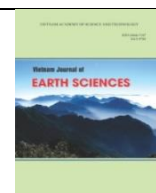




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Comprehensive assessment of coastal tourism potential in Vietnam

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ABSTRACT

Coastal tourism includes diverse resources and activities, so a comprehensive assessment is required to implement the sensible use of tourism potential. This paper deals with a comprehensive assessment of tourism potential in the coastal region of Vietnam based on 4 dimensions: attractiveness, accessibility, tourism service quality, and environmental quality & safety, covering 23 criteria. Analysis Hierarchy Process (AHP), Principal Component Analysis (PCA), Correlation analysis, and a Geographic Information System (GIS) were used in this study. AHP was applied to determine a weighting coefficient for each criterion. PCA was processed next to AHP, allowing a combination of the considered sites' internal and external tourism potentials. Then the relationship between tourism potential and revenue is tested based on correlation analysis. The results show that the provinces in the South-Central region have the highest potential for coastal tourism development, followed by the North-Central region. The Northern and Southeast region provinces and Mekong River Delta have low potential. However, these regions still have some bright spots for coastal tourism development, such as Quang Ninh, Ho Chi Minh City, Ba Ria-Vung Tau, and Kien Giang. This research also shows that tourism revenue depends more on external factors (supporting factors) than internal factors (tourism resources). Finally, the study proposed development plans for each group of coastal provinces based on their strengths and weaknesses, as well as suggested solutions to overcome the limitations of seasonality and the impact of climate change on Vietnam's coastal tourism.

Keywords: Comprehensive assessment, coastal tourism, Vietnam.

1. Introduction

Coastal tourism is considered one of the fastest-growing forms of tourism in recent decades. World Tourism Organization of United Nations (UNWTO) shows that 12 of the 15 world's top destination countries in 2000 were countries with coastlines, including Vietnam (UNEP, 2009). Coastal tourism strongly depends on natural (climate, landscape, ecosystems) and cultural resources (historical and cultural heritages, arts and

crafts, traditions, etc.). Environmental conditions such as unpredictable climate conditions, algae blooms, winds, forest-associated risks, tsunamis, storms and floods, and many other constant features or unexpected events affect tourism development in coastal areas. The objective and reasonable evaluation of coastal tourism potential are essential for developing regional tourism. As coastal tourism includes diverse resources and activities, a comprehensive assessment is required to calculate real economic values and implement the sensible use of tourism

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potential. However, a comprehensive tourism sector assessment remains a challenge (UNEP, 2009).

Because many aspects contribute to tourism potential (Vystoupil et al., 2017), selecting the dimensions is the first consideration in a comprehensive assessment. Each destination has its mix of assets and issues. Therefore, a comprehensive assessment of tourism potential needs to use a set of indicators from the point of view of the characteristics of their destination. According to World Tourism Organization (2004), the following indicators are worthy of consideration by managers of coastal destinations: Damage to the natural environment of the shore zone, sustainability of key species, erosion of the shoreline, use intensity, seasonality, beach management, seawater contamination, reef systems, perception of cleanliness/quality, safety and security. The European Commission considers "passengers and ports, water quality and beaches" as supplementary indicators for assessing coastal tourism potential. Some previous studies have used decision-making methods to evaluate factors' importance in selecting tourism destinations. Siti Astariningsih Setyoputri et al. (2020) have determined the attractiveness of beach tourism objects in Kebumen Regency based on variables such as site attractions, event attractions, supporting facilities, accessibility, etc., and based on tourists' preferences. Hoang-Nam Truong & Woon-Jae Jang (2019) used a questionnaire survey and AHP to identify and evaluate the weight of factors that make a competitive coastal tourism industry in Southeast Asia. Luan Chen et al. (2017) applied the combination of Delphi and AHP methods in their study. The results indicated that infrastructure quality, tourism activities, and tour guide quality were the most critical factors regarding tourism destination selection. Debski M., Nasierowski W. (2017) presented the ranking of the main

criteria of destination choice based on a questionnaire study in Canada, Poland, Trinidad, and Tobago. Their paper's most critical essential criteria were cost, variety of activities, traditional festivals, infrastructure quality, and environmental conditions. Angelos Pantouvakis and Chritos Patsiouras (2016) investigated the most important criteria that prompted tourists to visit a destination. The results show that the main factors for tourists' choice of destination are traditional attractions, security, environmental conditions, various activities, and cost. Lai and Graefe (1999) used factors like attractions, infrastructure, and safety to develop possible destination choice criteria while studying Taiwanese overseas travelers. Previous studies indicated that the tourism potential of a site depends on its attraction, carrying capacity, seasonal variability, accessibility, sustainability, tourism infrastructure, and economic benefit. These studies mainly relied on the choices of tourists to assess the potential of tourist destinations. The critical criteria chosen by the previous studies are briefly summarized in Table 1.

Weighting tourism potential criteria are essential to the comprehensive tourism assessment procedure. Huong T.T. Hoang et al. (2018) applied the Analytic Hierarchy Process (AHP) to determine a weighting coefficient for each criterion in a multi-criteria assessment of tourism potential in the Central Highlands of Vietnam. López (2001) established a weighted value for each resource according to demand. Polls and surveys on visitors' preferences make it possible to calculate a weighting coefficient for each group of resources. Cerezo and Galacho (2011) estimated the weighted sum of tourism resources, accessibility, and facilities to assess the potential of eco- and adventure tourism. Multiple indicators for tourism potential are involved, making it possible to properly weigh the various aspects that impact an area's tourism potential (Rivero et al., 2014).

Table 1. Overview of important criteria chosen for comprehensive assessment of tourism potential in the previous studies

Previous researches	Mentioned criteria
World Tourism Organization (2004)	Damage to the natural environment of the shore zone, sustainability of key species, erosion of the shoreline, use intensity, seasonality, beach management, seawater contamination, reef systems, perception of cleanliness/quality, safety and security
European Commission (2016)	Passengers and ports, water quality, beaches
Siti Astariningsih Setyoputri et al (2020)	Site attractions, event attractions, supporting facilities, and accessibility
Hoang-Nam Truong, Woon-Jae Jang (2019)	Cost, attractions, quality, safety and convenience
Luan Chen et al. (2017)	Infrastructure's quality, tourism activities, tour guides' quality
Debski M, Nasierowski W (2017)	Cost, various activities, traditional festivals, infrastructures quality, environmental conditions
Angelos Pantouvakis, Chritos Patsiouras (2016)	Traditional attractions, security, environmental conditions, various activities, cost
Lai-hsin Lai, Alan R Graefe (1999)	Attractions, infrastructure, safety

In Vietnam, there is still a lack of studies on a comprehensive assessment of coastal tourism potential. The studies on an overall evaluation of tourism potential are mainly concentrated in mountainous areas (Huong T.T. Hoang et al., 2018). For Vietnam's coastal region, only a few studies evaluate individual components such as climate and geomorphology for tourism development (Duong Nguyen-Thuy et al., 2019; Nguyen Khanh Van et al., 2019). This study conducts a quantitative assessment of the tourism potential in the coastal area of Vietnam. The following research questions will be explored:

(1) How to comprehensively and quantitatively evaluate coastal provinces' tourism potential?

(2) What is the spatial pattern of the coastal tourism potential of Vietnam?

(3) How does tourism potential correlate with tourism development status?

(4) What tourism development strategy could be applied to provinces with different potentials?

2. Study area

Vietnam is a country in Southeast Asia and the easternmost country on the Indochinese Peninsula. The coastal area is significant in Vietnam regarding geopolitics, economics, ecology, security, and national defense. With the advantage of a long coastline, Vietnam has

many beautiful beaches stretching from the North to the South, with about 125 beautiful beaches, 50 large and small bays, and 4,000 islands known as a world wonder with exceptional aesthetic and geological-geomorphological values (Truong Quang Hai, 2020). The country's long coastline has created favorable conditions for 28 out of 63 provinces and cities to exploit the great potential of the East Sea directly, especially for coastal tourism (Fig. 1). The Vietnam Tourism Development Strategy to 2030 has identified that: "coastal tourism is one of the five main tourism products of Vietnam, along with cultural tourism, community-based tourism, agricultural tourism, and ecotourism" (Prime Minister of Vietnam, 2020). In the period 2010-2019, the number of international visitors traveling in coastal provinces grew at an average rate of 13.6% per year and reached more than 34 million in 2019, accounting for 70-80% of total international visitors to the country (Truong Quang Hai, 2020). Coastal tourism is also a favorite tourist activity of Vietnamese visitors, reflected in the total number of tourists coming to coastal provinces increasing at an average rate of 14.41% per year from 2010-2019. The total number of domestic tourists traveling to 28 coastal provinces reached over 147 million in 2019, accounting for about 60% of the domestic tourists in the country (Truong Quang Hai, 2020).



Figure 1. Map of Vietnam's coastal tourism resources

Despite many favorable conditions, Vietnam's coastal tourism faces challenges, such as climate change, rising sea levels, and coastal erosion. For instance, research by Ngo Van Liem et al. (2020) indicated that beach erosion from Son Tra to the Cua Dai region occurs seriously due to the effect of climate change, with an erosion rate of 3-10 m per year. Beach erosion has damaged the coastal residential areas and the tourism development in Vietnam.

Climate change-induced sea-level rise (SLR) is on the increase globally. In Vietnam, the average values of 3.3mm per year during the 1993-2014 period are above the worldwide average (MONRE, 2016), which makes Vietnam one of the most threatened areas in the world due to the effect of sea level rise. Coastal tourism, thus, is under threat from this hazard.

To achieve sustainable coastal tourism development, it is necessary to comprehensively assess the tourism potential of each coastal province as a basis for proposing sustainable development solutions following the strengths and limitations of each province.

3. Materials and methods

3.1. Criteria for Comprehensive Assessment of Coastal tourism Potential in Vietnam

A comprehensive assessment of tourism resources is multi-dimensional. This procedure should consider many factors, such as attractiveness, tourism capacity, seasonality, accessibility, sustainability, tourism infrastructure, and economic efficiency. Coastal tourism pays special attention to the beach quality, meteorological conditions, and water environment as the notion of the 3S (sea, sand, and sun) (Tran Duc Thanh et al., 2022). Top on the list of coastal resources is beaches and backshore areas that provide amenities for recreation and tourism (Beatley T. et al., 1994). Others

include coastal scenery, habitats for flora and fauna, geological exposures, and coastal landforms.

Furthermore, the coastal environment provides many resources for water sports and many coastal habitats. The environment is more or less central in the concept of sustainable tourism in coastal tourism. For tourism to continue to flourish in a coastal area, environment and tourism research need to be integrated to maintain environmental integrity leading to endless benefits due to tourism development (Lawal Mohammed Marafa, 2008). Based on an overview of previous research and prerequisites for coastal tourism development, 23 criteria have been selected for a comprehensive assessment of the coastal tourism potential of Vietnam. These criteria are grouped into 4 dimensions: (1) Attractiveness, (2) Accessibility, (3) Service quality, and (4) Environmental quality and safety. Almost criterion was scored follow to a scale of 5 levels, except the first criterion was assessed by a 3-levels scale (Table 2).

Our references come from a wide variety of sources, including the visitor's rating, government statistics, or studies that make the assessment would be more objective. For example, rating the cultural heritages and marine ecosystem criteria are based on ascending values according to the scale of importance: local level, regional level, national level, special national level, and international level. Ecosystems at the international level include Biosphere reserve, ASEAN heritage garden, and Ramsar; at the national level, including a nature reserve national park. Most of Vietnam's biosphere reserves and Ramsar sites are located in coastal areas. Beach quality is rated as excellent, good, fair, average, and poor based on the Travel gear ranking of beaches in Vietnam (TravelGear, 2021). Environmental safety is measured based on the effects of typhoons, coastal erosion risk, sea level rise, and flooding. These data are detected from the

Vietnam Geographical Atlas, state-level projects KC.09.17/16-20, the climate change and sea level rise scenarios for Vietnam conducted by MONRE, and the website of UNDRR for disaster risk reduction (Table 2). Environmental quality is evaluated based on coastal estuaries' water quality index (WQI), average annual temperature, annual temperature deviation, and yearly rainfall. The water quality index is taken from the "Report

on the environmental status of Vietnam in 2018 (MONRE, 2018). Meteorological information is taken from the 2019 statistical yearbook (GSO, 2020). Other criteria are measured based on the 2019 statistical yearbook (GSO, 2020), which reflects the quantity and quality of tourism infrastructure and services of the coastal provinces. The measurement methods of these criteria and the data sources are shown in Table 2.

Table 2. Selected criteria for Comprehensive Assessment of Coastal tourism Potential in Vietnam

Dimensions	Criteria	Measurement methods and data sources	Evaluation Scale		Score
			Level	Describe	
The attraction of coastal tourism resources	Marine-Island Ecosystem	Ranking based on International, National, and local titles (Huong T.T. Hoang et al., 2018)	International titles	Biosphere Reserve, ASEAN Heritage Garden, Ramsar	5
			National titles	Nature reserve, national park	3
			Local titles	Local marine ecosystem	1
	Beach Quality	Based on Travel gear.vn's ranking of beaches in Vietnam (TravelGear, 2021)	Excellent	Beautiful scenery, long beach, gentle slope, white sand, clear water, very suitable for swimming	5
			Good	Long beach, gentle slope, white sand, clear water, suitable for swimming	4
			Fair	Medium beach, steep slope, white sand, clear water	3
			Average	Short beach, steep slope, sand mixed with mud, turbid water, strong waves	2
			Poor	Small fragmented beach, no sand, steep slope, deep water, strong waves, not suitable for swimming	1
	Landscape diversity	The number of landscapes in the Vietnam landscape map (Pham Hoang Hai et al., 1997)	Very high	Beautiful scenery, very high diversity in the landscape with more than 19 landscape types	5
			High	Beautiful scenery, high diversity in the landscape with from 15 to 19 landscape types	4
			Medium	Medium diversity in the landscape with from 10 to 14 landscape types	3
			Low	Low diversity in the landscape with from 5 to 9 landscape types	2
			Very low	The landscape is monotonous, with less than 4 landscape types	1
	Cultural heritages	Ranking based on published ranking of national/international cultural heritages of Vietnam (Ministry of Culture-Sports	International level	World Heritage	5
			National special level	Special National Monuments ranked by the Prime Minister	4
			National level	National Monuments ranked by the Ministry of Culture, Sports and Tourism of Vietnam	3
			Regional level	Regional monuments	2

Dimensions	Criteria	Measurement methods and data sources and Tourism, 2021)	Evaluation Scale		Score
			Level	Describe	
			Local level	Provincial monuments	
Number of tourist attractions	The number of tourist attractions in each province (Figure 1)	Very high	There are from 83 to 100 tourist attractions within the province	5	
		High	There are from 64 to 82 tourist attractions within the province	4	
		Medium	There are from 45 to 63 tourist attractions within the province	3	
		Low	There are from 26 to 44 tourist attractions within the province	2	
		Very low	There are less than 25 tourist attractions within the province	1	
Accessibility	Convenience to the destination	The ability to access the tourist destination by various transportation options (i.e., plane, care, boat, train) (according to Geographical Atlas of Vietnam, page 23) (Ngo Dat Tam & Nguyen Quy Thao, 2020)	Very convenient	There are convenient routes, easy to find the way, and easy to access tourist attractions with 3-4 transportation options	5
			Convenient	There are convenient routes, easy to find the way, and easy to access tourist attractions with 2-3 transportation options	4
			Medium	There are quite convenient routes, easy to find the way, and easy to access tourist attractions with 1-2 transportation options	3
			Difficult	There is a quite convenient way, but finding the way is sometimes get lost, need a guide	2
			Very difficult	There is no convenient way, and it isn't easy to find the way	1
	Intercity connectivity	The number of passengers passing through the province in 2019 (Million persons.km) (GSO, 2020)	Very high	More than 16000 passengers pass through the province in a year	5
			High	There are from 12001 to 16000 passengers passing through the province in a year	4
			Medium	There are from 8001 to 12000 passengers passing through the province in a year	3
			Low	There are from 4000 to 8000 passengers passing through the province in a year	2
			Very low	Less than 4000 passengers pass through the province in a year	1
Service quality	Tourism infrastructure quality	Percentage of households with electricity and households with hygienic latrines by the province in 2019 (GSO, 2020)	Very high	The total percentage of households with electricity and households with hygienic latrines are from 187% to 200%	5
			High	The total percentage of households with electricity and households with hygienic latrines are from 175% to 187%	4
			Medium	The total percentage of households with electricity and households with hygienic latrines are from 164% to 175%	3
			Low	The total percentage of households with electricity and households with hygienic latrines are from 152% to 164%	2
			Very low	The total percentage of households with electricity and households with hygienic	1

Dimensions	Criteria	Measurement methods and data sources	Evaluation Scale		Score
			Level	Describe	
				latrines are from 140% to 152%	
	Accommodation quality	Number of tourism accommodations in 2019 (GSO, 2020)	Very high	There are more than 1360 tourism accommodations within the province	5
			High	There are from 1021 to 1360 tourism accommodations within the province	4
			Medium	There are from 681 to 1020 tourism accommodations within the province	3
			Low	There are from 341 to 680 tourism accommodations within the province	2
			Very low	There are less than 340 tourism accommodations within the province	1
		Number of high-quality accommodation facilities (star-rated hotels) in 2019 (GSO, 2020)	Very high	There are more than 708 star-rated hotels in the province	5
			High	There are from 532 to 708 star-rated hotels within the province	4
			Medium	There are from 355 to 531 star-rated hotels within the province	3
			Low	There are from 177 to 354 star-rated hotels within the province	2
			Very low	There are less than 177 star-rated hotels in the province	1
	Food and beverage quality	Number of food and beverage sites in 2019 (GSO, 2020)	Very high	There are more than 10128 food and beverage places within the province	5
			High	There are from 7597 to 10128 food and beverage places within the province	4
			Medium	There are from 5065 to 7596 food and beverage places within the province	3
			Low	There are from 2532 to 5064 food and beverage places within the province	2
			Very low	There are less than 2532 food and beverage places within the province	1
		The proportion of restaurants with business registration in total restaurants in 2019 (GSO, 2020)	Very high	There are more than 60% of restaurants with business registration	5
			High	There are from 45% to 60% of restaurants with business registration	4
			Medium	There are from 30% to 45% of restaurants with business registration	3
			Low	There are from 15% to 30% of restaurants with business registration	2
			Very low	There are less than 15% of restaurants with business registration	1
Entertainment service	Number of entertainment establishment in 2019 (GSO, 2020)	Very high	There are more than 244 entertainment places within the province	5	
		High	There are from 184 to 244 entertainment places within the province	4	
		Medium	There are from 123 to 183 entertainment	3	

Dimensions	Criteria	Measurement methods and data sources	Evaluation Scale		Score		
			Level	Describe			
				places within the province			
			Low	There are from 61 to 122 entertainment places within the province	2		
			Very low	There are less than 61 entertainment places within the province	1		
			Shopping service	Number of shopping centers in 2019 (GSO, 2020)	Very high	There are more than 273 shopping centers in the province	5
					High	There are from 205 to 273 shopping centers within the province	4
	Medium	There are from 137 to 204 shopping centers within the province			3		
	Low	There are from 68 to 136 shopping centers within the province			2		
	Very low	There are less than 68 shopping centers within the province			1		
	Tourism labor	Number of direct tourism labor in 2019 (GSO, 2020)	Very high	There are more than 17600 direct tourism labors	5		
			High	There are from 13201 to 17600 direct tourism labors	4		
			Medium	There are from 8801 to 13200 direct tourism labors	3		
			Low	There are from 4400 to 8800 direct tourism labors	2		
			Very low	There are less than 4400 direct tourism labors	1		
		The proportion of trained tourism laborers in 2019 (GSO, 2020)	Very high	There are more than 64% trained tourism labors	5		
			High	There are from 48% to 64% of trained tourism labors	4		
			Medium	There are from 32% to 48% of trained tourism labors	3		
			Low	There are from 16% to 32% of trained tourism labors	2		
			Very low	There are less than 16% trained tourism labors	1		
	Number of coastal resorts	Number of coastal resorts in 2019 (GSO, 2020)	Very high	There are more than 168 coastal resorts within the province	5		
			High	There are from 127 to 168 coastal resorts within the province	4		
Medium			There are from 85 to 126 coastal resorts within the province	3			
Low			There are from 42 to 84 coastal resorts within the province	2			
Very low			There are less than 42 coastal resorts within the province	1			

Dimensions	Criteria	Measurement methods and data sources	Evaluation Scale		Score
			Level	Describe	
Environmental quality and safety	Typhoon	The average number of typhoons affecting the area in 1 month (according to Geographical Atlas of Vietnam, page 9) (Ngo Dat Tam & Nguyen Quy Thao, 2020)	Low	average, there are from 0.3 to 1 typhoon affecting the province/month	5
			Medium	On average, there are from 1 to 1.3 typhoons affecting the province/month	3
			High	On average, there are from 1.3-1.7 typhoons affecting the province/month	1
	Environmental Quality	Based on the water quality index (WQI) of coastal estuaries (MONRE, 2018)	Excellent	The water quality index is from 91 to 100	5
			Good	The water quality index is from 76 to 90	4
			Medium	The water quality index is from 51 to 75	3
			Bad	The water quality index is from 26 to 50	2
			Very bad	The water quality index is from 0 to 25	1
	Tourism season	The appropriate duration for tourism activities (according to Geographical Atlas of Vietnam, page 9) (Ngo Dat Tam & Nguyen Quy Thao, 2020)	Very long	There are more than 301 days in a year good for tourism activities	5
			Long	There are from 251 to 300 days in a year good for tourism activities	4
			Medium	There are from 201 to 250 days in a year good for tourism activities	3
			Short	There are from 150 to 200 days in a year good for tourism activities	2
			Very short	There are less than 150 days in a year good for tourism activities	1
	Average annual temperature (°C)	Based on the bioclimatic criteria for humans (Nguyen Khanh Van et al., 2019). Average annual temperature data were taken from the Vietnam Statistical Yearbook 2019 (GSO, 2020)	18-24	Very suitable for coastal tourism	5
			24-27	Quite suitable coastal tourism	4
			27-29	Medium suitable coastal tourism	3
			29-32	Low suitable coastal tourism	2
			> 32	Not suitable for coastal tourism	1
	Annual temperature deviation (0C)	Based on the bioclimatic criteria for humans (Nguyen Khanh Van et al., 2019). The amplitude of annual temperature was taken from Atlas of Vietnam, page 9) (Ngo Dat Tam & Nguyen Quy Thao, 2020)	<6	Very suitable for coastal tourism	5
			6-8	Quite suitable coastal tourism	4
			8-14	Medium suitable coastal tourism	3
14-19			Low suitable coastal tourism	2	
>19			Not suitable for coastal tourism	1	
Average annual rainfall (mm)	Based on the bioclimatic criteria for humans	1.250-1.900	Very suitable for coastal tourism	5	
		1.900-2.550	Quite suitable coastal tourism	4	
		> 2550	Medium suitable coastal tourism	3	

Dimensions	Criteria	Measurement methods and data sources	Evaluation Scale		Score
			Level	Describe	
		(Nguyen Khanh Van et al., 2019). Average annual temperature data were taken from the Vietnam Statistical Yearbook 2020 (GSO, 2020)	< 1250	Low suitable coastal tourism	2
			< 650	Not suitable for coastal tourism	1
	Coastal erosion risk (m/year)	Based on the natural hazards map of coastal areas of Vietnam (Dang Van Bao, 2020; Ngo Van Liem et al., 2020)	0.0-1.5	Weak erosion	5
			1.5-3.0	Moderate erosion	4
			3.0-5.0	Strong erosion	3
			5.0-10.0	Very strong erosion	2
	Sea level rise (m)	Based on sea level rise to 2050 scenario (RCP 4.5 scenario) (MONRE, 2016)	<14m	Very low	5
			14-18	Low	4
			18-22	Medium	3
			22-26	High	2
			>26m	Very high	1
	Flood	Based on the number of houses destroyed + houses damaged by flood (UNDRR, 2010)	<=4400	Weak flood	5
			4400-8000	Moderate flood	4
			8000-15000	Strong flood	3
			15000-41000	Very strong flood	2
			>41000	Super strong flood	1

3.2. Weighting Criteria by Analytic Hierarchy Process (AHP)

This study used AHP to weight the criteria according to experts' opinions. Then we used a Weighted Linear Combination (WLC) for the rating score of the criteria (Table 3). AHP makes it easier to make decisions considering the environment, the landscape, tourism, and the economy (Duke & Aull-hyde, 2002; Ferrari, 2003; Ramanathan, 2001). The AHP decomposes the decision problem into criteria and levels according to common characteristics. The criteria of each level are compared pairwise concerning a specific criterion in the immediate upper level. Table 3 reports the pairwise comparison scale used in the AHP. It allows converting qualitative judgments into numerical values, also with intangible attributes.

Table 3. The AHP pairwise comparison scale (Thomas L Saaty, 1980)

Value of a_{xy}	Interpretation
1	x and y are equally important
3	x is slightly more important than y
5	x is more important than y
7	x is strongly more important than y
9	x is absolutely more important than y

AHP allows inconsistency but provides a measure of the inconsistency in each set of judgments. A consistency ratio (CR) of 0.1 or less is considered acceptable. If the value is higher, the judgments may not be reliable and should be elicited again. To determine weighted values, 30 experts experienced in tourism, geography, geology, geomorphology, meteorology, and landscape ecology were invited for an interview. Experts' opinions ensure conditions for AHP with a CR below 0.1.

3.3. Comprehensive assessment and classifying evaluation results

Once the weighted values of the criteria are available, each criterion is scored with different levels to measure the potential of tourist sites, as in Table 2. The scores corresponding to the evaluation levels of excellence, good, fair, average, and poor are 5, 4, 3, 2, 1. According to this classification, the score of each criterion of the individual coastal province/city is calculated using the following formula:

$$T_{ij} = S_{ij} \times w_j \tag{1}$$

Finally, the total score of each coastal province/city is calculated with the following formula:

$$T_i = \sum_{j=1}^n S_{ij} \times w_j \tag{2}$$

where T_{ij} is the score of criterion j of the province i (alternative i); T_i is the total score of the province i ; w_j is the weighted score of the criterion j ; and S_{ij} is the rating score of the criterion number j of province i that is derived

from Table 2.

As mentioned above, the AHP method was chosen to determine the weights of each criterion for coastal tourism development. Table 4 shows all weights of the 23 selected criteria. The criterion "attraction of coastal tourism resources" is more important than others, weighing 0.53. The remaining three criteria are almost equally weighted.

After calculating the weights for each criterion, the tourism potential of each coastal province is determined through the following formula:

$$Y = 0.20 \times X1 + 0.13 \times X2 + 0.09 \times X3 + 0.07 \times X4 + 0.04 \times X5 + 0.10 \times X6 + 0.05 \times X7 + 0.03 \times X8 + 0.04 \times X9 + 0.04 \times X10 + 0.02 \times X11 + 0.01 \times X12 + 0.01 \times X13 + 0.01 \times X14 + 0.03 \times X15 + 0.03 \times X16 + 0.01 \times X17 + 0.01 \times X18 + 0.01 \times X19 + 0.01 \times X20 + 0.02 \times X21 + 0.01 \times X22 + 0.03 \times X23 \tag{3}$$

Y is the tourism potential value calculated from 23 criteria X1-X23 described in Table 4.

Table 4. Weight scores of the criteria

Dimensions	Weight Scores (W1)	No.	Criteria	Weight Scores (W2)	Total weight Scores (W1*W2)
Attraction of coastal tourism resources	0.53	X1	Beach	0.38	0.20
		X2	Landscape diversity	0.25	0.13
		X3	Marine-Island Ecosystem	0.16	0.09
		X4	Cultural heritages	0.13	0.07
		X5	Number of tourist destinations	0.08	0.04
Accessibility	0.15	X6	Convenience to the destination	0.67	0.10
		X7	Intercity connectivity	0.33	0.05
Service quality	0.16	X8	Tourism infrastructure	0.16	0.03
		X9	Accommodation	0.27	0.04
		X10	Food and beverage	0.24	0.04
		X11	Entertainment service	0.12	0.02
		X12	Shopping service	0.09	0.01
		X13	Tourism labor	0.07	0.01
		X14	Number of coastal resorts	0.05	0.01
Environmental quality and safety	0.16	X15	Typhoon	0.21	0.03
		X16	Environmental quality	0.15	0.03
		X17	Tourism season	0.08	0.01
		X18	Average annual temperature	0.06	0.01
		X19	Annual temperature deviation	0.09	0.01
		X20	Average annual rainfall	0.08	0.01
		X21	Coastal erosion risk	0.13	0.02
		X22	Sea level rise to 2050 according RCP 4.5 scenario	0.04	0.01
		X23	Flood	0.17	0.03

The tourism potential is classified into 5 levels: Very High (S1), High (S2), Medium (S3), Low (S4), and Very low (S5). The following formula measures the distance of each rating level:

$$\Delta S = (S_{\max} - S_{\min}) / M \quad (4)$$

In which: ΔS is the distance between the levels; S_{\max} is the highest score; S_{\min} is the lowest score; M is the number of levels.

The GIS software (ArcGIS 10.0) was used to integrate attribute data with spatial data and show the spatial pattern of each group criterion and the total score of 28 coastal provinces on maps.

3.4. Principal Component Analysis (PCA) in tourism assessment

PCA evaluates the tourism potential based on categorical indicators of an ordinal nature. This technique was selected because it is appropriate for each category, representing a higher level of potential. PCA makes it possible to visualize and analyze correlations between variables and reduce the number of variables in a dataset by combining them into components, which allows a better understanding of complex reality. The statistical relations between various criteria are explained through the components. This initial hypothesis is that "given a particular component value, the criteria are independent of each other" (Thomas L. Saaty, 2000). This is local independence and suggests that the relationships between the criteria are due to the relationships between each criterion and the component. When a specific value of the component is set, two related criteria become (locally) independent criteria. Components assign a specific value to each sample element or the population analyzed. They make it possible to establish the relative position of each criterion on a continuous component scale.

3.5. Correlation analysis in tourism assessment

To find out the relationship between tourism potential and the current status of tourism development in the coastal provinces, a correlation analysis between tourism criteria (represents tourism potential) and tourism revenue (represents the current status of tourism development) was conducted. The tourism revenue of each coastal province is collected from the 2019 statistical yearbook (GSO, 2020) (Table 6). Statistical analyzes such as PCA and correlation analysis were performed using XLSAT software.

4. Results

4.1. Mutual relation among input variables to tourism potential assessments

4 dimensions determine the tourism potential: (1) Attraction of coastal tourism resources; (2) Accessibility; (3) Service quality; (4) Environmental quality and safety. The PCA results showed that factor 1 (F1) explains 58.44% of the variation of the variables and represents the tourism quality. Factor 2 (F2) explains 32.08 % of the variation of the variables and indicates the environmental quality and safety (Fig. 2).

Figure 2 shows the mutual relation between 4 dimensions in assessing the relative tourism development potential. These dimensions can be divided into two groups: internal and external factors. Internal factors can be classified as the attractiveness of tourism resources. External variables support tourism development, including tourism service quality, accessibility, and environmental quality & safety... (Dwyer & Kim, 2003). The tourism development potential of the coastal provinces can be seen in four quadrants as follows:

- The first quadrant (I) (group 1) consists of good accessibility and service quality provinces. It includes the most favorable external factors for coastal tourism

development. Some provinces represented in this group include Ho Chi Minh City, Da Nang, Khanh Hoa, Kien Giang, Ba Ria-Vung Tau, and Binh Dinh provinces.

- The second quadrant (II) (group 2) covers the provinces with very attractive coastal tourism resources, including Quang Ninh, Hai Phong, Thua Thien-Hue, Quang Nam, Nghe An, Thanh Hoa, Quang Binh, Quang Tri, Ha Tinh, Quang Ngai, Binh Thuan, Ninh Thuan provinces. These provinces have favorable internal factors for coastal tourism development.

- The third quadrant (III) (group 3) comprises the provinces with few favorable conditions for coastal tourism development,

including Thai Binh, Nam Dinh, Ninh Binh, Tra Vinh, Bac Lieu, Soc Trang, and Ca Mau provinces. These provinces have focused on nature conservation and maintaining environmental quality. Therefore, the location of these provinces is the opposite of all variables.

- The fourth quadrant (IV) (group 4) encompasses the provinces in southern Vietnam with good environmental quality and safety for coastal tourism development. This group includes Ben Tre, Tien Giang, and Phu Yen provinces. In particular, these provinces have less affected by storms, have good environmental quality, and have a favorable climate for tourism activities.

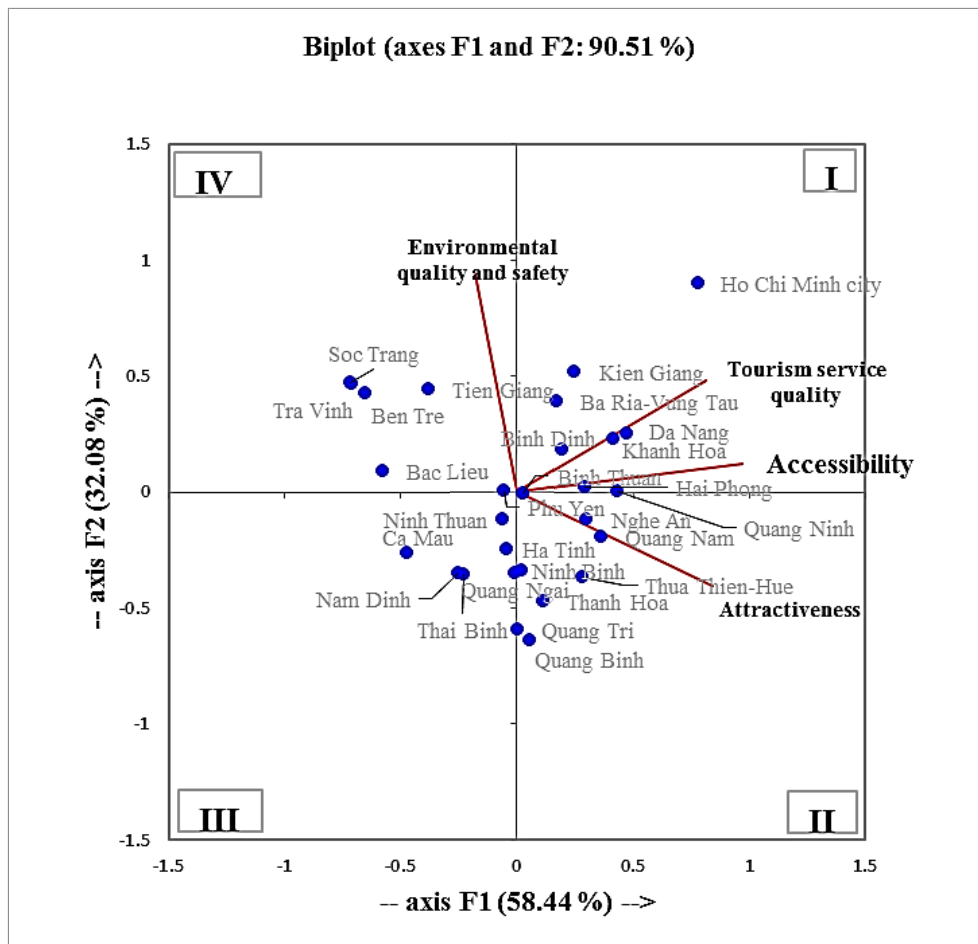


Figure 2. PCA result with correlations between variables and F1, F2 components for tourism potential

The mutual relationship between tourism variables is shown in Table 5. Tourism revenue positively correlates with external variables such as "tourism service quality" and "accessibility." It means that provinces with good accessibility and tourism service will achieve high tourism revenue and vice versa. In particular, tourism revenue is closely correlated to "tourism service quality" (correlation coefficient = 0.7) (Table 5). However, tourism revenue is not strongly correlated with internal tourism variables such as attractiveness and environment quality. The correlation test also shows that attractiveness, accessibility, and tourism service quality are closely correlated with the total score

(correlation coefficients are 0.91, 0.92, and 0.72, respectively).

Meanwhile, environmental quality does not correlate with the total score (correlation coefficient = -0.13). This means that the potential of coastal tourism development is closely related to internal and external variables than environment quality. Table 5 shows a positive correlation between attractiveness and accessibility (correlation coefficients are 0.74). That means that places with high attractiveness have been invested in tourism development with good infrastructure, which makes it convenient for tourists to access the destination.

Table 5. The correlation matrix between tourism criteria and tourism revenue

	Attractiveness	Accessibility	Tourism service quality	Environmental quality and safety	Total score	Tourism revenue
Attractiveness	1	0.742	0.404	-0.425	0.913	-0.025
Accessibility	0.742	1	0.812	-0.059	0.922	0.531
Tourism service quality	0.404	0.812	1	0.212	0.716	0.699
Environmental quality and safety	-0.425	-0.059	0.212	1	-0.126	0.211
Total score	0.913	0.922	0.716	-0.126	1	0.276
Tourism revenue	-0.025	0.531	0.699	0.211	0.276	1

In bold, significant values (except diagonal) at the level of significance $\alpha=0.050$ (two-tailed test)

4.2. Coastal tourism potential in Vietnam

The contribution of each factor to the potential tourism assessment in 28 coastal provinces is shown in Table 6 and Fig. 3. The provinces of the Central Coast, from Quang Binh to Ba Ria-Vung Tau, have great tourist attractions based on the potential of their beautiful beaches. The northern and southernmost provinces have less attractiveness than these provinces (Fig. 3A). Accessibility and tourism services have high values in developed tourist places, such as Quang Ninh, Nghe An, Quang Nam, Da Nang, Nha Trang, and Kien Giang provinces (Figs. 3B, C). As the South-Central Coast and Kien Giang provinces are less affected by storms and provide a safe tourism

environment for tourists, the environmental quality & safety value in these regions also achieved a high value (Fig. 3D).

The results of a comprehensive assessment of tourism potentials in 28 coastal provinces are classified into 5 levels: very low (0.0-2.0), low (2.0-2.5), medium (2.5-3.0), high (3.0-3.5) and very high (3.5-4.0). The spatial pattern of tourism potential of the 28 coastal provinces is shown in Fig. 4. Accordingly, the South Central coast region provides the highest coastal tourism potential thanks to the high attractiveness of coastal tourism resources and good environmental quality. This region is considered a center of coastal tourism in Vietnam, developing high-class beach resorts. Da Nang city, Quang Nam, and Khanh Hoa province are the tourism nucleus

of the region with very high potential for coastal tourism development. Next is the North Central region, with medium to high potential for coastal tourism development. Although this area has attractive tourism resources and good accessibility, it is often affected by natural hazards such as storms and floods in the summer, so the tourism potential is lower than in the South Central Coast region. In this region, there are 4 provinces (Thanh Hoa, Nghe An, Quang Binh, and Thua Thien-Hue) with high tourism potential, only Ha Tinh and Quang Tri provinces have medium potential. In the Southeast region, Ho Chi Minh City and Ba Ria -Vung Tau have very high tourism potential thanks to the

attractiveness of tourism resources and good external factors such as service and infrastructure quality. The remaining 4 provinces of the Southeast region have low tourism potential. The northern and southernmost provinces have less potential for coastal tourism development. However, some bright spots in these regions, such as Quang Ninh province in the North and Kien Giang province in the South, have a very high potential for coastal tourism development. Ha Long (Quang Ninh) and Phu Quoc (Kien Giang) have been invested in becoming sea tourism centers of Southeast Asia and the world thanks to their outstanding tourism resource values.

Table 6. Results of component and comprehensive assessment of coastal tourism potential in Vietnam

Coastal province	Attractiveness	Accessibility	Tourism service quality	Environmental quality and safety	Total score	Tourism revenue in 2019 (Mill. USD [*])
Quang Ninh	2.46	0.53	0.42	0.53	3.94	37.40
Hai Phong	2.23	0.53	0.35	0.54	3.65	11.10
Thai Binh	1.67	0.32	0.22	0.43	2.64	0.58
Nam Dinh	1.62	0.32	0.21	0.43	2.58	0.90
Ninh Binh	2.05	0.41	0.25	0.45	3.16	0.58
Thanh Hoa	2.21	0.42	0.27	0.41	3.31	5.30
Nghe An	2.18	0.57	0.31	0.50	3.56	4.50
Ha Tinh	2.00	0.44	0.18	0.50	3.12	1.10
Quang Binh	2.35	0.41	0.18	0.40	3.34	13.20
Quang Tri	2.17	0.41	0.18	0.40	3.16	1.60
Thua Thien-Hue	2.18	0.51	0.34	0.41	3.44	9.80
Da Nang	2.24	0.52	0.55	0.55	3.86	93.00
Quang Nam	2.42	0.51	0.37	0.48	3.78	20.40
Quang Ngai	2.18	0.41	0.19	0.48	3.26	0.47
Binh Dinh	2.15	0.44	0.40	0.58	3.57	2.60
Phu Yen	2.11	0.41	0.20	0.59	3.31	0.13
Khanh Hoa	2.27	0.56	0.44	0.58	3.85	23.40
Ninh Thuan	2.09	0.41	0.19	0.55	3.24	0.13
Binh Thuan	2.17	0.41	0.26	0.57	3.41	2.90
Ba Ria-Vung Tau	2.26	0.44	0.37	0.67	3.74	15.30
Ho Chi Minh city	1.79	0.75	0.74	0.64	3.92	1160.40
Tien Giang	1.37	0.32	0.23	0.67	2.59	5.50
Ben Tre	1.07	0.22	0.17	0.67	2.13	3.20
Tra Vinh	0.92	0.21	0.17	0.67	1.97	1.10
Soc Trang	0.90	0.21	0.17	0.67	1.95	0.50
Bac Lieu	1.23	0.22	0.17	0.57	2.19	0.22
Ca Mau	1.42	0.21	0.19	0.46	2.28	0.82
Kien Giang	2.10	0.55	0.37	0.69	3.71	15.30

(^{*}) 1 USD corresponded with ca. 23 kVND; Source: (GSO, 2020)

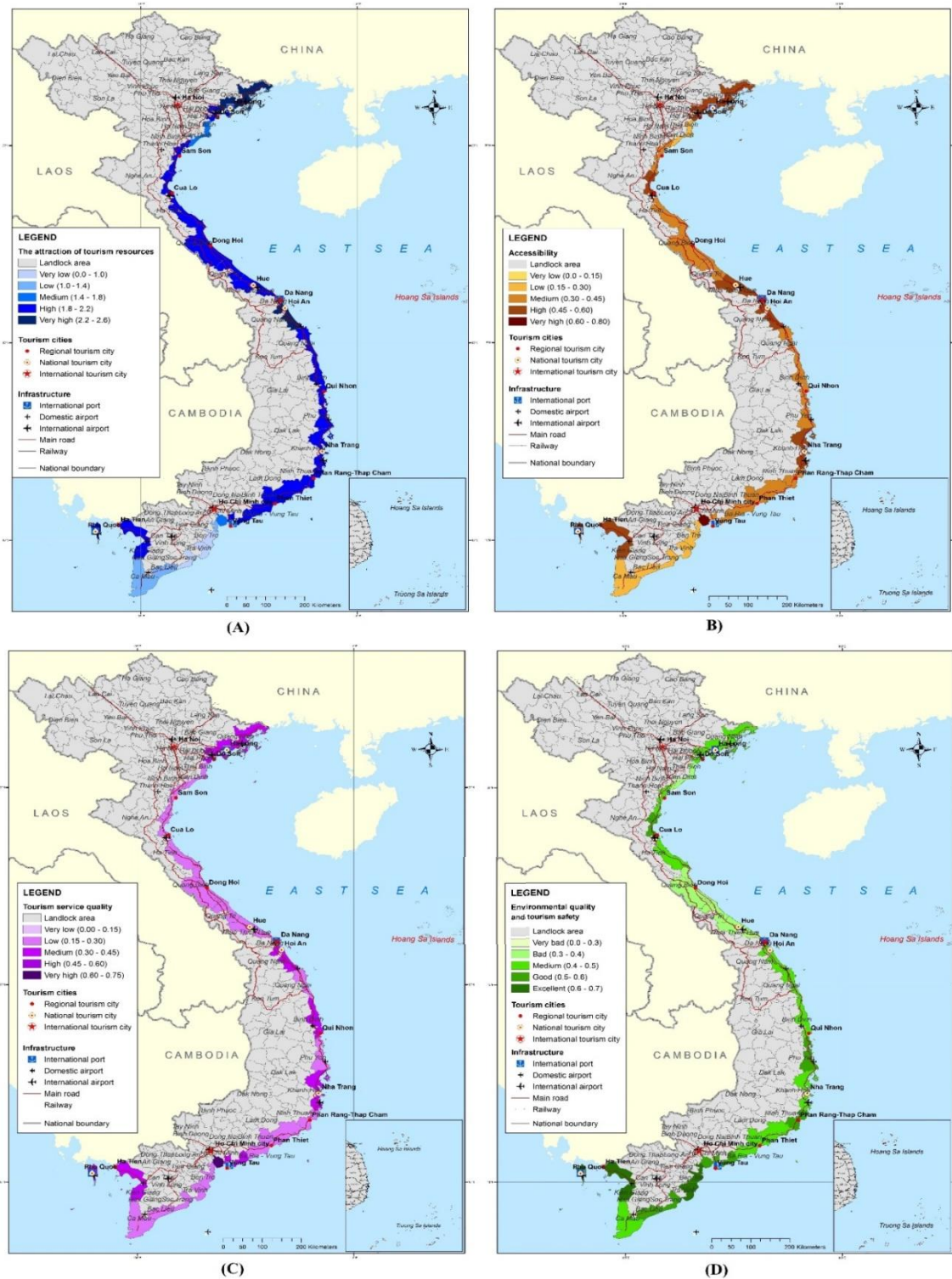


Figure 3 (A) Spatial pattern of attraction of coastal tourism resources, (B) Spatial pattern of accessibility, (C) Spatial pattern of coastal tourism services, and (D) Spatial pattern of environmental quality and safety

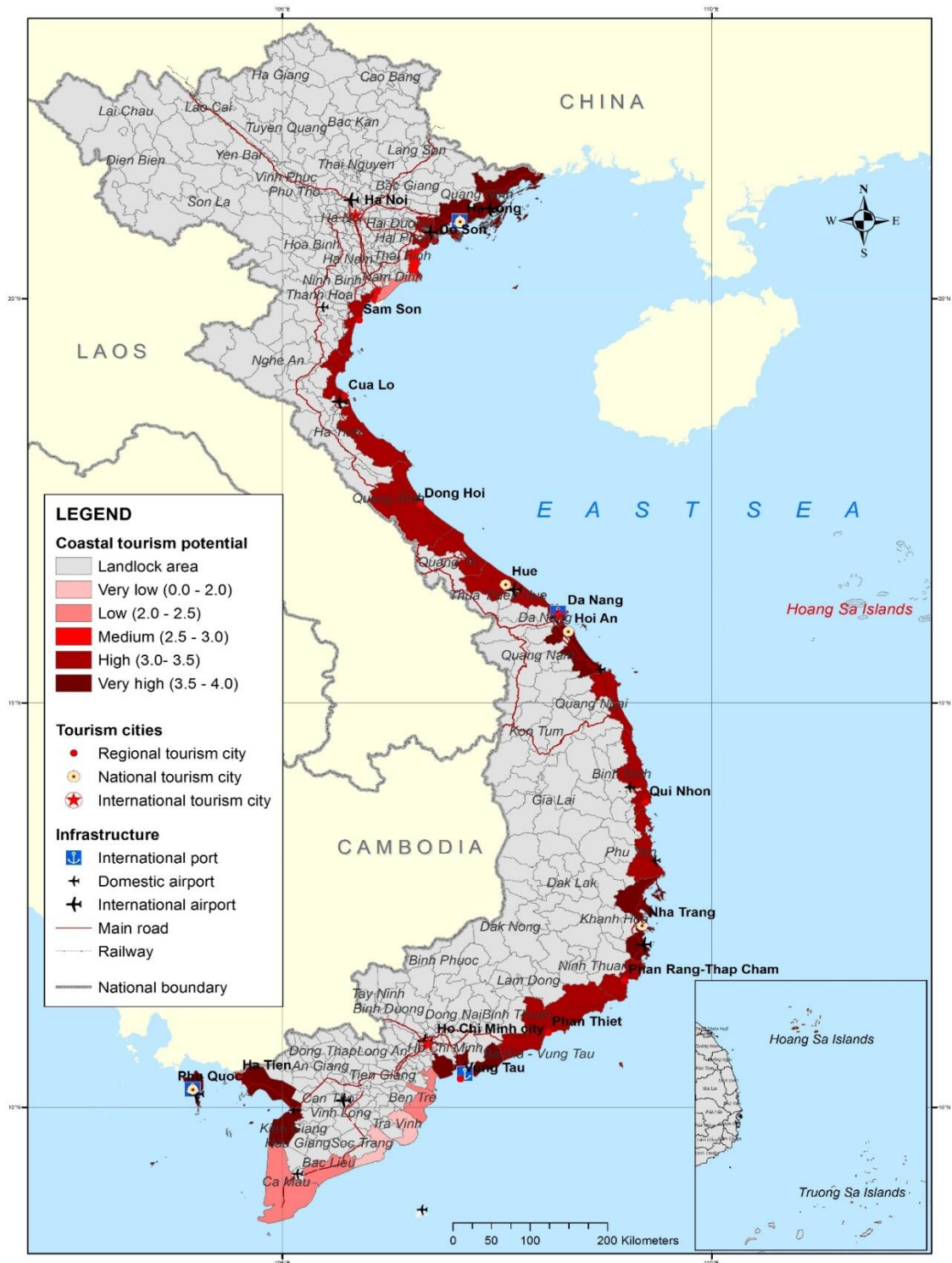


Figure 3. Spatial pattern of coastal tourism potential of Vietnam

5. Discussions

5.1. Role of facilities and infrastructure in coastal tourism development and the necessity of Marine Spatial Planning in the context of climate change and sea level rise

The PCA analysis shows that although internal factors are prerequisites for tourism development, tourism revenue is more closely related to external factors than internal factors. For example, the provinces such as Phu Yen and Ninh Thuan, despite having high attractiveness and good environmental quality, tourism revenue is very low due to limited tourist service quality and accessibility (Table 6). In contrast, Ho Chi Minh City is an exceptional case. Although its coastal tourism attraction and environmental quality are at a medium level, the tourism revenue is always leading the country thanks to the excellent service quality and accessibility. Besides, the southernmost provinces, Ca Mau, Bac Lieu, Tra Vinh, and Soc Trang, received relatively low tourism revenue because their resources and supporting factors hinder their development. That means the coastal tourism development strategy must focus on external factors such as infrastructure and service quality. This statement is supported by other studies in the world, such as Oldham et al. (2000) and Uduma-Olugu N & Onukwube H. N (2015) that indicated that the provision of infrastructure and other supporting inputs such as transport, water, power, food, and beverages would improve the current state of coastal tourism in Africa. Although facilities and infrastructure play an important role in coastal tourism development, they have been threatened by coastal erosion, sea level rise, and extreme weather throughout the world (Aiello et al., 2013; Mullick et al., 2020). Current and projected rising sea levels and extreme weather events, such as increased storm intensity, trigger massive waves and tides that result in storm surges that overtop

and encroach into the land surface area. Other tourism facilities under threat from weather extremes from climate change include servitudes, coastal roads, railway facilities, and tidal pools, all threatening the attractiveness of some resorts (Dube et al., 2021). In Vietnam, coastal erosion and sea level rise has become common in many sections of the country. Coastal erosion has caused many property losses and adversely affected the socio-economic development of coastal provinces, especially the section from Son Tra to the Cua Dai region, which is considered the center of coastal tourism in Vietnam with an erosion rate of 3-10 m/year (Ngo Van Liem et al., 2020). Vietnam is regarded as one of the most affected countries by climate change, of which sea level rise is one of the most significant effects. Research by Nguyen Minh Hai et al. (2022) in Hai Phong coastal area, northern Vietnam, indicates a sea level rise of about 21.4 cm over 60 years (1960-2020) and significant acceleration in sea level rise recently. The effects of sea level rise are significant on all economic sectors, including coastal tourism (Small C & Nicholls R.J, 2003). Immediate results include submergence, increased flooding, and saltwater intrusion into surface water.

In contrast, long-term effects will increase coastal erosion, which has been destroying many tourism facilities and infrastructure in the coastal areas of Vietnam. Integrated Coastal Zone Management is justified as a tool for managing coastal resources, adapting to climate change, and accommodating increasing tourist pressures. At the same time, strategies are recommended to ameliorate projected impacts (M.R.Phillips & A.L.Jones, 2006). Marine Spatial Planning (MSP) is also considered a promising procedure in tackling developmental and management issues related to the oceans and seas, and thus problems related to coastal and marine tourism in the

context of climate change and sea level rise (Papageorgiou, 2016).

5.2. Comparison with coastal tourism in other parts of the world and solutions for sustainable coastal tourism development in Vietnam

Despite recent increases in the number of marine tourists, Vietnam's coastal tourism still faces seasonal constraints, resulting in overcrowding in the summer and an uneven distribution of tourists among coastal provinces. The seasonality is evident in Vietnam's North and north central provinces, with a cold winter and a hot summer. At the same time, this feature is quite fuzzy in the south-central and southern provinces, which have a hot climate all year round with rainy and dry seasons. These features are similar to coastal tourism in Croatia and Tunisia, two countries on the Mediterranean Sea's northern and southern coasts. Research by Rutin (2010) reveals that Croatia and Tunisia present two different models of coastal tourism. The Tunisian model shows continuity and stability in the number of incoming tourists throughout the year.

In contrast, the Croatian model is seasonal, with a very high peak during the summer and a minimum influx of tourists during the winter. The main reason for this difference is the colder Croatian winter; the result is high seasonal instability in the Croatian tourism industry. The seasonal characteristic of coastal tourism represents several economic aspects, such as low annual occupation rates, low number of permanent jobs, and low quality of tourism products (Jordan, 2000). Many coastal resorts in the northern part of Vietnam stay empty during winter. Although they still require maintenance and employment in the tourism industry, there must be based on seasonality. Such seasonality may also lead to

a lack of motivation of workers in the tourism industry and to less investment in tourism employment, which may ultimately cause a lack of highly skilled workers in the tourism industry. In the southern part, on the other hand, the seasonal effect is lower, the employees can be more competent, and a large portion of the jobs in tourism can be permanent and stable throughout the year.

In the northern provinces with cold winter, it is necessary to integrate sea tourism with other types of tourism such as cultural tourism, MICE tourism, and ecotourism to increase the attractiveness of tourism programs and the diversity of tourism products. In the southern part, although the seasonal effect is lower, it is recommended that the tourism facilities be opened to the academic world by promoting the holding of academic congresses. These strategies would encourage stability in the tourism industry of Vietnam and boost its popularity as a multivariable destination.

Each province or city in Vietnam has its strengths and limitations for coastal tourism development. The choice of development orientation needs to base on these characteristics. Appropriate tourism development strategies for each group of coastal provinces are proposed in Table 7. Provinces with high external potential (group 1) should be strengthened intercity connectivity to diversify tourism product chains. While provinces in the middle part of Vietnam with good internal potential (group 2) should be prioritized to invest in upgrading the tourism services quality and tourism advertising. Provinces good at environmental quality and safety, especially in the southern path of Vietnam (group 4), should be prioritized to upgrade tourism infrastructure and diversify tourism products.

Table 7. Groups of coastal tourism potentials and proposed reasonable development orientations

Group	Coastal tourism potential divided by groups of criteria	Province name	Tourism development orientation
1	Good at accessibility and tourism service quality	Ho Chi Minh city, Da Nang, Khanh Hoa, Kien Giang, Ba Ria-Vung Tau, Binh Dinh	These provinces are suitable for coastal tourism development. It is necessary to strengthen intercity connectivity to diversify tourism product chains
2	Attractive coastal tourism resources and good accessibility	Quang Ninh, Hai Phong, Thua Thien-Hue, Quang Nam, Nghe An, Thanh Hoa, Quang Binh, Quang Tri, Ha Tinh, Quang Ngai, Binh Thuan, Ninh Thuan	These provinces are suitable for coastal tourism development and should be given priority to invest in upgrading the quality of tourism services and tourism advertising.
3	Both internal and external potentials are low	Thai Binh, Nam Dinh, Ninh Binh, Tra Vinh, Bac Lieu, Soc Trang, Ca Mau	There are few favorable conditions for coastal tourism development
4	Good environmental quality and safety for coastal tourism development	Ben Tre, Tien Giang, Phu Yen	Prioritize upgrading tourism infrastructure, diversifying tourism products

6. Conclusions

Based on integrating different quantitative methods, this study assessed the tourism potential of 28 provinces in the coastal area of Vietnam. The mutual relation between 23 variables related to coastal tourism development was analyzed in detail. Accordingly, the beach and landscape diversity variables are most important for assessing potential tourism value. The results show that the provinces in the South-Central region have the highest potential for coastal tourism development, followed by the North-Central region. The provinces in the Northern and Southeast regions and the Mekong River Delta have low potential. However, these regions still have some bright spots for coastal tourism development, such as Quang Ninh, Ho Chi Minh City, Ba Ria-Vung Tau, and Kien Giang. Four groups of coastal provinces that provide different tourism values were identified. Intercity connections should be bolstered in provinces with strong external potential to diversify tourist product chains. Investment in improving the quality of tourist services and promotion should be emphasized for provinces with high internal potential. Tourism infrastructure and product diversification should be prioritized in

provinces with high environmental quality and safety. Coastal tourist growth has minimal promise in certain regions.

Although there is high potential for marine economic development, Vietnam's coastal tourism is facing the challenges of climate change and seasonality. To overcome seasonality, it is necessary to integrate sea tourism with other types such as cultural tourism, MICE tourism, and ecotourism to increase the attractiveness of tourism programs and the diversity of tourism products. Integrated Coastal Zone Management and Marine Spatial Planning are justified as a tool for managing coastal resources, adapting to climate change, and accommodating increasing tourist pressures.

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