, in its southern and northern parts, respectively (Fig. 1). Gashaka-Gumti National Park shared an international boundary with the Republic of Cameroon in the East, bounded to the South by the Mambilla Plateau in Taraba State (Nigeria), to the North by Adamawa State (Nigeria), and to the West by the Gashaka Local Government Area (LGA) of Taraba State (Nigeria). GGNP occupied a total land area of 6,205.4 km^2. Out of this total land area, 3,954.68 km^2 (64.66%) are in Taraba State (Nigeria), forming the Gashaka section, while the remaining 2,161.11 km^2 (34.34%) are in Adamawa State, forming the Gumti section. The Gumti sector of the park within Adamawa state is found in Toungo LGA, while the Gashaka section is shared by Gashaka LGA and Sardauna LGA with major parts (3,768.52 km^2) making up 95.29% of Gashaka LGA. The remaining 186.16 km^2 (4.71%) falls in Sardauna LGA of Taraba State. The Park has strong international tourist appeal, since it serves as a stronghold for many threatened species, including the critically endangered Nigeria-Cameroon chimpanzee, white-bellied and giant pangolin, yellow-backed duiker, golden cat, forest buffalo and a wide range of other primates and antelopes. The park also contains Nigeria's tallest mountain, Chappal Waddi, and is one of the most important watersheds for the river Benue (the country's second-largest river) which sustains the livelihoods of millions of Nigerians downstream. Other attractions include the Mambila Plateau and the Gashaka River. The considerable international eco-tourism potential, as well as attraction for leisure, vacation, health, explorative, and scientific research activities, in addition to high-end tourism experiences have made the park a tourist hub. The park has garnered attention from tourists at both national and international scales due to the presence diverse array of wildlife, encompassing over 2,000 avian species, numerous geotourism sites, various vegetation types, local wind patterns, and several enclaves at varying altitudes. The major activities in the park are:

1. Wildlife viewing, including safaris.
2. Bird watching for both local and migratory species.
3. Hiking and trekking through the park's varied terrains.
4. Camping in designated areas.
5. Cultural exploration with local communities.
6. Photography of landscapes, wildlife, and traditional life.

Although the establishment of settlements is not permitted within the confines of national parks, the Gashaka-Gumti National Park (GGNP) encompasses certain settlements referred to as enclaves. Andrew (1999) characterizes these enclaves as “designated areas within the park intended for the purposes of livestock grazing and agricultural activities, which are regulated zones that safeguard and promote traditional modes of subsistence.” The enclave communities situated within the park include Shirgu, Nyumti, and Hunde, located in the central region of the park, which are primarily inhabited by pastoral communities, notably the Fulani pastoralists. Additional enclaves recognized by the legal framework of the Federal Republic of Nigeria consist of Gumti, Chappal Delam, Filinga, and Mayo Sabere. Conversely, there are illegal enclaves, such as Jakuba, notably the most prominent unauthorized settlement within the park. A significant number of settlements that do not qualify as enclaves are situated along the periphery of the park, including Gashaka. A diverse array of ethnic groups is represented within the enclaves of the park. The predominant occupations of the inhabitants include agriculture, animal husbandry, hunting, and fishing. The principal crops cultivated in the region encompass maize, groundnut, millet, guinea corn, beans, soya beans, rice, yams, sugar cane, and cassava, as documented by Oruonye *et al.* (2017). The presence of the enclaves and other illegal settlements in the Gashaka-Gumti National Park significantly influence the local climate and ecosystem through anthropogenic activities. These activities lead to habitat modification, biodiversity loss, and changes in land cover, which collectively impact the park's ecological balance. Human settlements contribute to habitat fragmentation (through the introduction of built-up areas and farmland) reducing the area of dense forests in the park from 367,500 hectares in 1987 to just 107,600 hectares by 2014, leading to a decline in riparian forests and savannah vegetation within the park (Elijah *et al.*, 2019).

The park is crisscrossed by many rivers (notably the rivers Kam, Gashaka, Yim and Gam-Gam) which, among other ecological functions, act as reservoirs of diversity. Visitors to this secluded region will find no roads here, only a small number of footpaths snaking through the wooded mountains in the direction of the Republic of Cameroon. Throughout the year, the park experiences a variety of climates, from tropical to humid. Visitors to the Gashaka-Gumti National Park are able to take pleasure in the flourishing forests, the extensive sweeping grasslands, the fresh highland plateaus, the rocky-mountains, rich wildlife and the captivating ethnic cultures. The study area is divided into two climatic zones; tropical continental and tropical rainforest, the latter falling within Koppen’s climate classification scheme that corresponds to the $\mathbf{A_w}$ and $\mathbf{A_f}$ type of climate, respectively.

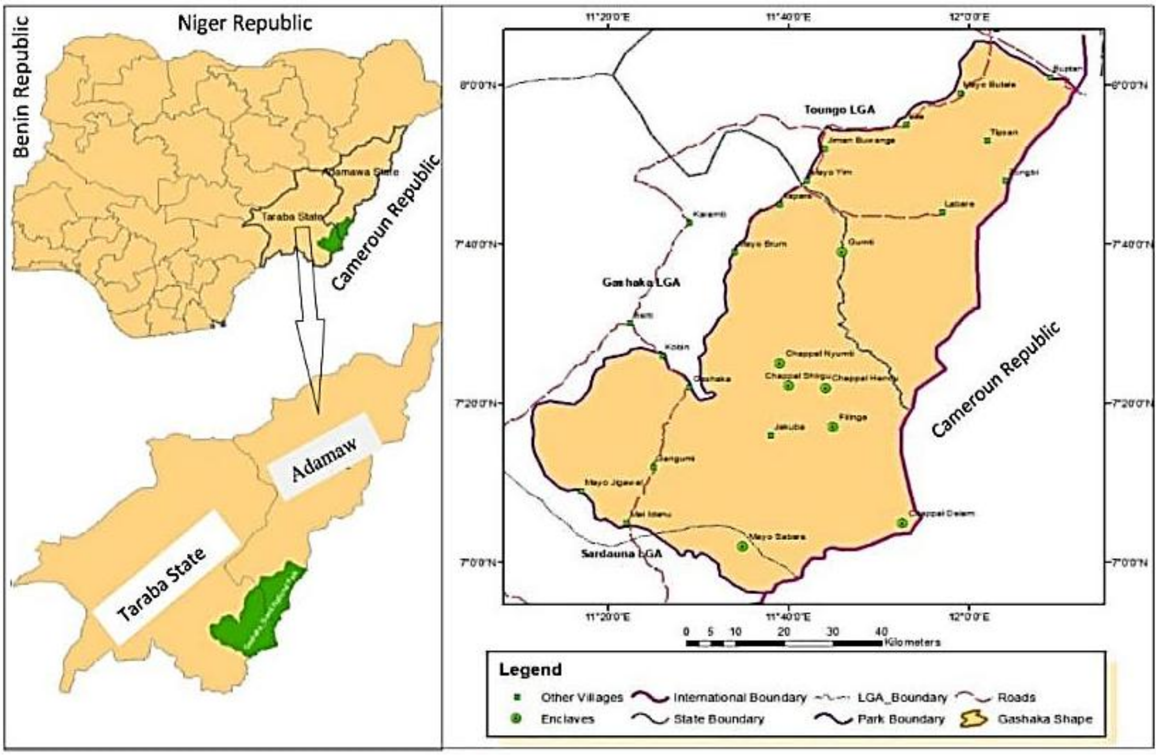

Fig. 1 – Study Area.

3. RESEARCH METHODOLOGY

The spatial pattern of the climatic conditions of Gashaka-Gumti National Park was assessed. This was done by an initial examination of the (2) most important climatic parameters, namely temperature and rainfall, in order to ascertain their spatial pattern of distribution. The examination was done through literatures reviews in which published climate variables and the characteristics of the study area were summarized, critically evaluated and interpreted so as to describe the climate type of the study area.

Diva Geographic Information System (GIS) Rainfall and Temperature data were collected online and statistically standardized into a mean value of rainfall and temperature for the 30-year period between 1994 and 2024, for mapping the spatial patterns of rainfall and temperature in the Park. One hundred equal distance points throughout the Park area were generated using the fishnet method in ArcGIS 10.7. The rainfall and temperature values of each of the points were extracted in the Diva GIS environment and the Kriging method was applied to interpolate the values. Kriging is an advanced geostatistical interpolation procedure that generates an estimated surface from a scattered set of points having z-values. It assumes that the distance or direction between sample points reflects a spatial correlation that can be used to explain variation in the surface. There are two kriging methods; ordinary and universal. In this study, universal kriging was used because there is an overriding trend in the rainfall and temperature data used for this research. The choice of kriging interpolation is because it is spatially efficient, suitable for irregularly spaced observation. The steps involved in the kriging in this study include: the collection of scattered points data for the variables (rainfall and temperature) across the study area, the variogram analysis carried out through the calculation of the semi-variogram, followed by the modelling of the variogram and calculating the weight before the interpolation. All these are done automatically within the ArcGIS environment.

The evaluation of tourism climate comfort was subsequently performed adopting the Tourism Comfort Index (TCI). The tourism Comfort Index, originally formulated by Mieczkowski (1985) as a quantitative measurement of tourism climate by combining several tourism-related climate factors into a single index. The index correlates a general assessment of human comfort with specific activities related to recreation and tourism. At present, TCI is one of the most cited and recognized climate indexes (Li *et al.* 2017) and integrates seven climatic variables: maximum daily temperature (unit: °C, abbreviation: Tmax); minimum average daily relative humidity (unit: %, abbreviation: RHmin); mean daily temperature (unit: °C, abbreviation: Tmean); mean daily relative humidity (unit: %, abbreviation: RHmean); precipitation (mm); sunshine duration (unit: hours/day, abbreviation: S); and wind (average wind speed, unit: m/s, abbreviation: W). These climatic variables were measured by the researcher at each of the seven enclaves namely; Shirgu, Nyumti, Hunde, Gumti, Delam, Filinga, and Mayo Sabere. The variables used for the TCI were derived from WorldClim.org and a complimentary measurement using Ibutton sensors (Hygrochron Ibuttons) from the Embedded data system of Maxim Incorporation United State of America (USA); the series used was the DS1923 series.

WorldClim.org is a database of high spatial resolution global weather and climate covering the past, present and future projections. The data is available at four spatial resolutions, between 30 seconds (~1 km^2), 2.5 minutes, and 5 minutes to 10 minutes (~ 340 km^2) Fick and Hijmans (2017). This resolution is good for this research work. The Ibutton DS1923 series data loggers are capable of operating in temperature ranges. The (-20°C to +85°C) range at 0.0625°C temperature resolutions has an accuracy between ±0.5°C and ±1.0°C through most of its operating range. DS1923 is currently the only Ibutton data logger that supports temperature and humidity using the logging Embedded data System (2025). The complimentary data measured were Tmax, Tmean, RHmin, RHmean, while the remaining variables were derived from the WorldClim data.

According to Mieczkowski (1985), the daily comfort index is intrinsically linked to the physiological ramifications of the cool night–hot day sequence, which pertains to the phenomenon of experiencing an uncomfortable day with greater ease following a restorative night's sleep (Grillakis *et al.* 2016). The estimation of the thermal comfort components was predicated upon the equation proposed by Cheng and Zhong (2019), articulated in Eq. (1):

$$\mathbf{CI=Tn-0.4(T-10)\ (1-Rn/100)} \qquad \mathbf{(1)}$$

Where Tn denotes the mean monthly temperature (°C) and Rn represents the mean monthly humidity (%). It was established that, notwithstanding its lack of reliance on a sophisticated heat budget model, the index exhibited commendable performance in comparison to the Universal Thermal Climate Index (UTCI) and surpassed several heat budget models (Broede *et al.* 2012). The TCI is predicated upon the concept of human comfort and comprises five sub-indexes. Its computation and weighing are delineated as follows:

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

Where; CID represents the daytime comfort index and CIA denotes the daily comfort index, P signifies precipitation, S indicates sunshine, and W corresponds to wind.

The CID sub-index, which encapsulates daytime comfort, is computed from Eq. (1), employing maximum daily temperature and minimum daily humidity. The CIA sub-index, which signifies average daily thermal comfort, is derived from Eq. (1), using mean daily temperature and humidity to incorporate the influences of exceedingly hot or cold nights (Perch-Nielsen et al., 2010). Further vlarifications can be found in Mieczkowski (1985) and Grillakis *et al.* (2016). Minor modifications were made to the original index to facilitate the transition from monthly to daily data. For instance, we adapted the monthly scale to a daily scale in accordance with both 24-hour and 12-hour formats. As illustrated in Table 1, a precipitation threshold of 50 mm was designated as zero on our rating scale for the computation of the daily-scale TCI. For the mean monthly sunshine duration per day, the mean monthly temperature, mean monthly wind speed, and humidity were supplanted by the observed daily data from the meteorological station. With an optimal rating for each variable set at 5.0 (Table 1), the maximum attainable value of the TCI is 100; therefore, the outcomes of Eq. (2) were ultimately classified according to the descriptive scale delineated in Table 2. One calculation example is as follows: for 1 day, Tmean = 22.5, Tmax = 31.1, RHmean = 60.4, RHmin = 21.3, W = 2.8, S = 8.5, and P = 21. According to Eq. (1), the obtained CID and CIA values are 20.5 and 24.5, respectively. Based on the Table 1 rating scales, the TCI is calculated as 83.

Descriptive statistical analyses were conducted to statistically describe the TCI of the study area. Tables and graphs, particularly the box plots graph, were used to presents the TCI across the enclaves and the months.

Table 1

Rating scales for sub-indexes of the Tourism Climate Index

Rates	Thermal comfort (^{O}C)	Precipitation (mm)	Sunshine Duration(h/d)	Windspeed (m/s)
5	20-27	0.0–0.9	>10	<0.8
4.5	19-20 or 27-28	1.0–4.9	9 to 10	0.89-1.6
4	18-19 or 28-29	0–9.9	8 to9	1.7-2.5
3.5	17-18 or 29-30	10.0–14.9	7-8.	2.6-3.4
3	15-17 or 30-31	15.0–19.	9 6-7 3.5	4-5.5
2.5	10-15 or 31-32	20.0–24.9	5-6	5.6-6.7
2	5-10 or 32 -33	25.0–29.9	4 to 5	6.8-8.0
1.5	0-5 or 33-34	30.0–34.9	3 to 4	8.1-10.7
1	5-0 or 34-35	0–39.9	2 t0 3	>10.8
0.5	35-36	40.0–49.9	1 to 2	
0	5 to 0	>50	<1	

Notes: The scale for thermal comfort applies for both the daytime comfort index (CIA) and daily comfort index (CID) sub-indexes. Wind speed rating scales were converted according to 1km/h=0.28m/s.

Table 2

Rating categories in the tourism climate index of Mieczkowski (1985)

TCI	Category	TCI	Category
90-100	Ideal	40-49	Marginal
80-89	Excellent	30-39	Unfavourable
70-79	Very good	20-29	Very unfavourable
60-69	Good	19 to 10	Extremely unfavourable
50-59	Acceptable	<10	Impossible

4. RESULTS AND DISCUSSIONS

4.1 Rainfall and Temperature Pattern and Characteristics of Gashaka Gumti National Park

Among the various climatic elements, only rainfall and temperature were examined and discussed for the purpose of this paper. This is because they are the principal climatic elements of major concern to tourists in the study area, as reported by Asa and Anake (2023).

4.1.1 Rainfall

The results of the analysis of rainfall data for the thirty (30)-year period between 1994 and 2024 revealed that the mean annual rainfall in the study area ranges from 1,341.9 mm in the Gumti enclave to 1,717.8 mm in Chappal Shirgu and Chappal Delam, as seen in Figure 1. The results correspond to those of Dada *et al.* (2006). The rainy season in the study area begins in late March and ceases in November, while the dry season lasts from December to March, is similar to what Kwaga *et al.* (2019) have reported. The analysis also shows that the average number of rainy days in the area is 274; therefore, rainfall in the study area exceeds evapotranspiration.

The spatial pattern of rainfall distribution inside the park and within the enclaves revealed that the extreme southern part of the park where the enclaves Mayo Sabere and Chappal Delam were situated, as well as the mountain top enclaves of Chappal Shirgu, Hunde and Filinga, has the highest amount of rainfall (1,626.5 mm – 1 717.8 mm).

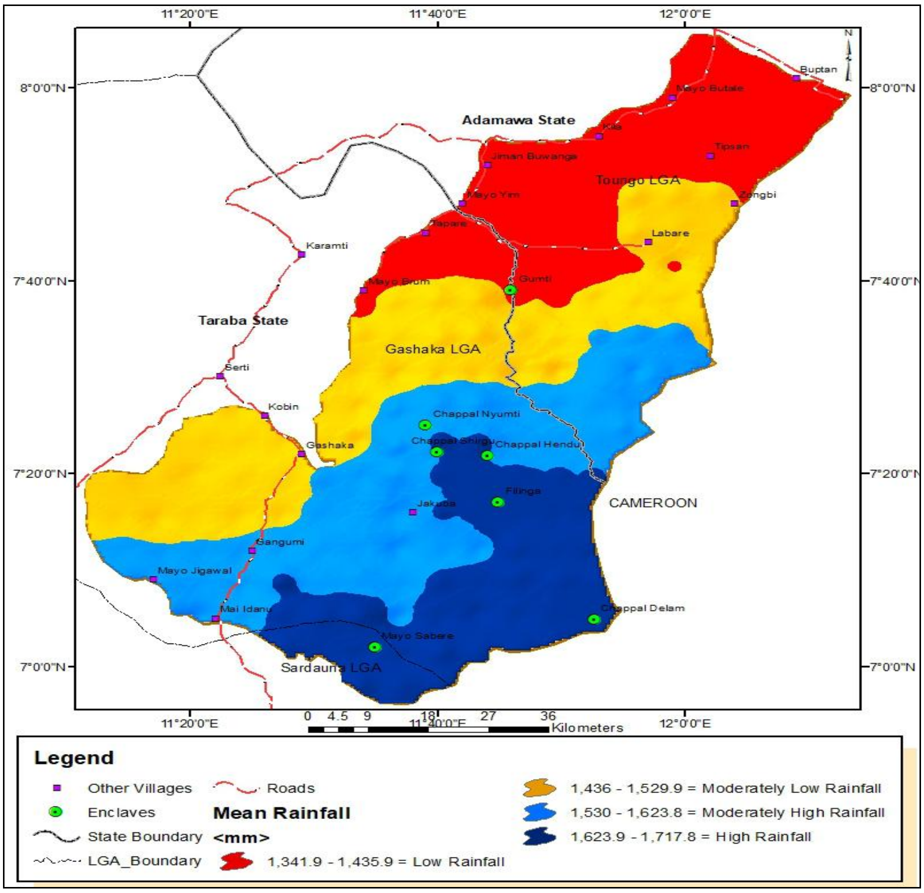

Fig. 2 – Spatial Pattern of Rainfall.

The minimum mean annual rainfall of (1,626.5 mm) was recorded in Filinga, while the highest (1,717.8 mm) was recorded in Chappal Shirgu and Chappal Delam. The northern part of the park, in the Gumti enclave, has the least amount of mean annual rainfall of 1,341.9 mm. Relative humidity in the park's enclave is high up, reaching 90% during the rainy season from April to November, while during the dry season it is as low as 45%. Based on this result, it can be concluded that the study area has a humid tropical climate type. According to Adalberto *et al.* (2006), the humid tropical climate is a bioclimatic area within the tropical zone characterized by persistently high temperatures and high air humidity, with 90% of the tropical ecosystems being hot and humid with consistently high mean monthly temperatures exceeding 18ºC throughout the year, and where rainfall exceeds evapotranspiration for at least 270 days out of a year.

4.1.2. Temperature

The spatial pattern of mean temperature within the park is almost the reverse of that of rainfall, as the places with the highest rainfall, such as the extreme south and the mountainous areas, had the lowest temperature, and vice versa (Fig. 3).

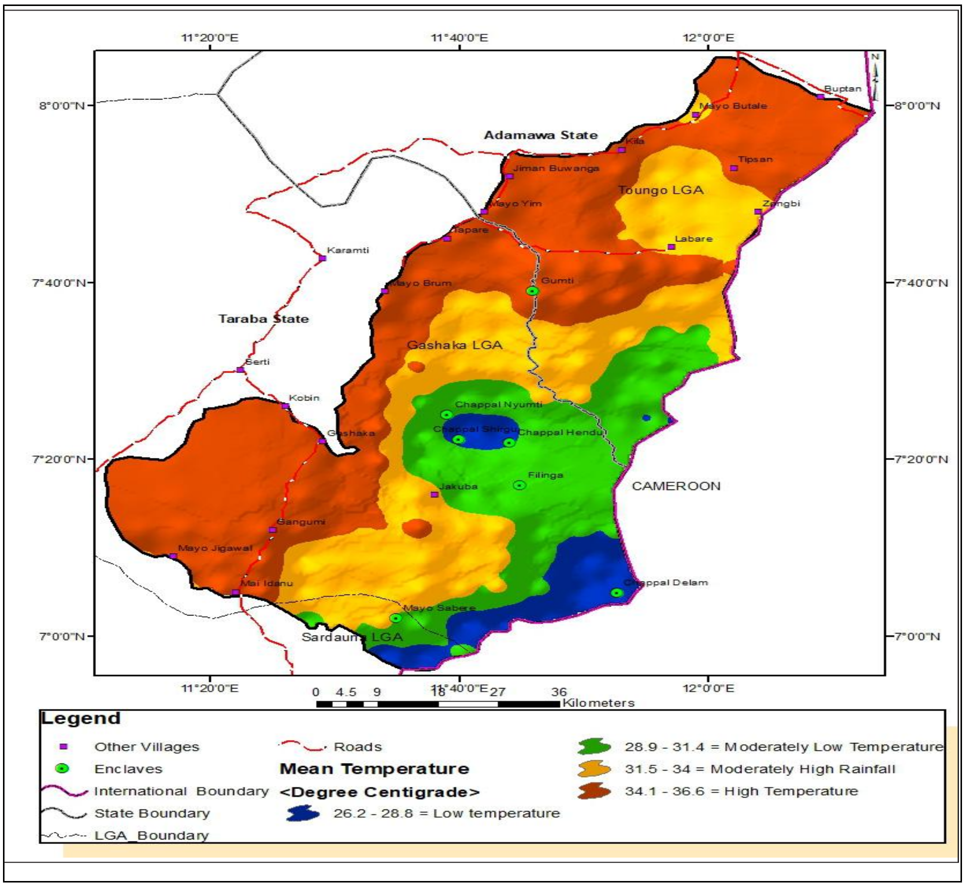

Fig. 3 – Spatial pattern of mean temperature.

The result presented in Figure 3 revealed that the temperature ranges from 28.9ºC to 36.6ºC. The enclave with the highest temperature is Gumti enclave, while the enclaves with the lowest temperatures include Chappel Delam and Chappel Shirgu. The other enclaves (Filinga, Mayo-Sabere and Chappel Nyumti) have moderate temperatures. Based on these findings, it has been concluded that Chappel Delam and Chappel Shirgu are the coolest enclaves because of their altitude, since the two enclaves are located at the highest altitude in the study area, while Gumti enclave is found at the lowest altitude and, therefore, has the highest temperature. This result confirmed the authenticity of the lapse rate theory, which shows a decrease in temperature with the rising altitude, meaning that for every 1,000 m above sea level there is a drop of 6°C.

4.2. Tourism Climate Comfort Index (TCI)

The result of the TCI revealed that the study area's TCI ranges from 60 to 100 based on the TCI rating of Mieczkowski (1985) in the category of good, very good, and excellent (ideal) days in the context of this research. However, TCI values under 60 were not observed in the area. Thus, the TCI rating of the study area ranges from 60 to 100 following Mieczkowski's (1985) rating.

4.2.1. Good days TCI

The descriptive statistical characteristics of Good-days TCI over the thirty (30) years across the enclaves are presented in Table 3a below while Table 3b show the means of the observed descriptive characteristics.

Table 3a

Descriptive Statistics of the Good-Days TCI (1994–2024)

	N	Range	Min	Max	Sum	Mean	Std. Deviation	Variance
Shirgu	30	23	7	30	179	18.25	7.436	55.295
Nyumti	30	20	10	30	221	18.25	6.468	41.841
Hunde	30	20	8	28	209	18.33	7.165	51.333
Gumti	30	19	10	29	197	18.83	6.250	39.061
Delam	30	20	9	29	222	18.50	7.293	53.182
Filinga	30	21	8	29	232	19.00	6.814	40.903
Mayo-Sabere	30	19	9	28	213	17.83	6.887	47.424

Table 3b

Mean Descriptive Statistical Characteristics of Good-Days TCI

	N	Range	Min	Max	Mean	Sum	Std. Error	Std. Dev.	Variance
Good days	30	23	7	30	17.75	210	2.104	7.288	53.114
Valid N (listwise)	30								

From Tables 3a and 3b above, it can be observed that the minimum good-days TCI is 9, which was recorded in March, as seen in Figure 4, while the highest good-days TCI is 29 days, recorded in August and September. The study area has mean good-days of 17.75, approximately 18 days, with a mean standard deviation of 7.288, while the mean standard error is 2.104. Overall, there is an average good-days TCI of 210 days per annum in the study area. These good-days TCI were focused in the months of June, July, August and September, with few days across other months, as seen in Fig. 4. These months where the good days were concentrated are coincidentally the peak of rainy season. However, despite having a good number of good-days, these months were the difficult period to access the park due to the effect of heavy rainfall at that time, which pose both traveling and expedition problems for tourists. The maximum number of good days ranges from 28 days in Hunde enclave and Mayo-Sabere, 29 days in Nyumti enclave, to 29 days in Gumti, Delam, and Filinga enclaves, all located in the central part of the park, while the enclaves of Shirgu and Nyumti had an average of 30 maximum days of the good-days TCI.

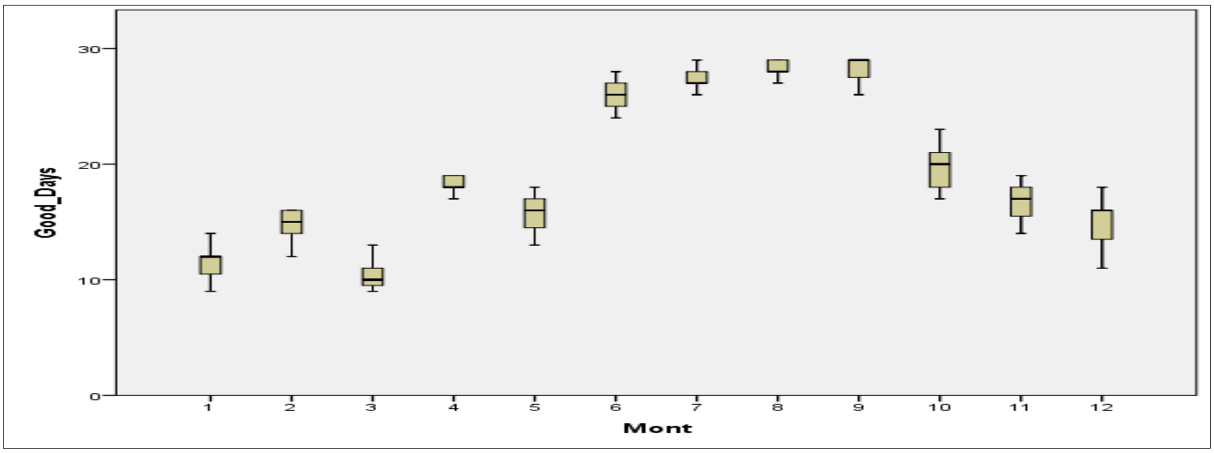

Fig. 4 – Box plot of Good-days.

4.2.2. Very-Good-Days TCI

Tables 4a and 4b show the descriptive statistics of very-good-days across all the enclaves, and average statistical characteristics of the very-good-days TCI, respectively, for the 1994–2024 period. The very-good-days TCI ranges from 0 to 30 days across all enclaves. The highest very-good-days TCI is recorded in Hunde enclave, with a mean of 13.08 days across all the months of the year.

Table 4a

Descriptive Statistics of the Very-Good-Days TCI (1994–2024)

	N	Range	Min	Max	Sum	Mean	Std. Error	Std. Dev.	Variance
Shirgu	30	29	0	29	160	13.33	3.274	11.340	128.606
Nyumti	30	29	0	29	157	13.08	3.192	11.057	122.265
Hunde	30	30	0	30	153	12.75	3.407	11.802	139.295
Gumti	30	28	0	28	157	13.08	3.269	11.325	128.265
Delam	30	28	0	28	158	13.17	3.293	11.408	130.152
Filinga	30	28	0	28	156	13.00	3.398	11.771	138.545
Mayo-Sabere	30	29	0	29	155	12.92	3.306	11.453	131.174

Table 4b

Mean Descriptive Statistical Characteristics of Very-Good-Days TCI

	N	Range	Min	Max	Sum	Mean	Std. Error	Std. Deviation	Variance
Very-Good	30	29	0	30	157	13.08	3.334	11.548	133.356
Valid N (listwise)	30								

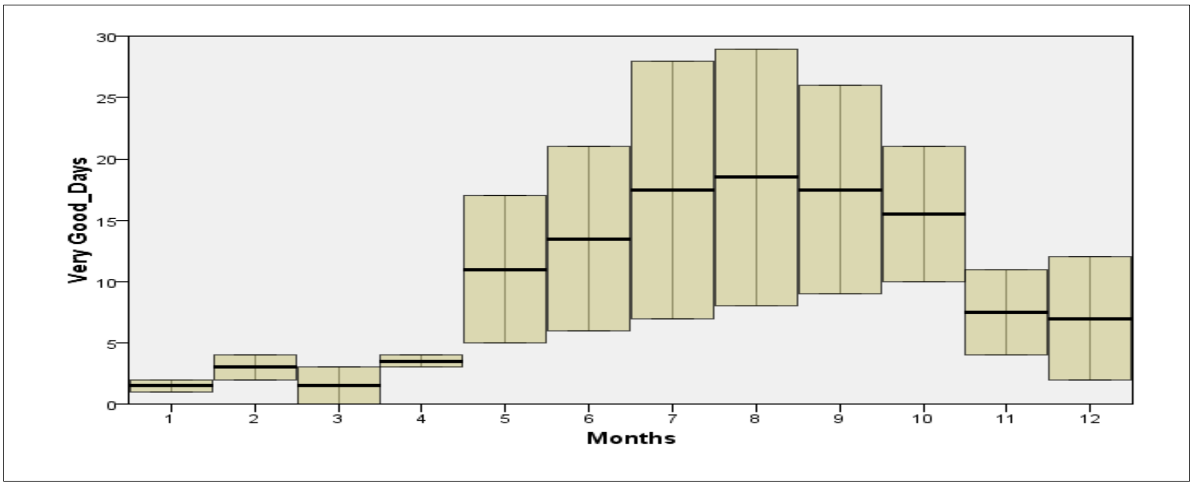

Fig. 5 – Box plot of very-good-days.

The mean annual very-good-days based on the TCI is 157, as seen in Table 4b. Generally, the study area's very-good-days were focused around the months of May, June, July, August, September, and October, as seen in Figure 5 above.

4.2.3. Excellent-Days TCI

The excellent-days TCI, which are the ideal days in the context of this research, was assessed and the results are presented below. Table 5a shows the descriptive characteristics of excellent-days Tourism Climate Comfort Index in the study area for the period of 30 years between 1994 and 2024, while Table 5b shows the mean descriptive characteristics of the TCI over the same period.

Table 5a

Descriptive Statistical Characteristics of Excellent-Days TCI

	N	**Range**	**Min**	**Max**	**Sum**	**Mean**	**Std. Error**	**Std. Dev.**	**Variance**
Shirgu	30	16	0	16	74	6.17	1.321	6.308	37.788
Nyumti	30	16	0	16	78	6.5	1.244	6.735	43.364
Hunde	30	17	0	17	78	6.5	1.548	6.403	41
Gumti	30	15	0	15	80	6.67	1.54	6.719	44.152
Delam	30	17	0	17	73	6.08	1.243	6.037	36.447
Filinga	30	16	0	16	77	6.06	1.721	6.100	36.000
Mayo-Sabere	30	15	0	15	80	7.08	1.006	6.947	48.265

Table 5b

Mean Descriptive Statistical Characteristics of Excellent-Days TCI

	N	Range	Min	Max	Mean	Sum	Mean Std. Error	Std. Deviation	Variance
Excellent-Days	30	16	0	16	6.50	77	1.317	6.454	41.652
Valid N (listwise)	30								

The result shows that the excellent-days range is 16 days with a mean annual excellent-days value of 77 days. The minimum excellent-days value is zero in the months of May and September, while the maximum is 16 in December; this means that, in some months and in some enclaves, there is no excellent-days TCI. The excellent-days TCI is concentrated around the last three (3) months of the year, (October, November, December) and the first three (3) months of the year (January, February, and March), as presented in Figure 6 below. These periods were, coincidentally, the periods when the park boomed with activity and every condition was at its best, both in terms of accessibility for expedition and weather. The study found no significant variations between the excellent-days and good-days in the study area, as they are all found within the same period with almost the same number of days. The result contrasts with the findings of Cheng and Zhong (2019) in the Grand Shangri-La region Plateau, where variations between very good-days and excellent-days were reported. It is possible that location and climatic difference might account for the disagreement between the two results.

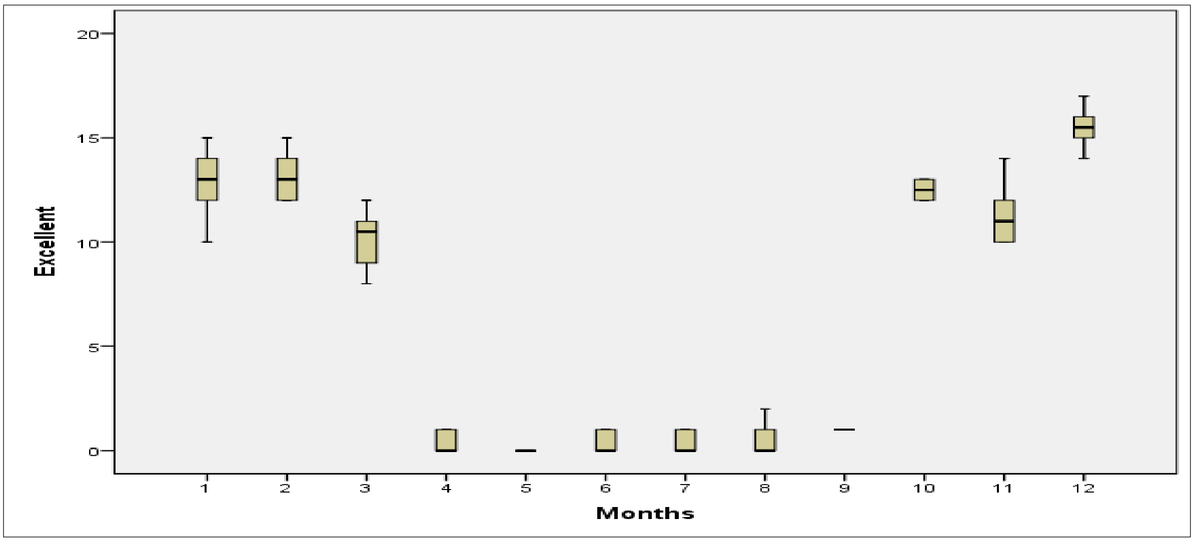

Fig. 6 – Box plot of excellent-days.

An analytical synthesis of the results of this research in the context of tourism can be regarded from three different perspectives: tourist satisfaction – this is due to the fact that thermal comfort plays a significant role in tourist satisfaction when it comes to a destination, while the TCI analysis results of this study show that tourists can best be satisfied when they visit the park between October and April, which is the ideal period for a visit; destination attractiveness – the results regarding the temperature analysis of the park indicate a pleasant thermal condition most of the year, which means that the pleasant thermal conditions have the ability to attract more tourists and boost local economies; and tourists' health and safety – the result of the study also shows that some periods have harsh weather, especially extreme thermal conditions between May and September when there is extreme heat and heavy rainfall, which can affect the vulnerable and elderly tourists visiting the park during that period.

Generally, the results of this analysis show that the ideal period to visit the park is between October and April. This is due to the comfortable temperature, moderate humidity and very low rainfall that usually obstructs tourism activities. These pleasant weather conditions make the period ideal for visits. Thus, considering the pleasant weather condition within these periods, tourists can plan their visits to coincide with the pleasant weather conditions in order to make sure they have an enjoyable and comfortable experience.

5. CONCLUSION

Based on the finding of this research, the following conclusions were reached: the climate of the study area can best be described as tropical humid firstly because of the area's location within the tropical climate zone and secondly, because it is characterized by high temperatures and high air humidity (90%) which is a continuous characteristic. Hence, the climate is hot and humid with mean monthly temperatures consistently high, exceeding 18ºC, throughout the year, as well as mean at least 270 rainy days per year, exceeding evapotranspiration.

The mean annual excellent-days TCI for the study areas is 77 days, the average good-days TCI is 210, and the mean annual very-good-days TCI is 157. Excellent-days TCI is focused around the last three (3) months of the year (October, November, and December) and the first three months of the year (January, February, and March). The results of this study also show that the ideal times to visit the park are between October and April, when the thermal conditions are warm and favourable, ranging between 28.9ºC to 36ºC, averaging 32ºC. The absence of heavy rainfall during these periods also contributes to making it an ideal time to visit the park. Hence, tourists were advised to plan their visit within these periods for an optimal and better experience.

Recommendation

The study recommends a cluster heat map analysis that will show the optimal travel period to the park so as to improve visits. It was also recommended that the park administration use the TCI of the Park to increase its marketing abilities and create awareness among their customers. Based on the results of the climate data analysed in this research, the researchers recommend that the data be used for sustainable tourism development in the Park, through education and awareness for both visitors and locals alike, especially among the inhabitants of the enclaves and other settlements. The authors also recommend engaging with the locals when it comes to managing the park. All these recommendations are aimed at achieving a sustainable development of tourism in the park.

Conflict of interest

The authors declare no conflict of interest, as they were all in agreement with the study methodology and the results presented and discussed as the true reflection of and contribution to the work.

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