

# Impacts of climate change on Quan Lan island tourism development and proposed solutions

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## Abstract

Tourism is one of the world's fastest-growing sectors and is considered a major contributor to environmental changes and vulnerable to climate change (CC). Quan Lan Island, one of the popular destinations in the region, is facing higher tourism development and is vulnerable to CC and environmental impacts resulting from tourism development. Although the tourism industry on the island has not developed strongly, tourism activities on Quan Lan Island are often affected by climate change and sea level rise. Therefore, this study aims to analyze the relationships between tourism and CC and recommend strategies for enhancing governance compatible with the coastal environment and changing the climate. The study applied a mix of qualitative methodologies. Primary data were collected basically through a semi-structured interview, stakeholder group discussion, and site observation, together with secondary data. The explored relationships prove that the tourism destination is developing in different directions. The tourism sector faces mostly different CC-related impacts and adaptations. To enhance the relationships, proper management of tourism infrastructure and services is suggested for CC and the environment.

Keyword: Quan Lan island, climate change, tourism, sea level rise, coastal

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## 1. INTRODUCTION

Climate change, which is ongoing at present and is likely to be complex in the future, Quan Lan Island is located in the Northeast region of Vietnam; so far, it has not been affected by obvious CC. However, with the current changes, Quan Lan Island may face some major problems due to the impacts of CC such as sea level rise, coastal erosion, temperature rise, and heterogeneous impacts from weather conditions such as storms, floods, hail, etc.

In 2023, Vietnam's tourism is on the way to recovery. Quan Lan Island attracts a large number of tourists every day. However, sea and island tourism is an economic sector that is sensitive to natural environmental conditions. The activities of this type of tourism are mostly dominated by nature, so it is easy to be affected by environmental conditions. impacts of CC. Faced with that situation, it is essential to assess the impact of CC on marine tourism on Quan Lan Island and propose solutions to cope with CC for marine tourism activities. This is the basis for functional authorities and investors to consider and offer appropriate solutions to develop tourism, making tourism a key economic sector in Quang Ninh province.

## 2. LITERATURE REVIEW

Tourism growth in coastal areas has become the fastest-growing industry and reached its peak in recent decades, also becoming one of the biggest industries in the world (UNEP, 2009; Nara et al., 2014; Tang,

2015; Kurniawan et al., 2016; Schuhmann et al., 2016; Andres et al., 2018). While many recent studies have identified the impacts of CC on coastal tourism (Becken, 2013; Fang et al., 2018), there has been a lack of focus on integrated assessments that analyze the full range of potential climate-induced impacts on a specific destination (Nurse et al., 2014; Scott et al., 2016; Scott and Verkoeyen, 2017). In particular, there is a dearth of research on the cumulative effects of these complex impacts on the tourism sector of small island developing states (SIDS), on which many are economically dependent (Scott et al., 2016; Scott and Verkoeyen, 2017). However, tourism can be one of the key contributors to rapid urbanization and environmental impacts. With good planning and management, tourism can be a positive driver, creating benefits for destinations around the world (UNWTO, 2004; 2013).

The Study on Climate Change, Coastal Tourism, and Impact Chains (Anastasia Arabadzhyan et al., 2020) indicates that the impacts of CC on tourism include:

- Loss of tourist experience value in the destination due to changes in environmental attributes
- + Loss of attractiveness of marine environments due to loss of species, increase of exotic invasive species, or degradation of landscape.
- + Loss of attractiveness and comfort due to beach availability reduction
- + Loss of attractiveness due to increased danger of forest fires in tourism areas
- + Loss of attractiveness of land environments due to loss of species, increase of exotic invasive species, or degradation of landscapes
- Loss of tourist experience value in the destination due to changes in human comfort (or health).
- + Loss of comfort due to an increase in thermal stress and heat waves.
- + Increase of health issues due to emergent diseases.
- Loss of tourist experience value in the destination due to the change in the quality of infrastructure and facilities.
- + Increase in damages to infrastructure and facilities (accommodation, promenades, water treatment systems, etc.).
- + Decrease of available domestic water for the tourism industry.
- + Loss of attractiveness due to loss of cultural heritage (monuments, gastronomy, etc.).

### 3. METHODOLOGY

- Expert method: Gather the opinions of experts on the impacts of CC on tourism. The opinions and assessments of experts are gathered from research papers, evaluation reports, and comments from conferences on CC.

- Interview survey method: The author conducts interviews with subjects operating in the field of tourism about their interest in and awareness of CC and some possible response solutions in the area they live in.

- Statistical methods, data synthesis, and inheritance of published studies: Through the statistical analysis of historical data and data on the impact of CC and sea level rise, the author provides an overview of the impact as well as extrapolates the impacts of CC in the future.

- How to assess the impact of CC

+ Identify CC manifestations for Quan Lan Island. This is the scientific basis for assessing the impact of CC on marine tourism on Quan Lan Island.

+ Identify priority areas, objects, and assessment scope: to have a more detailed assessment of the impact of CC on marine tourism in each region, it is necessary to have a detailed data source. More detailed climate scenarios for each region

However, due to time limitations and detailed data, the author makes the most preliminary assessment of the impact of CC on tourism on Quan Lan Island.

### 4. RESULTS

#### 4.1. Overview of tourism and CC in the Quan Lan Island area

Quan Lan is an island in Bai Tu Long National Park on Bai Tu Long Bay. Quan Lan Island (also known as Canh Cuoc Island and Cao Lo Island) has two communes, Quan Lan and Minh Chau, in Van Don district, Quang Ninh province. The island has geographic coordinates of 20° 53' 04" north latitude and 107° 30' 42" east longitude. The island consists of two communes, Quan Lan and Minh Chau, with five villages, and a part of the island area belongs to Bai Tu Long National Park (Figure 1). The island has an area of 118,638 km<sup>2</sup>, extending from the northeast to the southwest, from the foot of the Van Don mountain range to the Got mountain, about 40 km southeast of the center of Van Don district.

The island's population is about 9,000 people (according to statistics for 2019). These two island communes are located on the same sandy island with relatively flat terrain. The length of the island is about 20 km, and the narrowest place at the beach is the Trui dune, which is only about 100m. The distance from Quan Lan commune center to Minh Chau commune is about 12 km (Pham Quang Tuan et al., 2015).

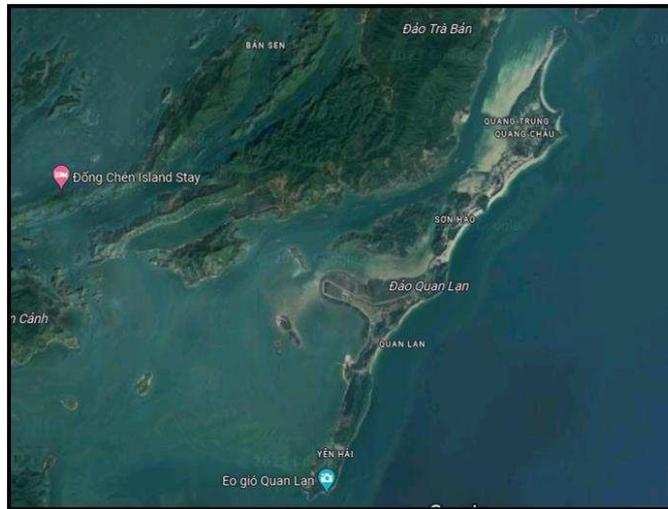


Figure 1. Map of the area of Quan Lan island

#### 4.1.1. Current status of tourism on Quan Lan Island

Quan Lan is favored by nature with the beauty of an island commune in the middle of the sea. Rich in both natural resources as well as historical and cultural values, Quan Lan-Minh Chau Island has many advantages for tourism development. In terms of cultural and historical values, one must mention the complex of national architectural and artistic historical relic sites (Quan Lan Temple, Temple, and Nghe Quan), which has been recognized since 1990. In which the communal house is a pagoda cluster. The temple is located in Doai village, right in the center of Quan Lan commune, on a beautiful land facing the large sea. Nghe is located about 1.5km away, in a wide, flat field that is peaceful all year round, next to the main road across the island.

Quan Lan-Minh Chau Island is also home to the National Historic Site of Van Don, an ancient trading port established in 1149 as one of the first seaports in Vietnam.

In terms of natural values, Quan Lan-Minh Chau Island has a stable, unspoiled ecosystem and a fresh-air environment, especially with many beautiful sandy beaches. In particular, Son Hao Beach is a tourist beach in the tourism development planning of Van Don district up to 2020 with a vision to 2030, with the orientation of developing the island into a center of quality beach resort tourism. This place with a stretch of fine white sand, a clear blue sea, and soaring natural and wild casuarina groves is an attractive destination for tourists from all over the world ( People's Committee of Van Don district, 2018-2022).

When it comes to Quan Lan-Minh Chau Island, it is also worth mentioning Tram Forest and Minh Chau Beach, which are overall spaces with a typical population of hundreds of years old brocade forest, covering an area of over 14 hectares running along the white sand dunes next to the beach. Ovum. Minh Chau Beach stretches for about 2km, has a gentle shore, smooth and clean white sand, and small waves suitable for organizing sports activities such as football, volleyball, tug of war, or sandboarding (Pham Quang Tuan et al., 2015).

From this potential, over the years, people and travel companies have organized beach resort services, dining, accommodation, and other entertainment.

In addition to visiting scenic spots, historical sites, and accompanying service points, the Quan Lan island area has built tourism products to bring interesting, new, and attractive experiences to tourists. such as: one day working as a fisherman on the island, squid fishing, digging sa worm, visiting Ba Mun national forest, etc.

According to the statistics of the People's Committees of two communes, Quan Lan and Minh Chau, the total number of tourists to Quan Lan island in recent years has grown at a fairly stable rate. In 2013, the total number of tourists to Quan Lan Island was just over 39,500; in 2019, this number has increased to over 113,800. In addition, the growth rate of the number of guests staying is also quite stable and reaches an average of 14.29% per year, higher than the growth rate of visitors. In 2022, tourism on Quan Lan Island will recover after COVID, and the number of visitors will be 111,300. Due to the characteristics of natural resources and geographical location, the rate of tourists staying on Quan Lan Island is quite high, accounting for over 60%. However, the average length of stay on the island for tourists is relatively short—about 1.5 days—because there are not many activities or attractive recreational facilities and services to keep tourists staying longer.

Located in the island system, Quan Lan-Minh Chau has high-quality and synchronous infrastructure, technical facilities, and services, meeting the needs of accommodation, meals, and other needs. other needs of visitors. Currently, on the island, there are about 100 accommodation businesses with over 1,300 rooms, of which about two-thirds are concentrated at Van Hai Beach, the center of Quan Lan commune, and the rest are in Minh Chau commune. Besides, homestay services also attract a certain number of visitors in the summer.

In recent years, Minh Chau-QQuan Lan has increasingly shown greater attraction, with an increasing number of tourists visiting the island. Tourism has initially brought social benefits to the local people, creating job opportunities at resorts, accommodation, and catering businesses with specific jobs such as guest house management, hotel shuttle bus for tourists, opening a restaurant, working as a guide, selling seafood, renting motorbikes and bicycles, etc. Since then, people's lives on the island have gradually and clearly improved. Tourism has also contributed to the step-by-step transformation of the economic structure here from agriculture with fishing as the main focus to tourist services.

The Quan Lan-Minh Chau tourist area has been recognized as a provincial tourist area, opening up many great prospects for tourism development here. Minh Chau - Quan Lan island area, Van Don economic zone, is planned into many different subdivisions.

Among them can be mentioned: Quan Lan tourist service urban area, thematic park area, and Sea Festival Square in Dong Nam village, Quan Lan commune; handicraft and tourist transport areas in Dong Nam. Thai Hoa village, Southeast marine eco-tourism area of Quan Lan center, service tourism area and natural forest conservation, high-quality marine eco-tourism area in Quan Lan and Minh Chau communes, Park Mangrove eco-tourism, natural forest park, Minh Chau tourist service residential area, natural forest eco-zone in the north of Minh Chau island, Quan Lan, etc.

When these subdivisions are realized, it will turn Minh Chau-Quan Lan Island into a beach resort with many diverse types of tourism, attracting tourists from the good exploitation, maximum potential, and benefits. The unique position for tourism on this beautiful island

#### **4.1.2. Status of climate change in Quan Lan Island, Quang Ninh Province**

Quan Lan Island's climate belongs to a humid tropical monsoon climate with cold winters. Summer is hot and humid with a lot of rain (from April to October), and winter (from November to April next year) is cold and dry, alternating with two springs and two autumns, which are short and transitional. Located in a location deeply influenced by the northeast monsoon circulation, Quan Lan Island has a lower temperature than other regions; the annual average ranges from 22.7 to 23.9°C. Quan Lan is considered one of the most rainy regions of the North, with an average rainfall of 1600–2700 mm/year, but it is spatially distributed very differently. Along with the general trend of the global climate, in recent decades (the period 1991–2020) (Institute of

Geography, VAST 2022), the climate on Quan Lan Island has had certain fluctuations in temperature, precipitation, extreme weather phenomena, and the like, as well as sea level rise (Ngo Hai Ninh, 2017).

a. Variation in temperature

According to the monitoring data of the Central Hydrometeorological Forecasting Center, on the basis of meteorological data collected at stations near Quan Lan Island (Bai Chay and Co To), specific data on the average temperature of each month and the average annual temperature in the period 1991–2020 are as follows (Institute of Geography, VAST 2022):

The impact of the cold winter here is shown through the presence and shortening of the cold winter period, specifically: if in Co To, every year, the average monthly temperature drops below 18°C for 3 months, there are only 2 cold months left in Bai Chay (Table 1).

Table 1. Average monthly and yearly air temperatures at 2 stations near Quan Lan Island (°C)

No	Climate station name	1	2	3	4	5	6	7	8	9	10	11	12	Năm
1	Co To	15.4	15.7	18.3	22.2	26.2	28.2	28.3	28.3	27.5	25.5	21.3	17.6	22.8
2	Bai Chay	16.3	17.5	19.7	23.3	26.7	28.7	28.5	28.3	27.4	25.9	21.4	18.1	23.1

The degree of deviation of the average air temperature for each year compared with the average level of the series is the same negative or the same positive at all stations, showing the impact of the same circulation regime. Maximum positive deviation from 0.7 to 1.1°C in 1998 at all stations. Maximum negative deviation from -0.8 to -1.0°C in 1986 at all stations (Table 2).

Table 2. Fluctuations of annual mean temperature, period 1991–2020

No	Climate station name	Deviation (+) max (°C)	Year	Deviation (-) max (°C)	Year
1	Bai Chay	0.9	1998	-0.9	1986
2	Co To	1.0	1998	-1.0	1986

Thus, the above results show that the average air temperature has a strong fluctuation in the time series and tends to increase. The average increase at all stations ranges from 0.2 to 0.3°C per decade.

a. Changes in precipitation in Quan Lan

Quan Lan Island has a summer rainy regime; in general, the rainy season starts in May, lasts 6 months, and ends at the end of October (Table 3). The annual rainfall tends to decrease.

Table 3. Average monthly and yearly average rainfall (mm)

No	Climate station name	1	2	3	4	5	6	7	8	9	10	11	12	Total
1	Co To	26.5	24.2	47.9	72.3	150.7	202.1	311.1	376.7	321.6	113.5	42.3	23.2	1699.3
2	Bai Chay	25.7	23.3	50.5	74.5	173.8	264.7	331.7	393.7	275.9	146.2	34.2	14.8	1804.8

The variability of precipitation is evaluated through the statistical characteristics of the standard deviation of total rainfall in the study area (Table 4). The annual standard deviation of total rainfall at the stations ranges from 391.4mm to 305.6mm. The place with a lot of rain has a larger standard deviation value for the year than the place with little rain. In the same place, the variation value of total annual precipitation is

greater than the variation value of monthly rainfall in the year. The average standard deviation of the rainy season months fluctuates between 100 and 300mm; in the months with little rain (December to February), the standard deviation of monthly rainfall ranges from 15 to 65mm.

b. Changes in precipitation in Quan Lan

Quan Lan Island has a summer rainy regime; in general, the rainy season starts in May, lasts 6 months, and ends at the end of October (Table 4). The annual rainfall tends to decrease.

Table 4. Average monthly and yearly average rainfall (mm)

No	Climate station name	Climate												Năm
		1	2	3	4	5	6	7	8	9	10	11	12	
1	Co To	39.7	23.2	44.7	52.5	78.7	113.3	201.2	196.6	188.2	92.6	48.7	21.3	392.6
2	Bai Chay	34.3	17.7	50.3	54.4	104.6	107.1	174.3	227.6	117.5	147.9	37.5	17.5	303.7

(Institute of Geography, VAST 2022)

Disasters and extreme weather events

Storms and heavy rains are common on the coast of Quan Lan Island, with the strongest wind speeds reaching 40–50 m/s (the storm's level is from 13 to 16). On average, 1–5 storms make landfall in the Gulf of Tonkin every year and directly affect the coastal area of Quang Ninh. In addition, extreme weather phenomena such as thunderstorms, hoarfrost, tropical depressions, hail, tornadoes, etc. also appear in Quang Ninh. Extreme weather events affect and cause severe damage to production and people's lives, and tourism is no exception.

c. Sea level rise

According to the latest scenario of the Ministry of Natural Resources and Environment (2020), if the sea level rises by 100 cm, about 1.94% of the area of Quang Ninh province is at risk of being flooded, mainly in coastal localities, of which Quan Lan island area (in Van Don) is at risk of flooding 1.16% of the area. This demonstrates the existence of CC in Quan Lan (Figure 2, Table 5) (Ministry of Natural Resources and Environment, 2020).

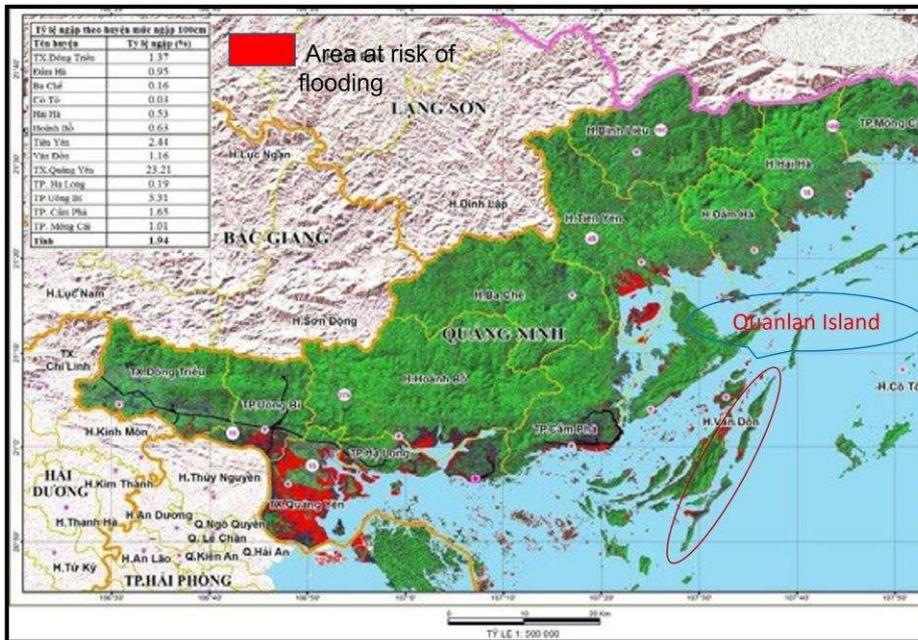


Figure 2. Map of flooded area in Quang Ninh province and Quan Lan island

Table 5. Sea level rise in Quan Lan island

District	Acreage (km <sup>2</sup> )	Inundation rate (%) for sea level rise					
		50cm	60cm	70cm	80cm	90cm	100cm
Quan Lan	11	0,78	0,90	0,96	1,03	1,08	1,16
Quan Ninh province	967655	0,94	1,23	1,44	1,59	1,75	1,94

**4.2. Impact of climate change on marine tourism activities on Quan Lan Island**

As a locality with a humid tropical monsoon climate and cold winters, the climate belongs to the area of interference between the oceanic climate and the continental climate and is located near one of the 5 largest hurricanes in the world, so natural disasters such as storms, floods, flash floods, droughts, saltwater intrusion, cyclones, sea level rise, etc. are phenomena that occur every year and cause a lot of damage to the locality. Accordingly, it is inevitable that marine tourism activities will be affected. Climate change will change the rain regime, severe cold, harmful cold, unpredictable weather season length, and sea level rise, greatly affecting marine tourism activities on Quan Lan Island. According to the assessment, CC and sea level rise in Quan Lan will have different impacts on tourism. Affected tourist objects include tourism resources, tourism infrastructure, and tourist technical facilities (Ngo Quang Duy,2008 & Hyman TA, 2014). The impacts of CC on tourism in Quan Lan are summarized in the following table 6:

Table 6. Impacts of CC on coastal areas and Quan Lan Island

Types of impact	Affected tourist objects
- Sea level rise	- Tourism resources
- Increasing storms and tropical depressions	- Infrastructure, material and technology for tourism
- Increase in sea level rise and saltwater intrusion	- Activities of tourism and travel service businesses

Impact of CC on sea tourism:

a. Impacts on tourism resources

Quan Lan Island is strongly affected by CC, especially in low-lying coastal areas. An increase in extreme weather events (heavy rains, storms, cyclones, and floods) plus rising sea levels cause erosion, washing, landslides, and flooding in coastal areas. Beautiful beaches such as Son Hao, Minh Chau, Quan Lan, etc., and small sandy beaches near the islands are in danger of being lost, while others are encroached by sea water into the mainland, increasing investment costs for the construction, reclamation, and protection of coastal areas. Some terrains with unique landscapes have great attraction for tourists, such as the tram forest area, but coastal landscapes are changed in a negative way.

Storms and tropical depressions hitting Quan Lan Island are dangerous weather patterns that usually appear from April through August. Normally, storms and tropical depressions that land on Quan Lan are concentrated in April, May, July, and August of the year. Thus, the storm season here coincides with the period of activity of the tropical convergence band. At that time, the combination of storms and tropical depressions with different weather patterns such as cold air and tropical convergence continued to cause heavy rains, damaging tourism resources,...

Fluctuations in rainfall in the region lead to changes in flow regime, intensity of floods, frequency, and characteristics of drought. Fluctuations in heat and rain cause groundwater reserves to decrease, changing groundwater levels and thereby affecting the ability to exploit freshwater for tourism activities on the island. In addition, sea level rise increases the possibility of saltwater intrusion, which also reduces freshwater reserves for production, the livelihoods of local residents, and island tourism in particular. Thus, CC and sea level rise impact the degradation of freshwater resources both in quantity and quality. In the context of mass tourism development, which exceeds the tourist capacity, the risk of a shortage and pollution of fresh water is very high.

Sea level rise accelerates saltwater intrusion into the inland area, causing biodiversity loss and degradation of natural habitats. Accordingly, fishery resources will also be reduced, leading to the gradual loss of some species that are currently considered local specialties and cannot meet the needs of tourists.

The island has long-standing tangible cultural relics: communal houses, temples, ancient houses, etc.; however, most of these relics are distributed in coastal areas, and this is the area that will be greatly affected by storms, sudden thunderstorms, cyclones, and landslides. In general, CC has had a negative impact on resources, even destroying them, thereby affecting the development of tourism activities.

#### b. Impact on the infrastructure and technical facilities of the tourism industry

Climate change and natural disasters adversely affect, increase risks to, and destroy the system of coastal roads, communication lines, electricity, vessels, passenger vehicles, and properties serving the tourism industry, such as cruise ships and travel services. In the rainy and stormy period, the technical facilities for tourism, such as the system of hotels, restaurants, shopping facilities, post offices, banks, etc., in the flooded area are at risk of flooding. Extreme weather can affect transportation, energy networks, and power transmission systems, especially during the rainy season. During the storm, it is difficult to access the transmission system for repair, and it takes a long time to recover. This will have a direct impact on the operation of tourism facilities, causing a decline in the quality of services for tourists. For large facilities, they can use backup equipment and machinery, which increases costs or can have adverse effects on the environment (using backup generators to generate noise or emissions causing the greenhouse effect).

Due to the impact of CC, the tourist season is from April to September. During this period, the heat affects traffic activities, including equipment, engines, and vehicles, significantly increasing the cost of transportation, maintenance and repair costs for road and waterway transport, construction, and means. In addition, the increased temperature contributes to the energy consumption of the engines, including the cooling systems in transport vehicles. Along with the need for technological innovation to reduce greenhouse gas emissions, the above impacts will increase transport costs. Rising temperatures cause biodiversity to decrease; some endemic species at some ecotourism sites may disappear; coral reefs may be degraded, reducing the attractiveness of tourism. Food used to prepare dishes to serve visitors is also affected.

#### c. Impact on travel and tourism activities

Tourism activities on Quan Lan Island include the stages of construction, sale, and implementation of part or the whole of a tourist program for tourists. If tourism resources are affected by CC, tourism activities will be affected directly or indirectly. This means that one of the most important functions of tourism is "creating a tourism agenda" that will be affected by the impacts of CC through tourism resources.

Besides the impact on resources, CC also affects tourism infrastructure and technical facilities, as mentioned, and this will directly affect the organization and implementation of tourism programs, to natural or humanistic tourist sites. In particular, among the types of tourism on the island—resort tourism, ecotourism, discovery tourism, sea tourism, etc.—certainly, sea tourism has the heaviest impact.

In addition, when there is a storm, accessibility to tourism on Quan Lan Island will also decrease because trains, tours, and tourist events taking place during this period will be canceled or delayed. In particular, with the phenomenon of thunderstorms, strong winds of level 6 or higher, and rough seas, overnight cruises on Ha

Long Bay stopped working, and sea and island tourist routes were not licensed for tourist ships. travel... because it is necessary to ensure the safety of tourists' lives. When there are storms, heavy rains, boats that stop working, and power outages, it makes it difficult for tourism activities, accommodation, and food supply for tourists, and tourists cannot get to the shore on time. In addition, with each passing storm, the tourism landscape environment deteriorates, and environmental problems are threatened, affecting local tourism. This shows that there are many potential risks due to storms affecting the island's marine tourism.

The greater the volatility of the climate, the greater the damage because tourism products cannot be stored or moved and are easily damaged. Cancellation, suspension, or delay of tourist plans will affect a series of stages and parts of the tourism industry. As volatility increases, so will the passivity of the tourism industry. These impacts have caused the scale of visitors to fluctuate (sometimes it increases very large, but sometimes it decreases suddenly), the revenue to be unstable, and the costs incurred in operating operations to remedy the damage caused by the loss of income to be unstable. Losses increase, thereby reducing profits. The erratic and extreme changes of natural disasters increase travel risks such as accidents during storms, floods, and landslides, which also greatly affect the psychology and lives of tourists. visitors when going to high-risk areas and times such as mountainous areas, coastal areas, and in the season with many natural disasters.

#### d. Positive impact on the tourism industry

However, in addition to the negative impacts of CC, the tourism industry also has good opportunities and conditions for development if there are solutions and options to adapt to CC and exploit other aspects. emerging from the impacts of CC. Increasing temperatures and local extremes of weather in different regions, such as prolonged heat and deep drought, will lead to the need to travel to places with more pleasant weather, such as swimming in the sea. Sea resort. In recent years, unusual heat waves have caused millions of tourists to flock to the beautiful beaches in Quan Lan.

In addition, prolonged drought, less rain in the summer, or a longer hot period mean that the tourist season will be extended. Tourism often takes place in the absence of rain and during the dry season. Therefore, when the hot period lasts for a long time and there is little rain, it will make tourism activities convenient, vibrant, and easy, attracting a large number of tourists at this time.

### **4.3. Proposing solutions to cope with the impacts of CC on the development of marine tourism in Quan Lan**

#### **4.3.1. General solutions**

- Developing the marine tourism development strategy, CC response plan of the tourism industry in Quang Ninh province and Quan Lan island area: When developing the province's sea tourism development strategy, the following factors should be considered: Potential threat of CC to tourist objects, tourist areas are likely to be affected. On that basis, develop a management plan to respond to the tourism crisis caused by CC. Before developing the plan, it is also necessary to consult with all parties, such as tourism service establishments, travel agencies, residents, and tourists.

- Raising awareness of the people of Quan Lan Island on CC issues: Promote propaganda, education, and awareness-raising, forming a sense of proactive response to CC, and using resources sparingly. water, energy, and environmental protection for workers. To do this, the authorities should take specific measures, such as:

- + Organizing training courses and thematic activities for subjects operating in the field of tourism
- + Increase advertising and propaganda on CC- related content, rational and economical use of natural resources, and environmental protection.
- + communicating experiences and guiding the subjects to know how to adapt to CC and respond to incidents.
- + Regularly and unexpectedly inspecting tourism and travel service establishments on CC awareness issues, investing in rescue and rescue equipment, training in skills to promptly respond to CC incidents and natural disasters, and implementing measures for sustainable environmental protection.

- Invest in and develop infrastructure and technical facilities on Quan Lan Island:
  - + Invest in tourism infrastructure and technical facilities; pay attention to building solid houses to avoid storms and tornadoes; increase the system of dykes and sea embankments to prevent high tides; and protect the coastal areas from saline intrusion and coastal erosion.
  - + Invest in more loudspeaker systems in the area, mainly in places where there is a possibility of danger, so that people as well as tourists and tourism businesses receive early notice, promptly respond, and prevent disaster.
  - + Building a safe anchorage area: boats and high-speed boats are invested with great value, so it is necessary to have a safe place to park when natural disasters happen to avoid damage and loss of property.
- Orientation to develop sea tourism on Quan Lan Island in the direction of eco-tourism and green tourism
  - + Promulgating policies to encourage investors and units in Van Don district and Quan Lan island to develop tourism in the direction of eco-tourism, green tourism based on inherent natural resources Avoid the case for economic benefits without paying attention to environmental protection, preserving tourism resources.
  - + Manage the number of visitors to meet and match the tourist capacity of the island.
  - + It is necessary to pay attention to waste generated from tourism activities and coastal drift to protect the environment. There is a garbage collection system and a safe treatment system.
  - + Save energy and water. It is necessary to increase the use of renewable energy and recycled materials to create tourism products. Turning tourism activities, such as planting and protecting the environment of forests, seas, etc., into tourism products. This activity should be regularly applied to the tourism development of Quan Lan Island.
- Encourage organizations and individuals to participate in consulting and supporting services for CC response activities in the tourism sector. Provincial authorities should have mechanisms to encourage incentives and support. provide support to businesses, individuals, or people participating in CC response activities. Support loans for economic development for people in coastal areas and on islands so that they can focus on economic development. Avoid cases where local residents over-exploit available resources for their livelihood.
- Building and setting up marine rescue teams and quick response teams to the negative effects of CC; and at the same time, propagate, educate, warn, and distribute leaflets to tourists and people to let them know the areas, locations, times, and cycles of dangerous strange creatures appearing at beaches. This solution is very important because visitors feel secure in subjective and objective safety and are fully and adequately cared for, both physically and mentally.
- Coordinate with internal and external units to well implement the CC response. First of all, it is necessary to coordinate between tourism and districts, especially districts in important areas. tourism development and promote the role of institutions and the participation of the community in efforts to respond to CC in the field of tourism management.

**4.3.2. Specific solutions for each affected object are evaluated**

Object	Solutions
Quan Lan island tourism resources (natural resources, human resources)	<ul style="list-style-type: none"> <li>- Take measures to protect beaches and the coastal environment (especially beaches for tourism);</li> <li>- Take measures to protect marine and coastal ecosystems: coral reefs, coastal protection forests because Quan Lan island is located in Bai Tu Long national park, and biodiversity in areas of Cham forest, mangrove forest, and coastal casuarina forest.</li> <li>- Protection of coastal cultural and spiritual relics: communal houses, temples, old houses, etc.</li> </ul>

Infrastructure and technical facilities for island tourism	<ul style="list-style-type: none"> <li>- Strengthening the building of a disaster warning system and response to CC</li> <li>- Prevention of landslides and damage to roads; embankment roads for tourism; outdoor amusement parks; restaurants, hotels,...</li> <li>- Building lightning protection system on the island;</li> <li>- Consolidating the work of collecting, treating, and storing fresh water on the island.</li> <li>- Building a system of works for the collection and treatment of domestic waste and waste water</li> <li>- Increase planting of trees on roads.</li> <li>- When investing in building new facilities for tourism, attention should be paid to the selection of materials and construction technologies in an environmentally friendly direction.</li> </ul>
Activities of tourism establishments and services on the island	<ul style="list-style-type: none"> <li>- Use water efficiently: facilities have equipment to collect rainwater. Large enterprises can re-treat water for the cooling systems of hotel facilities and other operations for reuse.</li> <li>- Energy efficiency: Tourism service establishments are designed to maximize the use of sunlight, wind, and air to reduce natural energy consumption. Use fuel-saving forms of green energy (such as solar energy, wind energy, compact lights, photovoltaic lights, the use of natural light in architecture, etc.).</li> <li>- Using green products: businesses encourage employees, tourists, and people to use green, environmentally friendly products. For example, instead of using plastic bags for one-time use of goods, the locality should orient households here to replicate the model of using bags many times, then let guests in.</li> </ul>

## 5. CONCLUSIONS AND RECOMMENDATIONS

Quan Lan Island is under the strong impact of CC. The area is often affected by storms, floods, prolonged heat and cold, harmful cold, and winter. In particular, the biggest risks to the island are sea level rise, increased inundation areas, and saltwater intrusion. The tourism industry of the island is in the process of developing; although the number of tourists is not large, the benefits from tourism have contributed to the development of livelihoods, improved living standards, and created jobs for local people. Due to the impact of CC, many factors in the tourism industry of Quan Lan Island are strongly affected: Infrastructure, technical facilities, tourism resources, tourism products, organization of activities, etc. are all affected by CC to different degrees. In the increasingly complicated trend of CC, raising awareness about CC for people, tourists, and state management agencies and businesses; Integrated implementation of CC adaptation solutions plays an important role in the sustainable development of tourism in Quan Lan, Quan Ninh province.

This review of recent research on Quan Lan Island and climate change has assessed the varied literature and factors that are helpful in understanding why the small island is particularly at risk from climate change. The scientific literature is clear that hazards affecting Quan Lan Island have already increased due to anthropogenic climate change and that these hazards are projected to continue to intensify with higher levels of global warming. Tourism Quan Lan Island has high exposure to these hazards, and the socioeconomic characteristics of these islands contribute to their acute levels of vulnerability. These patterns of hazards, exposure, and vulnerability across Quan Lan Island lead to a range of current impacts and projected risks that affect every aspect of tourism. Quan Lan Island residents also view climate change as a distant problem that may be beyond their control. Adaptation planning and implementation in tourism on Quan Lan Island have been the focus of much activity and research. These negative impacts of climate change are seen as significant threats to developing tourism on Quan Lan Island.

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