

Utilization of the Beach Climate Index (*BCI*) based on Meteorological Review to Support Tourism Development in Bangka Island

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Keywords: *BCI*, Beach, Development, Tourism.

Abstract: Bangka Island has a beautiful nature, especially in the beach and coastal areas. The tourism sector has been focused to develop the economy. Climatology factors have a strong impact on natural conditions that can affect tourism activities, so they need to be considered. This study aims to analyse the beach climate index in Bangka Island. Application of ECMWF ERA-Interim reanalysis data and observation data from the Pangkal Pinang Class I Depati Amir Meteorological Station over a 30-years periodic were analysed to determine the comfort level of the beach climate using the Beach Climate Index (*BCI*). Meteorological parameters used in *BCI* are temperature, precipitation, wind speed, and sunshine duration. Furthermore, this measurement is used to analyse as temporally and spatial data in monthly periodic. The result shows that the comfort level each month is classified as "Very Good" in general, with the category of "Excellent" in June, July, August (JJA) so it is recommended for tourists who want to visit Bangka Island during the dry season. Thus, this study is important to support information services on the tourism sector development.

1 INTRODUCTION

Tourism is one of the sectors that contribute to Indonesia's development (Sumargana, 2004). Many tourist destinations in Indonesia have the potential to develop. One of them is Bangka Island. Bangka Island from Bangka Belitung province has many beach destinations (Habibi et al., 2007). The number of tourist visits every year has increased rapidly (Bangka Belitung Culture and Tourism Department, 2010).

Tourism development is a series of efforts to realize integration in the use of tourism resources and integrate all forms of aspects outside tourism that are directly or indirectly related (Swarbrooke, 1996).

Tourism development has proven to have a positive impact on the existence of major changes in people's lives. It has an economic impact by expanding business and employment opportunities, increasing per capita income and increasing the country's foreign exchange (Priambudi, 2013).

In developing the tourism sector, weather and climate information factors play an important role in

the decision-making process and the travel experience of consumers or tourists (Scott and Lemieu, 2010; Eugenio and Campos, 2010; Gossling et al., 2012). Climate factors need special attention because they are closely related to natural conditions that can affect tourism activities. Morgan et al. (2000) had conducted research in 34 countries including Indonesia, which was represented by the Bali area using parameters of precipitation, wind, air temperature, sun exposure time, thermal sensation, and bathing water temperature to determine the level of tourism comfort based on the *BCI* index (Beach Climate Index). The results showed that several tropical destinations such as Gambia, Bali (Indonesia), Cancun (Mexico), and Jamaica have hotter thermal sensation values throughout the year. When entering the transition season of Bali, Indonesia is very worth a visit for a tour.

	Pre-holiday period			Holiday period		Post-holiday period	
	Planning of the trip			Trip		Overall assessment of the trip	
Decisions taken by the tourist / Perceptions	Motivation trip Destination choice Possible dates Takes out insurance	Destination choice in "last-minute" bookings Planning activities Itinerary/Routes		Planning of activities Enjoyment Safety Comfort Tourist spending Satisfaction		Memories Satisfaction Loyalty Recommendation	
Weather/Climate	← Climate in home region → ← Weather in home region → ● Climate at destination → ● Weather at destination →		← Weather at destination →		← Climate in home region → ← Weather in home region → ← Weather/Climate at destination →		
	Month	Week	Day	Day	Week	Months	Years

Figure 1: Climate and Meteorology information towards tourist decision (Scott and Lemieu, 2010).

The purpose of this study is to analyze the comfort level in the beach area of Bangka Island using the *BCI* Index (Beach Climate Index) with spatial and temporal data. We hope the result can be a reference for foreign and local tourists who will take a vacation to Bangka Island.

2 DATA AND METHODOLOGY

2.1 Data

This study was conducted over Bangka Island, Bangka Belitung Province, located in latitude (104.9-107.1) and longitude (1.30S-3.25S). The data used is as follows.

- ECMWF ERA-Interim reanalysis data synoptic monthly mean for the parameters of skin temperature, wind speed 10m, total precipitation, and sunshine duration with a resolution of 0.125° x 0.125° and the period 1987-2017.
- Daily observation data for the years 1987-2017 for parameters of precipitation, wind speed, sunshine duration, relative humidity, and average temperature of Pangkal Pinang Class I Depati Amir Meteorological Station were obtained from Database Online BMKG. ECMWF reanalysis data is processed spatially using ArcGIS 10.3 (trial version) to display the mapping by inputting the *.nc to *.xls file extension which is converted using ODV software. Daily observation data is processed statistically using Microsoft Office Excel.

2.2 Methods

Daily observation data is processed using Microsoft Office Excel to obtain normal data for 30 years by calculating monthly average for parameters of precipitation, wind speed, sunshine duration, relative humidity, and average temperature. Auliciems et al. (2007) developed an effective temperature in terms of the correlation between air humidity and daily average temperature to show the perceived temperature and comfort conditions using the following equations (Houghten et al, 1923).

$$ET = -0.4 \left(DBT - 10 \left(1 - \frac{RH}{100} \right) \right) \quad (1)$$

where *ET* (°C) is the effective temperature, *DBT* is dry ball temperature as the daily average temperature, and *RH* is relative humidity.

Based on research conducted by Morgan et al (2000), a beach climate index has been developed to determine the comfort level of tourism in coastal areas with a scale of 0-100 using the following equation.

$$BCI = 0.18TS + 0.29P + 0.26W + 0.27S \quad (2)$$

where *BCI* is beach climate index, *TS* is thermal sensation obtained from skin temperature, *P* is total precipitation, *W* is wind speed, and *S* is sunshine duration.

Table 1: *BCI* Weighting Scheme for Precipitation and Sunshine (Lemesios, 2016).

Rating	Precipitation (mm)	Sunshine (hrs)
100	<15	10 or more
90	15-30	9h-9h59min
80	30-45	8h-8h59min
70	45-60	7h-7h59min
60	60-75	6h-6h59min
50	75-90	5h-5h59min
40	90-105	4h-4h59min
30	105-120	3h-3h59min
20	120-135	2h-2h59min
10	135-150	1h-1h59min
0.0	>150	<1h

Each parameter is processed based on a scale according to criteria determined by Lemesios et al (2016). The scaling results of each parameter are entered into equation (2) to obtain the Beach Climate Index (*BCI*) with weighting scheme (scale) <40 (Unfavourable), 40-60 (Acceptable), 60-70 (Good), 70-80 (Very Good), and >90 (Excellent).

Based on the results of the calculations are used to analyse the comfort level of tourism on Bangka Island spatially and temporally for the rainy season period, namely DJF (December, January, February), the dry season, JJA (June, July, August), the transitional season, MAM (March, April, May), and SON (September, October, November) to obtain information on the comfort level of tourism to support the development of the coastal and marine tourism sector.

Table 2: *BCI* Weighting Scheme for Effective Temperature (Lemesios, 2016).

Rating	Effective Temperature (°C)
100	32.5-34.4
77	34.5-35.4
39	29.0-32.4
24	35.5-36.4
21	26.0-28.9
2	21.0-25.9

Table 3: *BCI* Weighting Scheme for Wind Speed (Lemesios, 2016).

Rating	Wind Speed (m/s)
100	<4
50	4-6
0	>6

Table 4: Classification of *BCI* score (Lemesios, 2016).

Rating	Comfort Level for Beach Activity
>80	Excellent
70-80	Very Good
60-70	Good
40-60	Acceptable
<40	Unfavorable

3 ANALYSIS AND RESULTS

Comfort is one of the important aspects of tourism. There are Many aspects that affect the comfort level, one of them is the meteorological parameter. Based on Beach Climate Index (*BCI*), the spatial data shows that there is a variation of the condition. By using

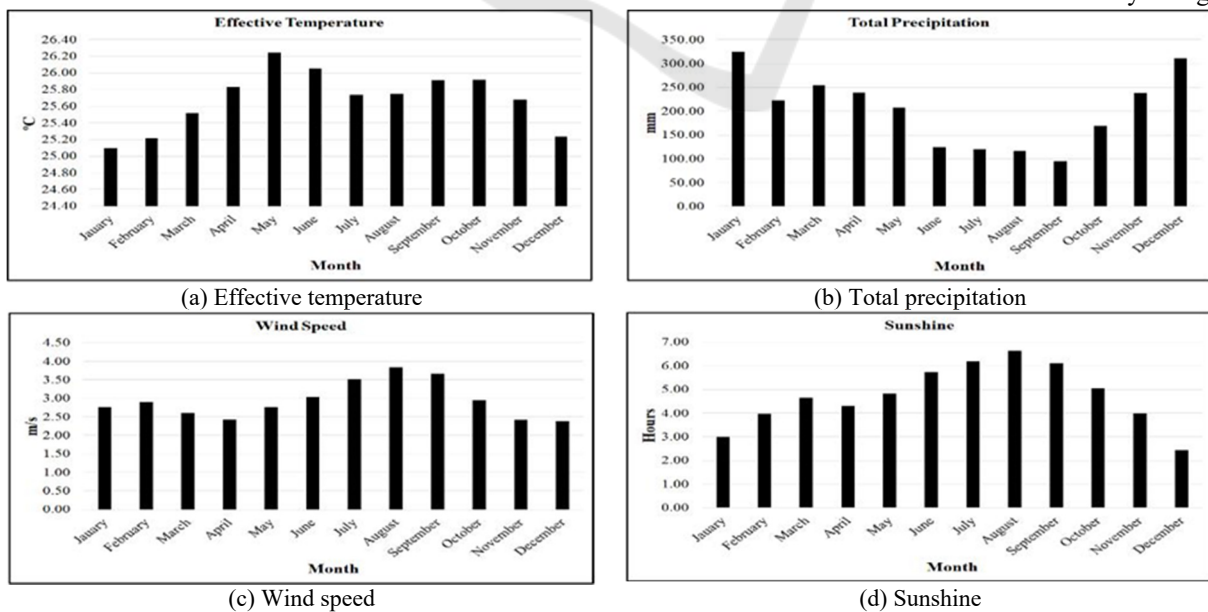


Figure 2: Monthly average observation.

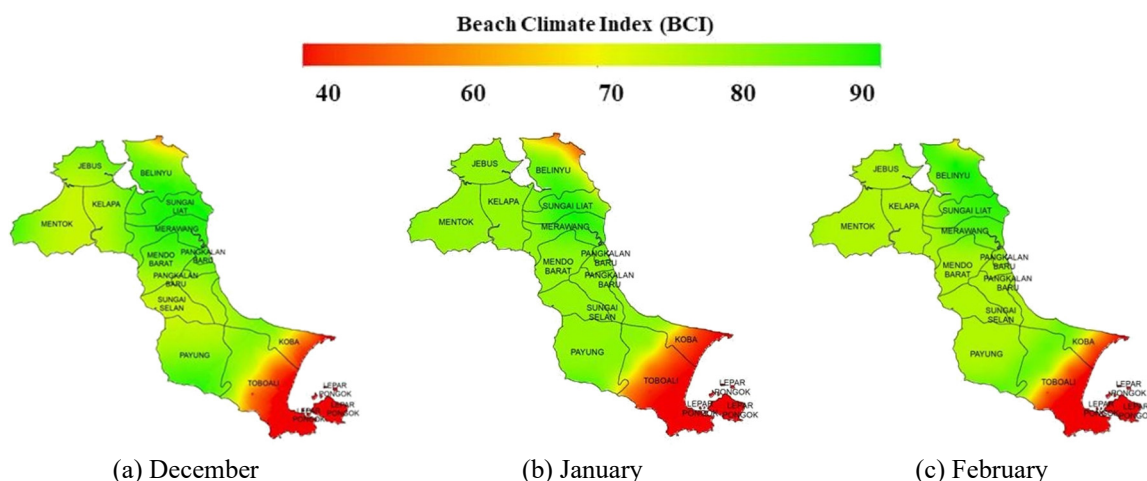


Figure 3: Spatial data of *BCI* in Bangka Island during DJF period.

spatial data and temporal data as comparison, we can estimate the beach climate in Bangka Island.

By processing spatial data and temporal data as a support to analyze the comfort level based on meteorological parameters in the beach areas. The mapping results were put together based on the characteristics of the seasons on Bangka Island namely the DJF (December, January, February), MAM (March, April, May), JJA (June, July, August), and SON (September, October, November) periods.

Processing the observation data as a comparison parameter to analyze meteorological aspects for the comfort level. The grouping is then based on the classification of beach climate index values categorized as "excellent", "Very good", "Good", and "Acceptable". With the temporal data as control, further study regarding the level of comfort is very easy by using *BCI* in knowing the exact time and destination for your trip. Grouping based on seasonal patterns in Indonesia aims to find monsoon

phenomena related to the comfort level of the beach. Variation of the index during the DJF period shows an increase in the west coast, and a decrease in the southeast coast, although the spatial data didn't show a significant change. While in the northeast coast change of the mapping was not significant but tend to show an increase especially in Belinyu.

From the results of observing data processing, the period in the DJF month, Bangka Island is in the wet season. Where in January is at the top of the precipitation. From the temporal data, this period generally is a wet season, short sunshine duration, low effective temperature, and high humidity (See Figure 3).

Tjasyono (2008) found that the first transition season happened during the MAM period, where the transition goes from wet to dry season. Based on temporal observation as shown in Figure 4, during this period the average monthly precipitation began to decrease. However, in March and April, it was still

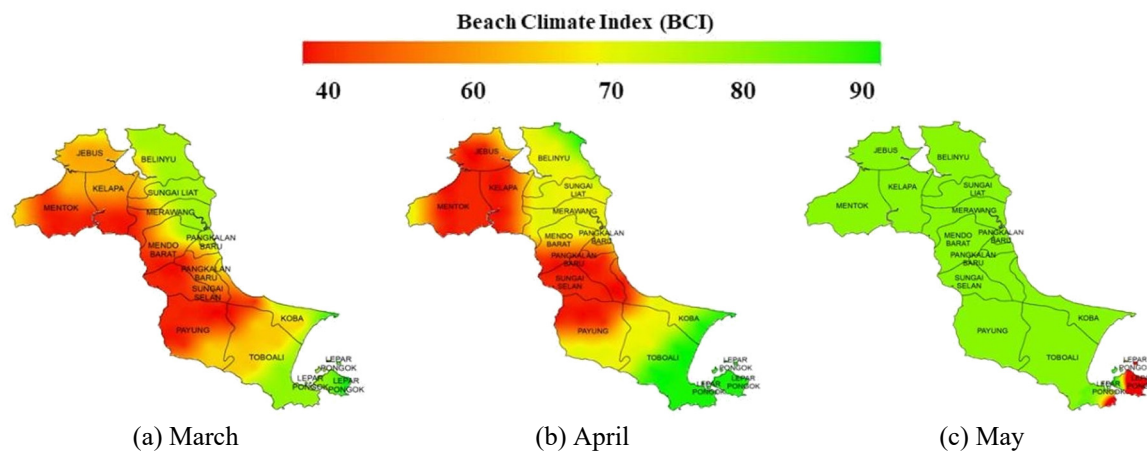


Figure 4: Spatial data of *BCI* in Bangka Island, MAM.

From the observations of the JJA period, it tends to provide statistical values which are also not much different from temporal data with the weather condition being dry with the precipitation below 150 mm and the sunshine duration about 6-8 hours/day (see Table 5).

For the SON period, the pattern is almost the same as in MAM because this pattern classified as the transition months where October and November have differences in index with other months. For August, it still follows the condition of the previous month, JJA where the west coast is still categorized as "Very good". Whereas for September and November the west coast has decreased to "Acceptable" and for the southeast coast "Excellent". In November, Lepar Island are in top condition. transition and October-November for the dry-wet transition season (see Table 6).

4 CONCLUSIONS

Based on the data analysis it can concluded that the BCI index (Beach Climate Index) spatially and temporally on Bangka Island generally shows the category of "Excellent" in June, July, August (JJA) so it is recommended for tourists who want to visit Bangka Island during the dry season.

ACKNOWLEDGEMENTS

We acknowledge, European Centre for Medium-Range Weather Forecasts which develop and compute ECMWF ERA-Interim for reanalysis file data and also Pangkal Pinang Class I Meteorological Station for observation data (meteorological parameters).

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