

The Bioclimatic map of Southern Vietnam for tourism development

Nguyen Khanh Van^{1*}, Hoang Thi Kieu Oanh², Vuong Van Vu¹, Le Thi Thuy Hien³

¹*Institute of Geography, VAST, Hanoi, Vietnam*

²*Saigon University, HCM City, Vietnam*

³*Hong Duc University, Thanh Hoa, Vietnam*

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ABSTRACT

Although research and evaluation of climate conditions for tourism development are a pressing issue, in Vietnam in general and in the Southern region in particular, these studies are still limited. Based on climatological parameters (T-annual temperature, R-rainfall and N-rainy days) with their levels of classification representing the bioclimatic impact on tourism, the bioclimatic classification map of Southern Vietnam is built at the scale of 1:250,000. Base on the calculated data from 20 meteorological stations of Southern Vietnam in many years (1981-2015), 12 suitable bioclimatic units are established. It is a necessary scientific background to organize territory for tourism in Southern Vietnam. With plentiful bioclimatic resources, one can organize many types of tourism in Southern Vietnam. The result of classification and bioclimatic map for tourism is an important and necessary scientific basis which help the orientation of development and tourism territory organization of the governments.

Keywords: Bioclimatic units; bioclimatic classification map; bioclimatic assessment for; tourism; Southern Vietnam.

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1. Introduction

Climate resources play an important role in tourism activities, but until the early 1980s, the relationship between climate and tourism had just begun to study strongly. Many studies about climate with tourism geography have widely published. In fact, the climate is considered as a key resource for many types of tourism and this resource can be measured and evaluated (de Freitas et al. 2008; Asgary et al., 2011). Besides, the climate can also

have a two-way impact on tourism activities (Becken, 2013; Scott and Lemieux 2009). In general, Climate allows conducting or facilitating for outdoor tourism activities (Gomez Martin, 2005). But weather and climate can also pose a danger to tourism, such as extreme temperatures and storms, etc (Matzarakis, 2008). In addition, depending on weather and climate conditions, the number of visitors to a tourist destination is also very different (Maddison D, 2001; Bigano A, Hamilton JM, Tol RSJ, 2006; Lin et al., 2006). With the importance of climate,

*Corresponding author, Email: ngkhvan@gmail.com

tourism climate classification, especially in large areas, is the best way for tourists to choose suitable destinations. Some authors studied in detail the differentiation of climatic conditions in localities, such as bioclimate classification in cities in Poland (Kraków, 2014), in Lake Balaton in Hungary (Matzarakis, 2007), in North America (D. Scott, 2004), in Eastern Australia (Hadwen W, 2011), in Sun Moon Lake in Taiwan (Lin, 2008), etc. In general, in modern science, especially in tourism study, climate classification has achieved many clearly good results, for example, studies of Ali Reza Eslami (2011) and Lori Armstrong (2015) based on the average daily and yearly climate data combining with GIS (Geographic Information System) application in the construction of bioclimate maps, classification of climatic conditions, and optimal weather for tourism development. Using popular bioclimate elements such as daily rain, daily temperature, snow coverage, sultry level... Krzysztof Blazejczyk has categorized into 30 types of tourism bioclimate. The temperature of these types of climates has divided into levels corresponding to the levels of human physiology reaction when participating in recreational activities, tourism.

Climate research now focuses on climate change using quantitative methods to assess the impact of climate change on tourism activities (Jaume Rosselló-Nadal, 2014; Natalie Chin, 2018; Micah J. Hewer and others, 2018). Some researchers consider that climate change causing disasters affects tourism. They gave warnings to the tourism industry to adapt to climate change (Nurrohman Wijayaa, Alhilal Furqan, 2018; Dominique Paquina and others, 2016). The studies about the effects of climate change on tourism were carried out in Europe (Cathrine Fox Maule, 2017), Canada (Micah J. Hewer, 2018), areas in the middle latitude like Taiwan (Tzu Ming Liu, 2016), Australia (Bas

Amelung, Sarah Nicholls, 2014), Antarctic continent (Shahab Kariminia and others, 2013). In particular, a number of studies used the tourism climate index, for examples, Physiologically Equivalent Temperature (PET)-a combination of daily air temperature, relative humidity, wind velocity, vapor pressure, and global radiation, to forecast for tourism activities until 2039 (Hojjatollah Yazdanpanah, 2016).

It is clear that there are more and more researches on tourism bioclimate for the specific regions in the world. It also shows the important role of climate conditions as well as bioclimate resources for tourism and resort activities. This is the direction with a stronger development prospect in the future for applied climate research.

In Vietnam, the development of tourism is one of the driving forces to promote bioclimate studies on human health in tourism activities. The studies of Pham Ngoc Toan, Phan Tat Dac (1980), Dao Ngoc Phong (1984), Tran Cong Minh (2007) have considered as the foundation for tourism bioclimate research in Vietnam. Some studies assessed the effects of climate and weather on Vietnamese physical condition, for example, Dao Ngoc Phong (1980), Trinh Binh Di et al. (1985). Studying the weather and climate for tourism activities had some works of Vu Boi Kiem (1990), Tran Viet Lien (1993), and Dang Kim Nhung (1990),... from 1990 to now, base on the practical needs of tourism development, as well as the development of tourism types, there are many works conducting research and assessment the conditions and bioclimate resources for developing tourism in specific areas. For example, The studies of assessments of natural conditions and natural resources for the development of some types of tourism in Da Lat city and areas nearby (Nguyen Huu Xuan, 2009), in Thua Thien Hue province (Nguyen Detective, Nguyen Hoang Son,

2011), in Quang Ninh-Hai Phong area (Nguyen Dang Tien, 2016), in Central Highlands (Nguyen Thu Nhung, 2018). These studies show that bioclimate conditions can have positive and negative effects on tourism. Bioclimate resources for developing tourism types need to be analyzed and evaluated separately according to the characteristics of each tourism activity. Many authors used human bioclimatic maps to assess the advantages of climate for tourism activities, and show its disadvantages in studied areas for the development of various tourism types in local as well as for the best choice of time and region of visitors for their travel and vacation.

In the study area-Southern Vietnam, many researches have initially assessed some indicators of tourist bioclimate in a specific area (Ba Ria Vung Tau), land areas, sea and some islands in the South of Vietnam (at some climate monitoring stations or meteorological stations) (To Hoang Kia, Dang Van Phan, 2012, Nguyen Tham, Dinh Thi Thu Thuy, 2014). However, the full assessment of bioclimatic conditions which finds out the differentiation with the rule of bioclimate resources, and shows the evaluation results on the map for tourism territorial organization in the whole Southern region has not yet been implemented. For tourism development in Southern Vietnam, it is necessary to study and use the general criteria to classify the Southern tourism bioclimate; Moreover, the above general criteria should also be categorized into the different levels of impact (very convenient, convenient, rather favorable) for people and tourism activities. Therefore, this paper is a first step towards the visualization of bioclimate classification, as well as an assessment of advantageous levels of bioclimatic resources for tourism in Southern Vietnam.

2. Study area

Located in the South of Vietnam, the Southern region stretches from 8° North to 12° North with an area of 64,166.7 km² (equivalent to 19.4% of Vietnam's area). Southern Vietnam is bounded by Cambodia to the west and northwest, (819 km), the Central Highlands and Central Coast of Vietnam to the north and northeast, the East Sea to the east and the Gulf of Thailand to the southwest. In this geographic location, the majority of the Southern territory has a tropical and subequatorial climate (small parts in the south part of Southern Vietnam) with lots of sunshine and heat all year. Influenced by Southeast Asia summer monsoon, the climate of the South has two distinguishable seasons: the rainy season from May to October and the dry season from November to April; System of rivers and canals in Southern Vietnam is relatively developed, with an average density of 0.68 km/km². The Southern, especially the Southeast region, plays a very important role in the tourism industry in Vietnam, accounting for 46% of the total tourism revenue of the country.

3. Data and methods

Climate and weather impact on human life in an overall way, so that there are more and more different bioclimate indicators used to assess the effects of climate impact on human and travel activities. There are some common indicators such as TCI (Tourism climatic index) (Mieczkowski Z., 1985), PET (Physiological Equivalent Temperature index) (Matzarakis and Mayer 1997; Höppe, 1999; Matzarakis et al, 1999), CIT (Climate index for tourism) (De Freitas, 1985, 1990), SET (standard effective temperature) (Gagge et al., 1986). These indicators showed the simultaneous effects of major climatic factors. If calculated for the year, these indicators will show the potential of the tourism bioclimate of each territory, if calculated for the months,

they will show what happens with this resource in the year.

To identify bioclimatic types for tourism, the climatic classification method is used in this paper. In Southern Vietnam, based on some major climatic factors playing an important role in tourism and their rutable distribution in geographic space, criteria system of bioclimatic classification for tourism are established. This classification of criteria of tourism bioclimate is also based on the results of Indian researchers (Tran Viet Lien, 1993) that is the most widely used method and remained value until now.

In order to classify the bioclimate of the Southern region, factors reflecting thermal-moisture basic conditions are selected such as: (1) mean annual temperature (T), (2) total annual rainfall (R), and (3) number of rainy days (n). Based on the statistical climate data for many years (1981-2015) of 20 climate stations in the Southern (Appendix 1), with the support of mapping method and geographic information system (GIS) to convert the point-data of climatic factors at individual climate station into digital data, tourism climate map of Southern Vietnam (rate of 1:250,000) is established.

3.1. Annual temperature

Temperature is considered an important and valuable factor for tourism. The periods of high temperature will limit the activity of visitors and people in leisure activities. Favorable temperature is an important factor to choose a destination, especially for the tropical region with hot climatic conditions all year around. Climate of the Southern located mainly in the tropical monsoon region (sub-equator climate only in the southernmost) with a relatively high average temperature, always above 25°C. The highest temperature is usually in April or May, the end of the dry season (at Vung Tau station: 28.5°C and Phu Quoc station 28.4°C (Fig. 3)). The hottest

period (the highest temperature of the year) in Europe or the Arabian Peninsula (in the northern hemisphere) is usually July-August, but in South Vietnam this period is in the middle of the rainy season, the temperature is significantly reduced (at Vung Tau station: 27°C, at Phu Quoc station: 27.3°C). The higher the temperature, the less comfortable visitors feel. At the end of the dry season and at the begin of the rain season (in April and May), the high temperature can cause some health problems, especially dangerous for the elders and children. Some human symptoms that occur when the temperature rises such as headaches, dizziness, and neurological disorders.

As mentioned, Southern Vietnam has relatively flat topography with a high average annual temperature, but in some areas with uplifted blocks or mountain blocks also leads to certain differences in temperature. In the Southern, there are mountainous areas such as Ba Den mountain -990 m (Tay Ninh province), Chua Chan mountain -800 m (Dong Nai province), Bay Nui -250-700 m (An Giang province), Mountainous areas of Binh Phuoc province with an elevation of about 200-400m. Because of the decrease in temperature with an increase in height (about 0.5-0.6°C/100m high), the annual average temperature in these areas will be lower than the surrounding areas. Gössling and Hall (2006a) showed that only 1°C also affected to the comfort levels of tourists. In the Southern, the annual temperature in the plain areas with the elevation below 100m is above 26°C. On the other hand, the study area stretches on nearly 5 latitudes and many places bordering the sea, so the temperature between regions is also different. For example, the temperature of coastal areas is slightly lower than the inland areas; or Phu Quoc is located at a lower latitude, so the temperature is higher than the temperature in Vung Tau. Therefore, finding the spatial differentiation of temperature in

Southern Vietnam is also an effective way to find out different geographic areas for tourism demand.

The statistical temperature data in the Southern show that the annual average temperature varies from 27.4°C (very hot) in Rach Gia to below $\leq 24^\circ\text{C}$ (slightly hot) in mountainous and highland (Binh Phuoc) (Table 3). To reflect the effect of heat

resources to human in tourism activities, the annual average temperature in the South is arranged into different levels: Very hot $T > 26^\circ\text{C}$ corresponding to acceptable heat levels; Hot $24^\circ\text{C} < T \leq 26^\circ\text{C}$ - suggested to be good and Slightly hot $T \leq 24^\circ\text{C}$ - very good condition (Table 1). The map of the annual average temperature distribution in the Southern region is shown in Fig. 1.

Table 1. Classification criteria of bioclimate for tourism in Southern Vietnam

Criteria	Levels	Meanings	Symbol	Scale of assessment
Annual temperature (T: °C)	$T > 26$	Very hot	I	Acceptable
	$24 < T \leq 26$	Hot	II	Good
	$T \leq 24$	lightly hot	III	Very good
Precipitation (R: mm)	$R \geq 2000$	Abundant rain	A	Acceptable
	$1500 < R < 2000$	Moderate rain	B	Good
	$1300 < R < 1500$	light rain	C	Very good
	$1300 < R$	Very light rain	D	Very good
Number of rainy days (N: days)	$N \geq 160$	The high number of rainy days	a	Acceptable
	$140 \leq N < 160$	Medium number of rainy days	b	Good
	$120 \leq N < 140$	The low number of rainy days	c	Very good
	$N < 120$	Very Low number of rainy days	d	Very good

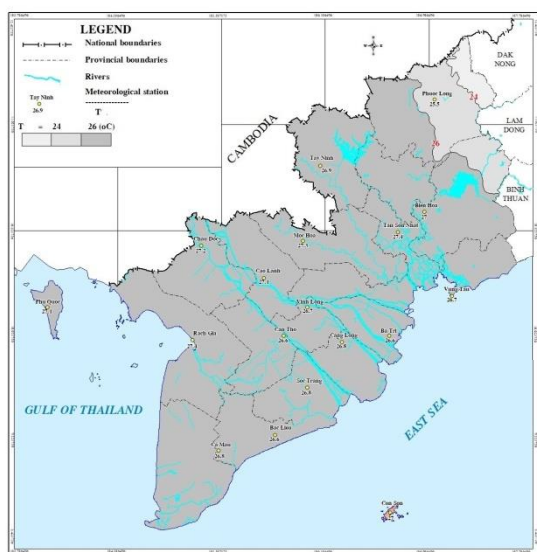


Figure 1. Annual temperature distribution map of Southern Vietnam at scale 1:250,000

3.2. Precipitation

Precipitation plays an important role in leisure and tourism activities. Prolonged heavy rain makes difficult and effects to travel

time. For example, heavy rain and some types of rain (drizzle, hail, showers) can cause disadvantages for tourism. The analysis of regional climatic characteristic shows that rainfall in the Southern region mainly due to the southwest monsoon depends on the geographical location and topographic conditions. In a relationship of the southwest monsoon circulation, rainfall is also variation in different areas of Southern Vietnam from heavy rain to very light rain. Phu Quoc is located at the westernmost point of the Southern. This local is the first place in the sea receiving the summer monsoon, so it has the largest rainfall in the region, reaching 3029 mm/year. On the contrary, Chau Doc and Vinh Long situated deeply in the Mekong River Delta with the lowest and the most lowland in the Southern, the rainfall therein is very little, only about 1250 to 1300 mm/year.

The total annual rainfall in the Southern region in comparing with the tourism climate indicators of Indian researchers (Tran Viet

Lien, 1993), the total annual rainfall in the Southern is arranged in different levels such as Abundant rainfall- $R \geq 2000\text{mm}$ -corresponding to acceptable condition; Moderate rainfall of $1500\text{mm} < R < 2000\text{mm}$ - corresponding to good condition; Lightly rainfall $1300\text{mm} < R < 1500\text{mm}$ and very lightly rainfall $R > 1300\text{mm}$ - very good for tourism (Table 1). Total annual rainfall distribution in the Southern region is shown in Fig. 2.

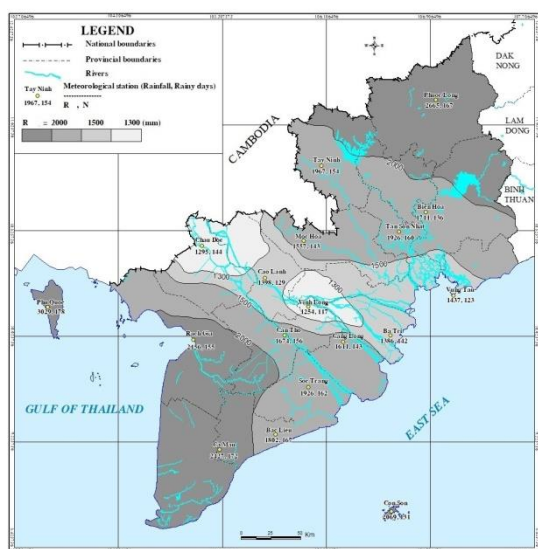


Figure 2. Distribution map of rainfall amount and number of rainy days in Southern Vietnam at scale 1:250,000

3.3. Number of the rainy days

Rainfall amount always has a linear relationship with the number of rainy days. For many outdoor tourism activities, the number of rainy days influenced directly to some types of tourism (such as sightseeing activity, cultural tourism or ecotourism), tourist season and Tourist Transport Management. In the Southern, the number of rainy day is observed in island such as Phu Quoc (178 rainy days/year), or in Ca Mau peninsula-where the terrain is perpendicular to the southwest monsoon direction (171 rainy

days/year), or the wind uplift terrain like Phuoc Long, Binh Phuoc province (167.3 rainy days/year). Meanwhile, the number of rainy days in some places situated deeply inland, in the lower Mekong River like Cao Lanh is very small (128.8 rainy days/year). The number of rainy days for tourism of Southern Vietnam is divided into 4 levels: rainy days $N \geq 160$ corresponds to the acceptable level; rainy days $140 \leq N < 160$ corresponds to a good rating for tourism; rainy days $120 \leq N < 140$ and rainy days $N < 120$ corresponding to a very good condition for tourism (Table 1).

All calculations and data in the applied geographical statistical system on the map are performed by MapInfo Version 11.1.

To provide more information for assessing the advantages of tourism bioclimatic units, some typical diagrams of bioclimatic factors (also indicators of bioclimatic tourism map) are also established (Fig. 3). Base on high-temperature font all year around of the Southern, the rainfall amount and number of rainy days are classified as follows:

Abundant rain areas are often uplift terrains such as Binh Phuoc mountainous area, or Phu Quoc island on the Gulf of Thailand. The topography and location of these areas are very convenient to receive the rain from the southwest monsoon; In these areas, amount of rainfall is large (2665 mm/year for Phuoc Long and 3029 mm/year in Phu Quoc), but the number of rainy days is also high (167.3 days/year in Phuoc Long and 178.3 days/year in Phu Quoc). The number of rainy days is continuous over 20 days per month in the rainy season, from May to October. Although in the tropical area, the rain is often rain shower, quickly stopped, but heavy and continuous from morning to afternoon. It causes an increase in humidity, and some health effects (diseases infections, respiration, and allergies, stresses). They are the main

obstacles to some outdoor tourism activities and on the sea (Figs. 3a, d).

In the Southern, the low rainfall areas are the lee-wind position (Vung Tau) or deep inland with relatively low topography (Cao Lanh). In these places, rainfall amount is low (1437 mm/year in Vung Tau, 1398 mm/year in Cao Lanh) and the number of rainy days is also low (122.8 days/year in Vung Tau,

128.8 days/year in Cao Lanh). While in Vung Tau, there are more than 20 rainy days per month in the rainy season, but in Cao Lanh, the number of rainy days is only about 13-19 days/month; Especially in the dry season, every month there are only a few rainy days. The dry, less rainy weather is really a favorable condition for tourism (Figs. 3b, c).

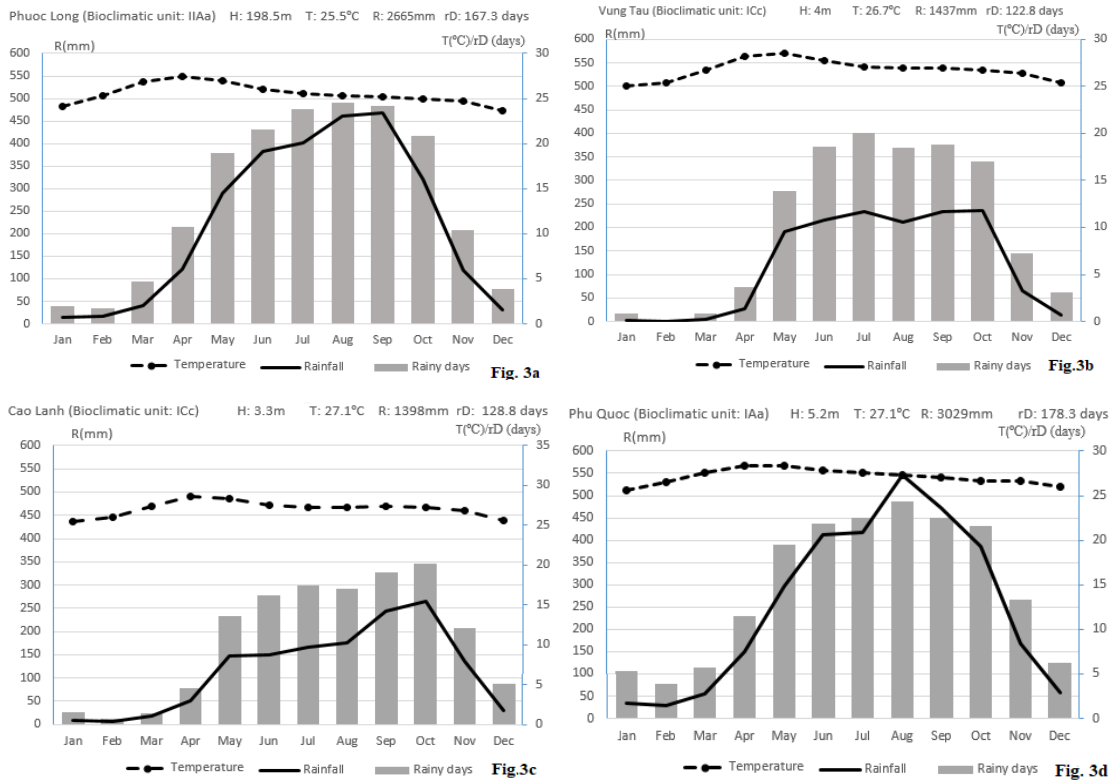


Figure 3. Tourism bioclimatic diagrams at stations in Southern Vietnam

4. Results and Discussions

The Southern tourism bioclimate map was established on the basis of overlapping analysis of annual average temperature data (Fig. 1), total rainfall amount and number of rainy days (Fig. 2). 12 types of tourism bioclimate in the Southern region are shown in Table 2 and Fig. 4.

On the southern tourism bioclimate map, in the low delta area, there are 10 types of very hot bioclimatic, that rainfall amount from very low, low, medium with rainy days from very few, few, medium to high (IDb, IDb, ICc, ICb, IBc, IBb, IBa, IAc, IAb and IAa). According to the Southern High Mountain belt, there are two more types of hot bio-climate with a lot of rainy days (IIAa) and a bit hot, heavy rain with

a large rainfall amount and a high number of rainy days (IIIAa). Because of the criteria classified by the impact of climate on people in tourism activities, these bioclimatic units reflected partly the favorable level of the tourism bioclimatic types in each region.

Table 2. Classification of bioclimate for tourism of Southern Vietnam

THERMAL REGIME	PRECIPITATION	A. Abundant rain R ≥ 2000 mm			B. Moderate rain 1500 ≤ R < 2000 mm			C. Little rain 1300 ≤ R < 1500 mm		C. Very little rain R < 1300 mm	
		a: Numerous days of rain N ≥ 160 days	b: Average days of rain 140 ≤ N < 160	c: Little days of rain 120 ≤ N < 140	a: Numerous days of rain N ≥ 160 days	b: Average days of rain 140 ≤ N < 160	c: Little days of rain 120 ≤ N < 140	b: Average days of rain 140 ≤ N < 160	c: Little days of rain 120 ≤ N < 140	b: Average days of rain 140 ≤ N < 160	d: Very little days of rain N < 120 days
III. Slightly hot T ≤ 24 (oC)	The number of rainy days	IIIAa									
II. Hot 24 < T ≤ 26 (oC)		IIAa									
I. Very hot T > 26 (oC)		IAa (3)	IAb	IAc	IBa	IBb (2)	IBc	ICb	ICc (2)	IDb	IDd

Note: (...) The number of occurrences of bioclimate units

The description and assessment (Table 1) of tourism bioclimatic units are shown below:

(1) IAa: Very hot, abundant rainfall, numerous rainy days (Fig. 4) appeared 3 times in the areas along the Gulf of Thailand-Phu Quoc, Ca Mau Peninsula and the areas of Dong Phu, Bu Gia Map (Binh Phuoc) and Vinh Cuu (Dong Nai). The total area of this bioclimatic type is 16408.94 km², about 25.77% of the Southern region. For human health in tourism activities, this type is generally rated at only quite advantages because of overheating, abundant rainfall and the high number of rainy days. But some types of marine tourism activities such as sea bathing, marine sports (sailing, boating, parachuting, windsurfing,...) are might prove practical for the very hot weather.

(2) IAb: Very hot, abundant rainfall, medium rain days. Appeared 1 time in Hon Dat, Tan Hiep, Rach Gia, Chau Thanh, Giong Rieng (Kien Giang) and Vi Thanh, Phung Hiep, Long My (Hau Giang), O Mon (Can Tho) with an area of 2440.66km², about 3.83% of the whole Southern Vietnam. This

type is rather favorable for tourism because of the very hot temperature and abundant rainfall.

(3) IAc: Very hot, abundant rainfall, a few rainy days. Only in Con Dao with a system of 16 islands (Fig. 4). This type occurs in the smallest area comparing to other types of bioclimate, only about 74.61 km², 0.12% of the Southern area and considering be quite favorable due to overheating and heavy rain.

(4) IBa: Very hot, moderate rainfall, numerous rainy days. Appeared 1 time in the coastal part of Soc Trang and Bac Lieu (Long Phu, My Tu, Thanh Tri, My Xuyen, Vinh Chau districts and Soc Trang city). This area is 3402.93 km², 5.34% of the Southern, is a rather favorable level for tourism because of the very hot temperature and the numerous rainy days.

(5) IBb: Very hot, moderate rainfall, medium rainy days. Appeared 2 times in Kien Giang, An Giang, Can Tho, Tra Vinh, Tay Ninh, Binh Duong, Ho Chi Minh City. Compared to other types of bioclimate, this type occupies the largest area,

17440.57 km², accounting for 27.07% of the Southern area (Fig. 4) and is preliminarily evaluated at favorable levels for tourism activities due to rainfall and numbers of Rainy days are at a quite advantage. The

only limitation is that this type of bio-climate is very hot. But for coastal areas, this type of bio-climate has a favorable advantage for sea-bathing tourism combined with many types of Sea sports.

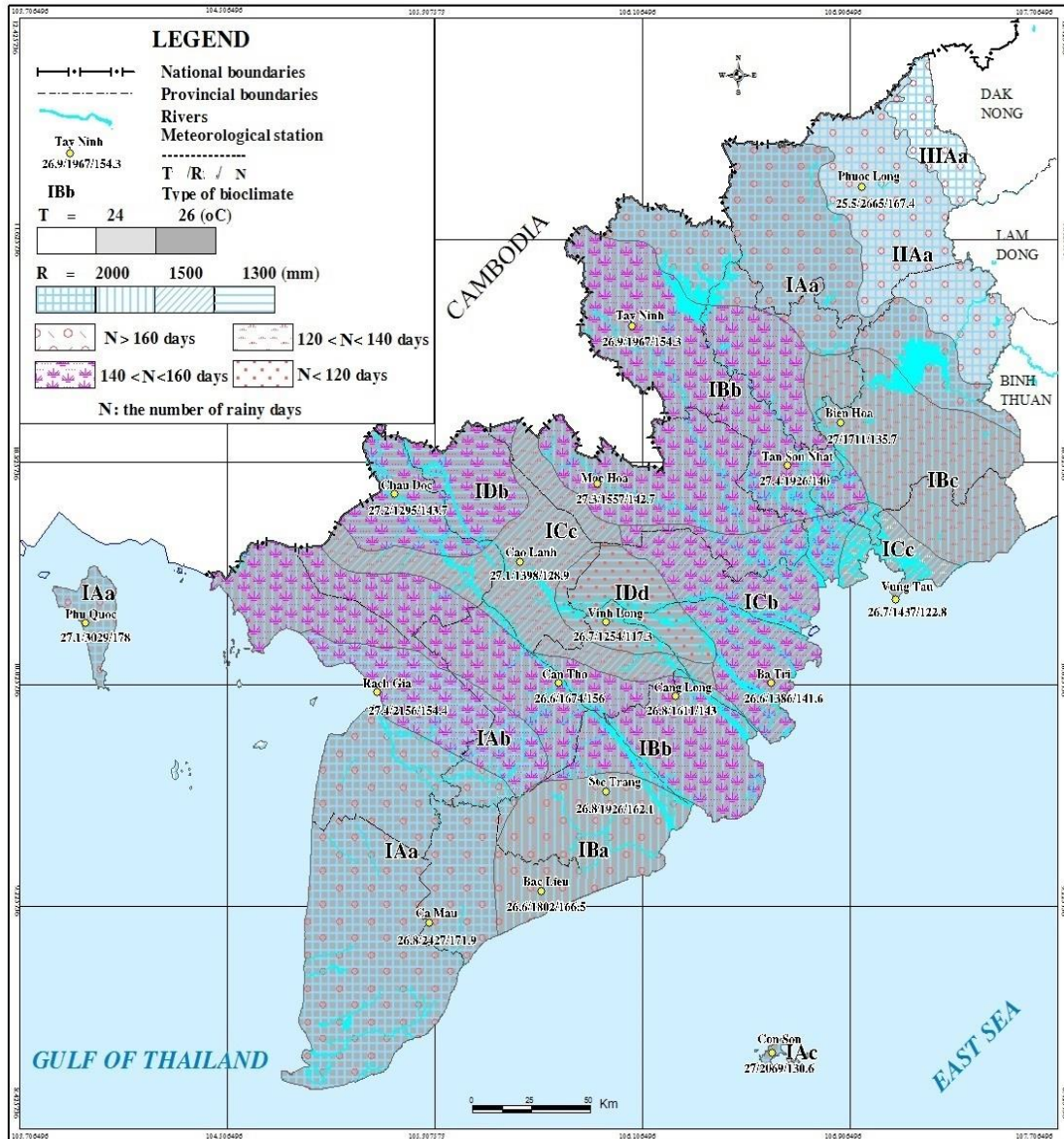


Figure 4. Tourism bioclimatic map of Southern Vietnam at scale 1:250,000

(6) Ibc: Very hot, moderate rainfall, a few rainy days. Appeared 1 time in Bien Hoa (Dong Nai) and Tan Uyen (Binh Duong). The

area of this bioclimate is 4687.56 km², accounting for 7.36% of Southern Vietnam. This bioclimate is favorable for tourism and

its only limit is very hot. However, for the coastal regions, this bioclimate brings more advantage for sea bathing tourism and sea sports.

(7) ICb: Very hot, low rainfall amount, medium rainy days. 1 time in Northern of the lower Mekong River, in Go Cong, My Tho (Tien Giang), Can Gio (Ho Chi Minh city), Can Duoc (Long An). It occupies an area of 4426.97 km², equal to 6.95% Southern Vietnam. This kind of bioclimate is assessed to be very favorable because of the low rainfall amount and medium rainy days. The only limit of this bioclimate is a very hot temperature but it is the best place for a combining of sightseeing and sea travel.

(8) ICc: Very hot, low rainfall amount, a few rainy days. Occurred in 2 areas: some districts of Long An, Dong Thap, Vinh Long, Ben Tre (Mekong River Delta) and in Vung Tau peninsula (Long Dat, Ba Ria, Tan Thanh districts) and Nhon Trach district (Dong Nai) and Can Gio district (Ho Chi Minh city). The area of this type is 4861.85 km², accounting for 7.63% Southern Vietnam. The common assessment of this bioclimate for tourism is very favorable because of the low rainfall amount, a few rainy days

(9) IDb: Very hot, very low rainfall amount, medium rainy days. Appeared 1 time in Dong Thap Muoi, a pan-like valley with alkaline soil where the only sedge could grow in vast fields. It has an area of 2974.36 km², equivalent to 6.7% Southern Vietnam. Estimation for this bioclimatic type is favorable for tourism. Although it is very hot the rainfall amount is very low and the number of days of rain is medium.

(10) IDd: Very hot, very low rainfall amount, very few rainy days. This bioclimate appeared 1 time in somewhere of Tien Giang, Ben Tre, Vinh Long provinces with 1946.85 km², about 3.06% off the study region. Although this bioclimatic type is very hot it is evaluated as very favorable for tourism activities.

(11) IIAa: hot, abundant rainfall, numerous rainy days. This type of bioclimate which appears 1 time in low hilly and mountainous regions at the elevation of 100 to 350 m, from Phuoc Long (Binh Phuoc) to Tan Phu (Dong Nai). This type has an area of 4243.94 km², equal to 6.66% Southern Vietnam. Although a hot climate is good, abundant rainfall and numerous rainy days are acceptable. General assessment for this bioclimatic type is a rather favorable level.

(12) IIIAa: Slightly hot, abundant rainfall, numerous days of rain. This type appears only one time in Bu Dang (Binh Phuoc) with an altitude of 300 m to over 350 m. For tourism assessment, it is rather favorable (temperature is very good but rainfall and the number of rainy days are acceptable).

12 bioclimatic types in Southern Vietnam (the area, the frequency of occurrence and the level of advantage for tourism) are shown in Table 3.

These above descriptions, analyses, and summaries prove that climatic resource is rather diversified. On the background of very hot (I) tropical climate at low relief (under 100 m), Southern Vietnam gets 10 bioclimatic units with the advantageous levels for tourism such as: Very favourable gets 4 types of bioclimate: IDd, IDb, ICb and ICc (2 times of appearance); Favourable is 3 bioclimatic units namely: IBc, IBa, IBb (2 times of occurrence); Rather favorable is 3 bioclimatic units left: IAc, IAb, and IAa (3 times of appearance).

From the above 100m, according to the high belt, Southern Vietnam has 2 types of bioclimate such as hot (IIAa) and slightly hot (IIIAa). Although these bioclimatic units are estimated as *rather favorable* for tourism because of abundant rainfall and numerous rainy days, the appearance of less hot climate in mountainous regions with many National Parks, Nature Reserve regions, Culture

Reserve regions is precious and unique resource for developing some kinds of tourism namely leisure tourism, ecotourism, culture tourism.

Table 3. Statistic area, times of appearance and advantage levels of bioclimatic types for tourism in Southern Vietnam

No.	Bioclimatic units	Area		Times of appearance	Common assessment for tourism
		km ²	%		
In low relief (under 100m)					
1	IAa	16408.94	25.77	3	Rather favorable
2	IAb	2440.66	3.83	1	Rather favorable
3	IAc	74.61	0.12	1	Rather favorable
4	IBa	3402.93	5.34	1	Rather favorable
5	IBb	17240.57	27.07	2	Favorable
6	IBc	4687.56	7.36	1	Favorable
7	ICb	4426.97	6.95	1	Very favorable
8	ICc	4861.85	7.63	2	Very favorable
9	IDb	2974.36	4.67	1	Favorable
10	IDd	1946.85	3.06	1	Very favorable
In North-West mountainous region (above 100m)					
11	IIAa	4243.94	6.66	1	Rather favorable
12	IIIAa	971.21	1.53	1	Rather favorable
Sum	12 units	63680.45	100.00	16	

We have the distribution of areas of favorable levels for tourism following:

In low terrain, plains (under 100 m): *rather favorable* level has 3 bioclimatic units with a total area as 22327.15 km², accounting for 35.06% Southern Vietnam. At *favorable* level gets 3 types of bioclimate with 24902.49 km², appropriating for 39.10% of study territory; *Very favorable* level has 4 types of bioclimate which occupies 11235.67 km², equivalents to 17.64% of the whole region.

In mountainous regions depending on a high belt (above 100 m), there are 2 types of *rather favorable* bioclimatic units, with an area of 5215.15 km², accounting for 8.20% Southern Vietnam.

5. Conclusions

12 types of bioclimate are differentiated and shown clearly on the map. Specifically, with the very hot climate, there are 10 bioclimatic units such as very low rainfall (IDd, IDb), low rainfall (ICc, ICb), moderate rainfall (IBc, IBb, IBa) and abundant rainfall (IAc, IAb, IAa). According to a high belt, Southern Vietnam has distinguished some

bioclimatic units such as hot temperature, abundant rainfall (IIAa) and slightly hot temperature, abundant rainfall (IIIAa). In Southern Vietnam and high belt, the presence of these bioclimatic units which is very important for a hot year all around tropical areas shows that Southern Vietnam has a diversified and rich climate resource.

The criteria and levels of bioclimatic classification are selected by the suitable and advantageous levels of climate to the human in tourism activities. These bioclimatic units which are classified and shown on map, are themselves bioclimatic synthetical index in combining three elements such as temperature, rainfall, rainy days. By this way, the value of each bioclimatic resource for tourism is initially estimated.

The qualitative analysis result of advantageous levels of bioclimatic units for tourism shows that in the low relief of Southern Vietnam: *rather favourable* level accounting for 35.06% the whole region, *favourable* level getting 39.10% and *very favourable* level occupying 17.64% of the territory and in the mountainous regions

(above 100m): only *rather favourable* level with 17.64% of the whole area.

With plentiful bioclimatic resources as above, we can organize many types of tourism in Southern Vietnam. The result of classification and bioclimatic map for tourism is an important and necessary scientific basis which help the orientation of development and tourism territory organization of the governments. On the other hand, the bioclimatic map for tourism of Southern Vietnam supports fundamental information and initial detail for tourist to choose a destination, suitable types of tourism, as well as adapted clothing with weather conditions and climate.

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Appendix 1. Some bioclimatic data (accounting for Temperature, Rainfall, Rainy days) are used in bioclimatic classification and built a bioclimatic map for tourism of Southern Vietnam

No.	Stations	Longitude	Latitude	Elevation (m)	Temperature (°C)	Rainfall (mm)	Rainy days (day)
1	Phuoc Long	106°59'E	11°50'N	198.5	25.5	2665	167.3
2	Tay Ninh	106°07'E	11°20'N	10.1	26.9	1967	154.4
3	Tan Son Nhat	106°40'E	10°49'N	9.0	27.4	1926	158.8
4	Vung Tau	107°05'E	10°22'N	4.0	26.7	1437	122.8
5	Thu Dau Mot	106°39'E	10°59'N	22.3	25.7	2187	140.7
6	Bien Hoa	106°50'E	10°57'N	10.9	27.0	1711	135.7
7	Con Son	106°36'E	8°41'N	6.3	27.0	2069	130.6
8	Moc Hoa	105°56'E	10°47'N	1.9	27.3	1557	142.6
9	Cang Long	106°12'E	9°56'N	1.5	26.8	1611	143.0
10	My Tho	105°46'E	10°02'N	1.0	27.0	1384	134.2
11	Can Tho	105°58'E	9°36'N	2.3	26.6	1674	155.8
12	Soc Trang	105°38'E	10°28'N	6.4	26.8	1926	162.1
13	Cao Lanh	103°58'E	10°13'N	3.3	27.1	1398	128.8
14	Phu Quoc	105°54'E	10°00'N	5.2	27.1	3029	178.3
15	Rach Gia	105°08'E	10°42'N	7.1	27.4	2156	154.5
16	Chau Doc	105°09'E	9°11'N	0.9	27.2	1295	143.6
17	Ca Mau	106°01'E	10°05'N	1.8	26.8	2427	171.9
18	Vinh Long	106°35'E	10°02'N	2.4	26.6	1254	117.3
19	Ba Tri	105°46'E	10°02'N	1.0	26.7	1386	141.6
20	Bac Lieu	105°58'E	9°36'N	2.3	26.6	1802	166.5