

## THE ASSESSMENT OF BIOCLIMATIC CONDITIONS SERVING OUTDOOR TOURISM ACTIVITIES IN GIA LAI PROVINCE

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**Abstract.** Assessment of bioclimatic conditions for outdoor tourism activities in Gia Lai province is conducted in two criteria: 1) Assessing the adaptability of territorial temperature-moisture conditions to the health of people participating in tourism activities by assessing the advantage of bioclimatic types on the bioclimatic map, scaled 1/100,000; the evaluation results show that all 11 bioclimatic types are very comfortable, that is, the bioclimatic conditions in the entire Gia Lai province are suitable for the health of participants in outdoor tourism activities. In addition, the additional assessment results of the comfortable level in different bioclimatic types by the number of rainy days/month show that: In the rainy season (from May to October), the number of rainy days is > 15 days/month, evaluated to be uncomfortable. In the dry season, the number of rainy days < 10 days/month is assessed to be very comfortable. 2) Determine the appropriate season for organizing outdoor tourism activities through the comfortable level of extreme climatic factors, including absolute maximum temperature ( $T_{max}$ ), maximum rainfall ( $R_{max}$ ), maximum wind speed ( $V_{max}$ ) and some special weather phenomena such as fog, thunderstorm in all months of a year. Evaluation results show that: The main season for organizing outdoor tourism activities in different areas of Gia Lai province is the dry season (from November to March, April of the following year). On the other hand, in the rainy months, the organization of outdoor tourism activities is entirely possible on the days when there are no extreme climatic factors and special weather phenomena.

**Keywords:** Bioclimate, bioclimatic conditions assessment, tourism, comfort level, health.

### 1. Introduction

Assessing the climatic conditions for tourism development is a research direction with high scientific and practical significance. On one hand, the theory of natural resources assessment for practical purposes, in general, is enhanced. On the other hand, the results of the bioclimatic resource assessment also help managers to be aware of the

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bioclimatic features of each region, the adaptation level of people participating in tourism with climate and weather conditions in different areas, thereby planning strategies to use and reasonably exploit tourism resources, getting the highest efficiency.

Researchers agree that the climatic conditions of a territory can positively and negatively affect tourism. In a climatic study, De Freitas *et al.* [1] evaluated climatic conditions by considering climate as a resource for different types of tourism activities. According to Gomez Martin [2] climatic conditions allow organizing or facilitating outdoor tourism activities, whereas extreme climatic factors can endanger tourists and possibly interrupt or cancel outdoor travel activities. Lin *et al.* [3] have determined that the number of tourists visiting a certain destination is more or less dependent on the weather and climatic conditions of the destination. Accordingly, researchers have classified the tourism climate of a certain territory to recommend tourists a suitable destination as well as to give the planners sufficient information to organize appropriate forms/types of tourism in that territory. For example Matzarakis [4] carried out the bioclimatic classification for tourism in Lake Balaton, Hungary; Lori Armstrong *et al.* [5] applied GIS to establish bioclimatic map, classify climatic and weather conditions to identify the optimal condition for tourism development based on daily and annual average climatic data.

In Vietnam, there have been studies on bio-climate serving people's welfare and relaxation: Weather in relation with disease by Dao Ngoc Phong [6]; Climate in relation with health by Pham Ngoc Toan [7]; In these studies, the authors have pointed out the impact of each weather and climate factors on human body, and the relationship between climate and health and disease.

The research direction of studying bioclimatic to serve the tourism industry has been conducted by many authors, especially the author Nguyen Khanh Van has research projects on bioclimate in tourism, namely: Fundamentals of bioclimate [8]; Study human bioclimate to serve relaxation tourism in Vietnam [9]; Proper uses of bioclimatic resources to serve the development of production, people's livelihoods and tourism in Hoa Binh lake area [10]; Bioclimatic conditions in some nursing zones in mountainous areas of northern Vietnam [11]; Using weighted scale method to evaluate climatic resources for tourism and relaxation at some tourist centers in Vietnam [12]. These research results are the scientific basis for the study and assessment of climatic conditions of areas serving tourism activities.

Gia Lai province has a rich and diverse tourism resource with majestic landscapes, cultural and historical relics, unique intangible cultural values. With these tourism resources, Gia Lai can strongly develop tourism types (TT), especially outdoor TT such as eco-tourism, sightseeing tourism, resort tourism and indoor TT such as cultural-belief and craft village tourism [13]. The development of a proper scientific basis for climatic resources is one of the important factors to determine the development orientation of appropriate TT and create new products specific to Gia Lai tourism.

## 2. Content

### 2.1. Methods and data used

#### \* *Methods*

##### - *Bioclimatic classification method*

Ecologically, the climate is studied in close relationship with the biological world. Therefore, the effect of climate impacts on organisms is a fundamental principle in the process of building a classification system. That is the main difference between bioclimate and the "general climate" as well as other applications of climate research. However, the bioclimatic map is firstly the climatic map and needs to properly reflect objective rules in the formation and differentiation of climate in the territory. Bioclimate as an ecological factor is expressed mainly through temperature and moisture regimes. Therefore, the combination of temperature-moisture is the basis for climate assessment and identification of classification characteristics, and simultaneously show the close relationship between climate and plants as well as the natural landscape in general. The basis for bioclimatic classification is the territorial temperature-moisture condition, which determines the existence of natural vegetation types arising in that territory. The bioclimatic classification system is created based on of differentiation of limited periods for plants and crops, which are cold or dry periods. Depending on the region, the criteria for the length of the cold season and the length of the dry season can be divided into different levels [8].

Bioclimatic classification map for tourism activities in Gia Lai province was established based on using the indices: annual mean air temperature, total annual rainfall, number of dry months. Based on the classification of these indices, the legend system of the bioclimatic map was established. The legend system is the basis for delineating the bioclimatic regions.

##### - *Method of assessing bioclimatic conditions for tourism activities*

Assessing the bioclimatic conditions for tourism is to assess the adaptation of temperature-moisture conditions to the health of participants in tourism activities based on bioclimatic maps. Human adaptability to each climatic factor will be the basis for assessing the comfort level for tourism activities according to each bioclimatic type.

On the other hand, when assessing bioclimatic conditions for tourism, it can be seen that: tourism activities in Gia Lai, especially the outdoors TT such as eco-tourism, sightseeing, and relaxation which are exploited seasonally and depend heavily on the occurrence of extreme climatic factors such as absolute maximum temperature ( $T_{\max}$ ), maximum rainfall ( $R_{\max}$ ), maximum wind speed ( $V_{\max}$ ) and some special weather phenomena such as fog, storm in a year. Therefore, in addition to assessing the appropriateness of bioclimatic subtype for the health of participants in outdoor tourism activities, it is necessary to determine the appropriate season to organize outdoor tourism activities in relation to special weather phenomena.

#### \* *Data used*

Data on climatic factors in the period 1980 - 2014 of 3 meteorological stations and 8 rain gauges in Gia Lai province [14].

- Data on tourism resources, socio-economic development and tourism situation of Gia Lai province in the period of 2010 - 2016 [13, 15].

## **2.2. Results**

### **2.2.1. Establishment of bioclimatic classification map for tourism in Gia Lai province**

Bioclimatic classification map of Gia Lai province, scaled 1/100,000 is divided into 2 levels:

#### **\*Climatic type**

The climatic type is the level that represents the overall climate condition of Gia Lai province, in other words, the temperature-moisture regime of the territory.

- Average annual air temperature: is the typical index for the background temperature of Gia Lai province. The annual average temperature in Gia Lai province ranges from 22 - 26 °C. The average elevation ranges from 800-900 m, gradually lower from North to South and incline from East to West. The province's background temperature is divided into 3 classes (Table 1).

**Table 1. Classification of annual average temperature**

<b>Symbol</b>	<b>Terrain altitude (m)</b>	<b>Rating level</b>	<b>T<sub>N</sub> (°C)</b>
I	< 200	Hot	> 24
II	200-700	Warm	22 - 24
III	> 700	Cool	< 22

Total annual rainfall: The total annual rainfall in Gia Lai province ranges from 1200 to over 2300mm. The total annual rainfall is divided into 4 classes (Table 2).

**Table 2. Classification of total annual rainfall**

<b>Symbol</b>	<b>Rating level</b>	<b>R<sub>N</sub> (mm)</b>
A	Heavy rain	≥ 2.000
B	Moderate rain	1.600 - 2.000
C	Little rain	1.200 - 1.600
D	Very little rain	< 1.200

#### **\* Bioclimatic subtype**

It is a sub-level of bioclimatic type. The number of dry months was chosen as the indicator of bioclimatic classification, which is an important factor affecting health as well as the ability of tourists to make outdoor tours.

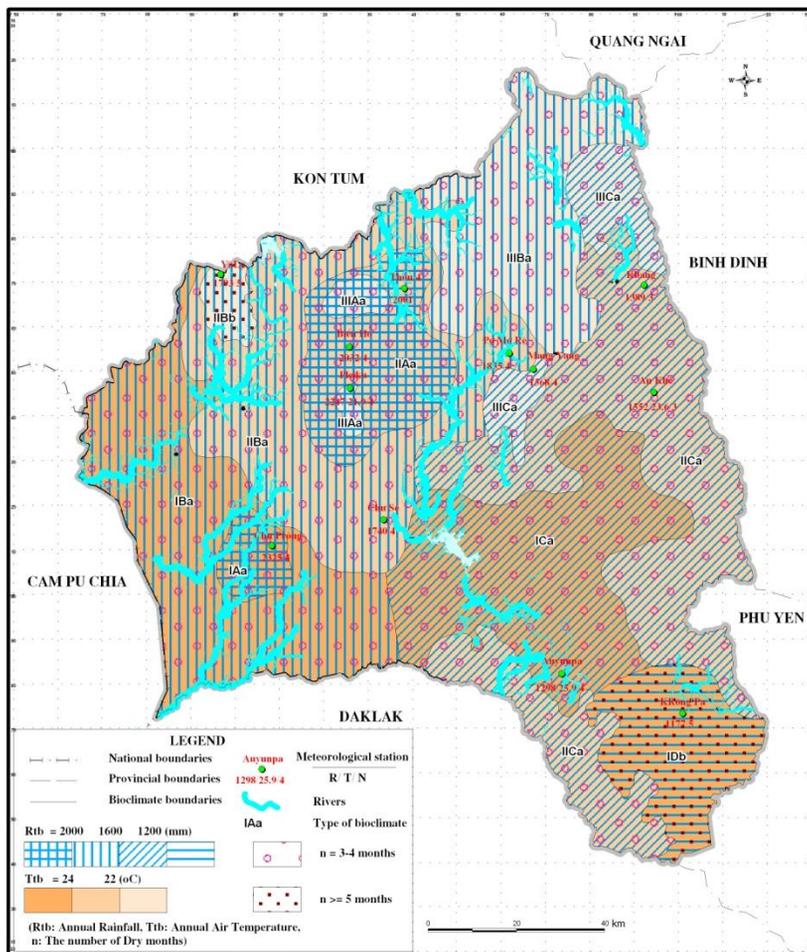
- The number of dry months: Months with < 50mm rainfall is called dry months. In Gia Lai during the dry season, the monthly rainfall has little spatial separation. In the Northeast of the province, the dry season starts in December and ends in late April (5 months) with 3 dry months (Kbang and An Khe stations). In the Southeast, the dry season also lasts for 5 months but because the location is sheltered from the northeast

monsoon, all months in the dry season are dry months. In the center of the province, the dry season lasts from November to the end of April (6 months) with 4 dry months. In the low valley area in the northwest of the province, because its location is contiguous to the high mountain area, the dry season starts early (from November) and ends at the end of April, lasts 6 months. In this area, the number of dry months is up to 5 months.

**Table 3. Classification of the average number of dry months per year**

Symbol	Rating level	Number of dry month
a	Average dry season	3 – 4 months
b	Long dry season	≥ 5 months

The legend system of Gia Lai tourism bioclimatic classification map is shown in a matrix form of temperature-moisture classification (bioclimatic type) and a number of dry months (bioclimatic subtype).



**Figure 1. Bioclimatic classification map for tourism in Gia Lai province, rescaled from 1/100,000**

The final bioclimatic units of the map are bioclimatic subtype. On the map, the bioclimatic condition of Gia Lai province is divided into 11 subtypes, including IIIAa, IIIBa, IIIBb, IIICa, IIAa, IIBa, IICa, IAa, IBa, ICa and IDb, of which there are 3 repetitive subtypes: IIIAa, IIICa, IICa (Figure 1).

### **2.2.2. Assessing bioclimatic conditions of Gia Lai province for outdoor tourism activities**

To assess the bioclimatic conditions in relation to human health, the author has analyzed and assessed the adaptation level to the climate and weather conditions of people when participating in tourism activities in different areas of Gia Lai province. The level of adaptation is assessed for each bioclimatic subtype of bioclimatic classification map based on the biological and climatic criteria for humans, including temperature, rainfall, sunny hours, wind speed, humidity.

Regarding the influence of climatic factors on human's sensitivity thresholds, the authors Nguyen Minh Tue [16], Nguyen Khanh Van [8] and Nguyen Hoang Son [17] have proposed the following biological climatic indicators as follows:

**Table 4. The influence of weather and climatic factors on human sensitivity threshold**

No.	Factor	Value	Category
1	Air Temperature(°C)	18 -24	Suitable
		24-27	Moderately suitable
		27-32	Marginally suitable
		> 32	Not suitable
2	Absolute maximum Air Temperature (°C)	< 32	Suitable
		32 - 36	Marginally suitable
		> 36	Not suitable
3	Annual Rainfall (mm)	1.250 – 2.550	Suitable
		<1.250	Marginally suitable
		>2.550	Not suitable
4	Number of dry months (months)	> 5	Suitable
		3 – 4	Marginally suitable
		< 3	Not suitable
5	Number of rainy days (days per month)	< 10	Suitable
		10 – 15	Marginally suitable
		> 15	Not suitable
6	Humidity (%)	50 – 80	Suitable
		< 50	Dry/Marginally suitable
		>80	Humid/Marginally suitable
7	Wind speed (m/s)	1 – 3	Suitable
		> 3 and <1	Not suitable
8	Number of sunny hours per year (hours)	>1.500	Suitable
		1.200 – 1.500	Marginally suitable
		1.000 – 1.200	Not suitable

In theory, the threshold of human sensitivity (degree of adaptation) to climate and weather in specific activity can be transformed into a level of comfort. For climatic conditions in Gia Lai province, the adaptation level of participants' health to tourism activities is converted into 3 comfort levels with scores from 3 to 1 and presented in Table 5.

**Table 5. The conversion of adaptation level to comfort level in tourism activities**

Suitability Level	Comfort level	Score
Suitable	Very comfortable	3
Marginally suitable	Comfortable	2
Not suitable	Not comfortable	1

**\* The comfort level of bioclimatic subtypes to the participants' health in tourism activities**

Evaluating bioclimatic units in Gia Lai province to determine which area of which bioclimatic subtype is comfortable for participant's health in tourism activities. Assessing the degree of comfort of bioclimatic subtypes based on the influence level of climatic factors in relation to human sensitivity threshold is presented in Table 4. The evaluated criteria are temperature-moisture regime which forms bioclimatic subtypes (temperature, rainfall, dry months). The assessment is implemented in 3 levels: very comfortable (mark 3), comfortable (mark 2) and not comfortable (mark 1).

*Annual average temperature*

- Cool region (III:  $< 22^{\circ}\text{C}$ ) Comfortable (mark 2)
- Humid region (II:  $22- 24^{\circ}\text{C}$ ) Very comfortable (mark 3)
- Hot region (I:  $> 24^{\circ}\text{C}$ ) Very comfortable (mark 3)

*Annual average rainfall*

- Heavy rain (A:  $> 2.000\text{mm}$ ) Comfortable (mark 2)
- Moderately rain (B:  $1.600 - 2.000\text{mm}$ ) Comfortable (mark 2)
- Little rain (C:  $1.200 - 1.600\text{mm}$ ) Very comfortable (mark 3)
- Very little rain (D:  $< 1.200\text{mm}$ ) Very comfortable (mark 2)

*Number of dry months/dry season*

- The region has an average dry season (a: 3-4 months) comfortable (mark 2)
- The area has a long dry season (b:  $\geq 5$  months) Very comfortable (mark 3)

In order to assess all 3 indices of bioclimatic subtypes, the author sums the score of each index and classify the total score into 3 levels of comfort:

The total score scale of bioclimatic subtypes ranges from 3 to 9. The lowest total score: 3; The highest total score: 9. Therefore, the comfortable level (CL) is divided by the total number of marks as follows: from 3 to 4: not comfortable; from 4 to 6: comfortable; from 7 to 9: very comfortable.

Evaluation results of bioclimatic subtype are presented in Table 6

**Table 6. Evaluation of bioclimatic subtypes for ecotourism, sightseeing and relaxation purposes in Gia Lai province**

Criteria	Bioclimatic subtype										
	IIIAa	IIIBa	IIIBb	IIICa	IIAa	IIBa	IICa	IAa	IBa	ICa	IDb
Average annual temperature	2	2	2	3	3	3	3	3	3	3	3
Average annual rainfall	2	2	2	2	2	2	2	3	3	3	2
Number of dry months	2	2	2	2	2	3	2	2	2	2	3
Total	6	6	6	7	7	8	7	8	8	8	8
Assessment result	CL	CL	CL	VCL	VCL	VCL	VCL	VCL	VCL	VCL	VCL

On the basis of territorial differentiation of bioclimatic subtypes in Gia Lai province, it can be seen that: The specific criteria (annual average temperature, total annual rainfall and dry months) of 11 types of bioclimatic have the same score of 2-3, corresponding to the level of comfortable - very comfortable. The overall assessment of the temperature-moisture conditions of the bioclimatic subtypes ranged from 6-8, corresponding to the comfortable and very comfortable for the participants' health.

- Bioclimatic subtype: IIIAa, IIIBa, IIIBb and IIICa are comfortable levels (CL).
- Bioclimatic subtype: IIAa, IIBa, IICa are very comfortable (VCL).
- Bioclimatic subtype: IAa, IBa, ICa, IDb are very comfortable (VCL).

**\* The comfort level of some bioclimatic factors to the health of people participating in tourism activities**

The comfort level assessment results of some bioclimatic factors for human health (average data in multiple years) are presented in Table 7.

Analyzing the evaluation results of the comfort level of each individual climatic factor by their scores in Table 7, we see the following:

Of 7 climatic factors, there are 6 factors that are evaluated at a comfortable level – a very comfortable level for participants in tourism activities. Particularly, the absolute maximum temperature factor in low areas <200 m is considered not comfortable. However, the absolute maximum temperature in these regions is the highest value observed in the entire data series (1980 - 2014), so in fact, the absolute maximum temperature does not significantly affect people health participating in tourism

activities. Wind speed and total sunny hours: all bioclimatic subtypes are considered very comfortable.

The total score of all 7 climatic factors in high, medium and low regions ranges from 17 to 18 marks, in which the score of very comfortable–comfortable (mark 3 and 2) dominates the region. This proves that bioclimatic conditions in different regions in Gia Lai province are comfortable to the health of people participating in tourism activities, especially outdoor TT such as sightseeing tours, eco-tourism.

**Table 7. Evaluation of the comfort level of some bioclimatic factors in Gia Lai in relation with human’s sensitivity threshold**

Station	Mean air temperature (°C)	Absolute maximum temperature (°C)	Annual rainfall (mm)	Number of dry months (month)	Humidity (%)	Wind speed (m/s)	Number of sunny hours per year (hour)	Total
Pleiku (800 m)	21.9	36.0	2.180,0	4	83	2.6	2.406	
Comparison result	CL	CL	VCL	CL	CL	VCL	VCL	
Score	2	2	3	2	2	3	3	17
An Khe (422 m)	23.6	38.3	1.576,2	3	83	2.6	2.347	
Comparison result	VCL	NC	VCL	CL	CL	VCL	VCL	
Score	3	1	3	2	2	3	3	17
Ayun Pa (160 m)	25.9	40.7	1.292,8	4	79	1.6	2.412	
Comparison result	VCL	NC	VCL	CL	VCL	VCL	VCL	
Score	3	1	3	2	3	3	3	18

*Source: Department of Climatology Geography, Institute of Geography*

In addition to the above climatic factors, the number of rainy days is also a climatic factor that significantly affects tourism activities. In Gia Lai province, the average number of rainy days per year fluctuates in different regions, ranging from 140 to 158 days per year. On the other hand, the number of rainy days in a month is important for organizing outdoor tourism activities. On rainy days, tourism activities are often not organized. Therefore, it is necessary to assess the comfort level for tourism activities in relation to the number of rainy days in each month of the year, especially during the rainy season.

According to Nguyen Duc Hoang [18], the comfort level to organize outdoor activities in relation to the number of rainy days in a month is divided as follows:

- The month with a number of rainy days: <10 days - Very comfortable (mark 3)
- The month with a number of rainy days: 10 - 15 days - Comfortable (mark 2)
- The month with a number of rainy days: >15 days - Not Comfortable (mark 1)

The evaluation results are presented in Table 8.

Data analysis in Table 8 shows that: In the high (Pleiku) and in the low regions (AyunPa) the rainy season months (May-October) the number of rainy days is > 15 days/month, meaning not comfortable to organize tourism activities. Particularly in the hilly and low region (An Khe), the number of rainy days > 15 days/month appears in August-November, indicating a phase difference compared to the two regions mentioned above. In the dry season, from November to April of the following year, the number of rainy days is <10 days in all regions, indicating a comfortable level. On the other hand, there are signs of divergence on the number of rainy days/month in the dry season, namely: in low mountainous areas (An Khe) in November with the number of rainy days > 15 days, considered to be at not comfortable level, and December has 10-15 rainy days, evaluated to be comfortable. In the lowlands and valleys (Ayun Pa), November has 10-15 rainy days, evaluated to be comfortable.

**Table 8. Comfort level assessment of number of rainy days with tourism activities in Gia Lai province**

Month Station	1	2	3	4	5	6	7	8	9	10	11	12	Total
Pleiku (800 m)	0.6	0.9	3.4	8.1	18.2	22.6	26.2	27.6	24.7	15.8	7.5	2.2	157.7
Score	3	3	3	3	1	1	1	1	1	1	3	3	24
An Khe (422 m)	8.6	3.5	4.2	6.5	13.3	11.8	13.2	15.7	18.1	19.4	17.4	13.9	145.7
Score	3	3	3	3	2	2	2	1	1	1	1	2	24
Ayun Pa (160 m)	1.7	1.6	2.6	6.8	15.6	15.3	17.1	20.9	20.6	18.5	13.3	6.2	140.1
Score	3	3	3	3	1	1	1	1	1	1	2	3	23

*Source: Department of Climatological Geography, Institute of Geography*

In summary, in different regions of Gia Lai province, outdoor tourism activities should be organized in the dry season months (November - April).

*\* Summary of assessment results of bioclimatic conditions to the health of participants in tourism activities*

Assessing the bioclimatic conditions of Gia Lai province to serve outdoor tourism activities is done on the basis of summarizing the evaluation of temperature-moisture conditions (air temperature, total rainfall, number of dry months) and evaluation results of some sub-indicators (number of rainy days/month, air humidity, number of sunny hours, wind speed). Evaluation results by the score are presented in Table 9.

**Table 9. General assessment of bioclimatic subtypes for tourism purposes in Gia Lai province**

Criteria		Bioclimatic subtype										
		IIIAa	IIIBa	IIICa	IIAa	IIBa	IIBb	IICa	IAa	IBa	ICa	IDb
Annual mean temperature	Cool	2	2	2	2	2	2	2	2	2	2	2
	Humid	3	3	3	3	3	3	3	3	3	3	3
	Hot	3	3	3	3	3	3	3	3	3	3	3
Annual mean rainfall	Heavy rain	2	2	2	2	2	2	2	2	2	2	2
	Moderately rain	2	2	2	2	2	2	2	2	2	2	2
	Little rain	3	3	3	3	3	3	3	3	3	3	3
	Very little rain	2	2	2	2	2	2	2	2	2	2	2
Dry season	Moderate	2	2	2	2	2	2	2	2	2	2	2
	Long	3	3	3	3	3	3	3	3	3	3	3
Number of rainy day per month	Rainy season	1	1	1	1	1	1	1	1	1	1	1
	Dry season	3	3	3	3	3	3	3	3	3	3	3
Humidity		2	2	2	2	2	2	2	3	3	3	3
Number of sunny hour		3	3	3	3	3	3	3	3	3	3	3
Wind speed		3	3	3	3	3	3	3	3	3	3	3
<b>Total score</b>		<b>34</b>	<b>34</b>	<b>34</b>	<b>34</b>	<b>34</b>	<b>34</b>	<b>34</b>	<b>35</b>	<b>35</b>	<b>35</b>	<b>35</b>

The lowest total score in 14 factors is 14 and the highest total score is 42. The total score is divided into 3 comfort levels as follows: from 14 - 23: not comfortable; from 24 - 33: comfortable; from 34 - 42: very comfortable.

Table 9 shows that: the total score of 11 bioclimatic subtypes reached 34 - 35, in the level of very comfortable, which means: in general, bioclimatic conditions in the

whole territory of Gia Lai province are considered very comfortable to the health of participants in outdoor travel activities. On the other hand, considering the comfort level of bioclimatic subtypes by the number of rainy days per month, it can be seen that: The number of rainy days per month has a clear degree of differentiation in bioclimatic subtypes. In the rainy season (from May to October), the number of rainy days  $> 15$  days/month is assessed not comfortable (mark 1). On the contrary, in the dry season, the number of rainy days  $< 10$  days/month is assessed to be comfortable (mark 3).

In summary, the evaluation results based on average data series show that: The condition of bioclimatic in Gia Lai province is very high for the health of people participating in tourism activities, especially outdoor TT. However, these tourism activities should be avoided during the rainy months because the number of rainy days in these months is quite high, causing many difficulties for organizing tourism activities and adversely affecting the ability to travel to tourist destinations of people participating in tourism activities.

### **2.2.3. Propose appropriate timeframe for organizing outdoor tourism activities**

The results of a general assessment of bioclimatic conditions for the health of participants in the tourism activities presented above show that overall, bioclimatic conditions on the whole territory of Gia Lai province are comfortable for the health of people participating in outdoor tourism activities. However, as the results of the assessment are carried out using the average data for multiple years, there is not enough basis to choose the appropriate time of the year to organize outdoor tourism activities. In fact, the appropriate season to organize outdoor tourism activities depends heavily on the occurrence of extreme climatic factors such as absolute maximum temperature ( $T_{\max}$ ), the highest rainfall ( $R_{\max}$ ), maximum wind speed ( $V_{\max}$ ) and some special weather phenomena such as fog, storm.

#### ***\*Assessing the impact of extreme climatic factors and special weather phenomena on the time of organizing outdoor tourism activities***

##### *- Effect of extreme climatic factors*

Extreme climatic factors are local and unpredictable over time. Climatic data have reported the value and date of occurrence of these factors in the period 1980 - 2014. Table 10 presents the maximal value of climate factors in different regions of Gia Lai province.

Analyze the data in Table 10, we can see that:  $T_{\max}$  has the greatest value in the dry months;  $R_{\max}$  and  $V_{\max}$  have the highest value in the rainy season months. That means: in the dry season extreme climatic factor  $T_{\max}$  makes climate/weather conditions become hotter, affecting the health of participants in outdoor travel activities. On the contrary, in the rainy season, the value of  $R_{\max}$  and  $V_{\max}$  makes the climate/weather

become wetter and also causes significant impacts on the health of the participants in the tourism activities as well as the time to organize the outdoor activities.

**Table 10. Value of extreme climatic factors in Gia Lai province**

Station	Climatic factor	Month											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Pleiku	$T_{\max}$ ( $^{\circ}\text{C}$ )	33.2	35.0	35.9	36.0	35.1	33.1	32.0	31.6	32.5	32.8	32.0	31.3
	$R_{\max}$ (mm)	34.2	26.5	73.9	101	159	227.8	146	204.2	156.1	140	96.3	65.8
	$V_{\max}$ (m/s)	18	20	20	21	24	22	22	24	24	18	28	18
An Khe	$T_{\max}$ ( $^{\circ}\text{C}$ )	34.0	35.9	37.2	38.3	37.8	37.6	36.5	35.0	35.2	34.4	32.0	31.1
	$R_{\max}$ (mm)	77	22.8	34.3	100.5	131.4	119.4	162	97.5	139.3	214.2	240.8	172.4
	$V_{\max}$ (m/s)	13	23	14	24	20	22	20	24	16	18	20	14
Ayun Pa	$T_{\max}$ ( $^{\circ}\text{C}$ )	36.1	38.5	39.6	40.7	40.5	37.4	37.1	36.1	35.9	34.9	34.3	33.4
	$R_{\max}$ (mm)	23	24.6	52.6	80.2	139.7	101.2	89.2	85.8	139.9	211.6	250.5	50.4
	$V_{\max}$ (m/s)	14	12	15	20	20	15	12	16	18	15	20	12

*Source: Department of Climatological Geography, Institute of Geography*

*- Effect of special weather phenomena*

As mentioned, special weather events in Gia Lai province affect outdoor tourist activities, mainly fog and storm. The appropriate time to organize outdoor tourism activities is determined on the basis of combining the results of evaluating the general bioclimatic conditions according to the average data for multiple years with the assessment of “comfortable” by the number of days that has storm and fog phenomena in each month.

Table 11 shows the number of days that storms and fogs occurrence per month in different bioclimatic subtypes in Gia Lai province. Data in Table 11 show that:

Storms appear mainly in the rainy season (May-October) with the number of stormy days exceeding 10 days/month. The month with most occurrence is May with the number of days >15 days/month, especially in the valleys region (Ayun Pa station) the number of storm in May is up to 21.3 days. In the highlands (Pleiku station) and low

mountainous areas (An Khe station), the number of the storms in May is the highest, but it is only about 16 days/month.

Fog occurrence is generally not much. In low mountainous areas, in February and March, the number of foggy days is higher than in other regions, reaching the maximum value of 5-7 days/month.

Determining the appropriate season for outdoor tourism activities in different regions of Gia Lai province is done through assessing the comfort level on the sensitivity threshold of participants in tourism activities before the occurrence of storm and fog every month for a year.

**Table 11. Number of stormy and foggy days in different bioclimatic subtypes in Gia Lai province in each month**

Station/ Bioclimatic subtype	Special weather phenomena	Month											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Mountainous Area (Pleiku)	Number of stormy day	0.1	1.0	4.7	10.7	16.3	11.1	10.3	10.1	12.5	7.3	0.7	0.1
	Number of foggy day	2.0	1.8	1.8	2.0	4.5	7.3	10.7	10.7	11.7	5.5	1.9	1.3
Hilly Area (An Khe)	Number of stormy day	0.1	0.5	2.8	9.0	16.3	9.3	11.3	9.5	12.0	6.0	0.7	0.0
	Number of foggy day	2.4	5.6	6.6	2.8	1.4	1.3	1.8	2.3	3.2	2.7	1.5	1.1
Lowland and valley area (Ayun Pa)	Number of stormy day	0.2	1.2	5.1	14.2	21.3	12.3	13.1	12.8	18.5	12.0	1.6	0.1
	Number of foggy day	4.2	1.4	0.0	0.0	0.0	0.1	0.0	0.1	0.5	2.7	3.0	4.1

*Source: Department of Climatological Geography, Institute of Geography*

According to Nguyen Hoang Son [4], the number of stormy and foggy days affects different levels of the sensitivity threshold of participants in outdoor tourism activities. Comfort levels are presented in Table 12.

The assessment results of comfort level by month due to the effects of storm and fog in different regions of Gia Lai province are presented in Tables 13, 14 and 15.

Based on the evaluation results presented in the above-mentioned tables, an analysis of the time to organize outdoor tourism activities in different regions was conducted:

- *High mountains (> 700 m)*

**Table 12. Effects of storm and fog on human sensitivity thresholds**

Special weather phenomena	Frequency (per month)	Comfort level
Storm	> 15 days	Not comfortable
	10 - 15 days	Marginally comfortable
	< 10 days	Comfortable
Fog	> 10 days	Marginally comfortable
	< 10 days	Comfortable

**Table 13. Time for organizing outdoor tourism activities in high mountainous areas of Gia Lai province**

Special weather phenomena	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Number of stormy days												
Number of foggy days												

Not comfortable     
 Marginally comfortable     
 Comfortable

According to the results in table 13, we see that:

The storm appears in the months of April-September. May is the month with the highest number of stormy days (16.3 days), considered not comfortable for organizing outdoor tourism activities. The months of April and June - September (10-12.5 days) are considered marginally comfortable. In the dry season (the October-march months of the following year) the number of storms is less (0.1-7.3 days), is considered comfortable.

Fog: in the July-September months, the number of foggy days fluctuates around 11-12 days, is considered marginally comfortable. In other months, fog appearance is less (1.8-5.5 days), is considered comfortable to organize outdoor tourism activities. Thus, in the high mountains, the most appropriate time for outdoor tourism activities is in the dry months (from November to April of the following year). During the rainy season, organizing outdoor tourism activities should avoid stormy days in the June-September months to minimize adverse health impacts, especially the tourists' travel.

- *Low hills and mountains (200 m – 700 m)*

**Table 14. Time for organizing outdoor tourism activities in low hills and mountains in Gia Lai province**

Special weather phenomena	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Number of stormy days	0	0	0	0	16	11	11	11	12	0	0	0
Number of foggy days	1	1	7	1	1	1	1	1	1	1	1	1

Based on Table 14, we see that:

Storm appearance in this area is not much. May has the most number of stormy days (16 days), followed by September (12 days), July (11 days), these months are considered not comfortable for organizing outdoor tourism activities. And the dry season months (October-March in the following year) number of stormy days is very few, ranging from 0–3 days, therefore considered to be comfortable for organizing outdoor tourism activities.

The fog rarely appears in this area. The month with the most foggy day is March (7 days). The remaining months have the number of foggy days fluctuating around 1-6 days. Thus, the number of foggy days hardly affects the organization of outdoor tourism activities.

Thus, in the hills and low mountains, in relation to special weather phenomena, the time to organize outdoor tourist activities is all year round. However, it is necessary to select the appropriate days to organize tourism activities in the months of May, July, September when the number of stormy days is high.

- Low areas and valleys (< 200 m)

**Table 15. Time for organizing outdoor tourism activities in lowland and valleys region of Gia Lai province**

Special weather phenomena	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Number of stormy days	10	10	10	10	21	10	10	10	18	19	10	10
Number of foggy days	1	1	1	1	1	1	1	1	1	1	1	1

According to the results in table 15, it can be seen that:

Stormy occurrence in this area is high, especially in months from September - May. The month with the most number of stormy days is May (21 days) and September (18-19 days). The remaining months in this period all have > 10 stormy days/month, considered not comfortable for organizing outdoor tourism activities.

The fog rarely appears in this area. All year round there is almost no fog, except for January and December, there are about 4 days of fog and are considered comfortable for organizing outdoor tourism activities.

Thus, in the lowlands and valleys, the time to organize outdoor tourism activities in months from May – October should be selected accordingly because in these months, storms frequently happen, affecting health as well as outdoor activities of tourists.

In summary, considering the main season for organizing outdoor tourism activities in different regions of Gia Lai province is the dry season (from November to March, April next year). However, in the rainy season, the organization of outdoor tourism activities is completely possible in the days when there are no extreme climatic factors and special weather phenomena.

On the other hand, the season of tourism activities depends not only on the comfort level of the weather conditions but also on the purpose of tourism and the participants in tourism activities. For example: visiting natural landscapes in the mountains in the fog, although the weather conditions are not good for the health and travel of the tourists, many tourists like to visit these landscapes in foggy weather conditions. Therefore, the right time to organize outdoor tourism activities should be considered in two respects: 1) The impact of climate and weather conditions on the health of tourists; 2) The purpose and interests of visitors when participating in a certain outdoor TT.

### **3. Conclusions**

Evaluation of bioclimatic conditions on human health is done through the establishment of a bioclimatic map for human health in Gia Lai province, scaled 1/100,000, thereby using the criteria of the suitability of Climatic indicators for health participants of tourism activities to assess each bioclimatic subtype distributed in Gia Lai province. The results show that: all 11 bioclimatic subtypes are comfortable, suitable for the health of participants in outdoor tourism activities. The results of additional the assessment of the comfort level in different bioclimatic subtypes by the number of rainy days/month show that: in the rainy season (from May to October), the number of rainy days is > 15 days/month, assessed to be not comfortable. In contrast, in the dry season, the number of rainy days <10 days/month is assessed at a very comfortable level.

The bioclimatic conditions in Gia Lai province are generally comfortable for outdoor tourism activities. However, some extreme climatic factors and special weather phenomena may adversely affect the health of people participating in tourism activities as well as the time to organize outdoor tourism activities. The main season for organizing outdoor tourism activities in different areas of Gia Lai Province is the dry season (from November to March April next year). In the rainy months, the organization of outdoor tourism activities can take place on days when there are no extreme climatic factors and special weather phenomena.

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