



RESEARCH ARTICLE

Applying DPSIR Model in Researching the Impact of Tourism Activities on The Environment in Ba Na Tourist Area, Da Nang City, Vietnam

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ARTICLE INFO	ABSTRACT
Received: Jan 11, 2024	<p>Tourism is an economic sector that has been occupying an important position, contributing significantly to the economic growth of each country. Besides, it also contributes to implementing the strategy of peace and friendly cooperation between countries in the world. In the process of development, the tourism industry has been revealing limitations such as the unreasonable management and use of resources, especially environmental issues. Therefore, it is necessary to develop tourism in a sustainable manner, bringing high economic efficiency, in harmony with other production and economic sectors and protecting the environment. This study applies the DPSIR model (Driving forces - D, Pressures - P, State - S, Impacts - I, and Response - R) to study the impact of tourism activities on the environment in Ba Na tourist area, thereby proposing a number of necessary solutions to develop tourism associated with environmental protection and recommending a framework for assessing the environmental impact of tourism activities in Ba Na tourist area.</p>
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INTRODUCTION

Environmental protection is a vital requirement for humanity; environmental protection strategy is an inseparable part of the socio-economic development strategy, sustainable development strategy; environmental protection aims at sustainable development to meet the needs of current generations while still maintaining potential and opportunities for future generations; investment in environmental protection is investment in sustainable development. Tourism development must respect natural laws, be in harmony with nature, and be environmentally friendly; encourage tourism development in accordance with the ecological characteristics of each region, with little waste, low carbon, and towards a green economy. Aiming at the goal of environmental protection, attaching importance to efficiency and sustainability in the exploitation and use of natural resources, focusing on biodiversity conservation, development must respect natural laws, be in harmony with nature, and be environmentally friendly. In Decision No. 1216/QĐ-TTg of the Prime Minister (Prime Minister, 2012) it is also clearly stated: The vision to 2030 is to "Prevent and repel the increasing trend of environmental pollution, resource degradation and biodiversity loss; improve the quality of living environment; proactively respond to climate change; create basic conditions for a green, low-waste, low-carbon economy for the prosperity and sustainable development of the country".

Ba Na is a nature reserve and a Ba Na tourist complex, located in the Truong Son Mountain range in A Son village, Hoa Ninh commune, Hoa Vang district, about 25km southwest of Da Nang City center. The entire resort complex is located on the top of Chua Mountain, 1487m above sea level (Figure 1).

Discovered more than 102 years ago, Ba Na tourist area is located in the central region of Vietnam with a cool climate all year round, with famous tourist attractions such as: Linh Ung Pagoda, Ba Temple, Linh Chua Linh Tu Temple, Linh Phong Zen Monastery, Thich Ca Buddha Temple, Tru Vu Tea House, Bell Tower, Linh Phong Bao Thap, Mountain Train, Debay Wine Cellar, Ba Na Flower Garden, Fantasy Park, Wax Statue Exhibition Area, French Village, Golden Bridge, Resorts, Mo Stream. In addition, Ba Na tourist area has many festivals held periodically every year to serve tourists, the most typical of which are: Flower Festival (Time: February to March every year); B'estival Beer Festival (Time: May to September every year); Halloween Festival (Time: September to October every year); Winter Festival (Time: November to December every year); Sunshine Carnival (Time: May to September every year).

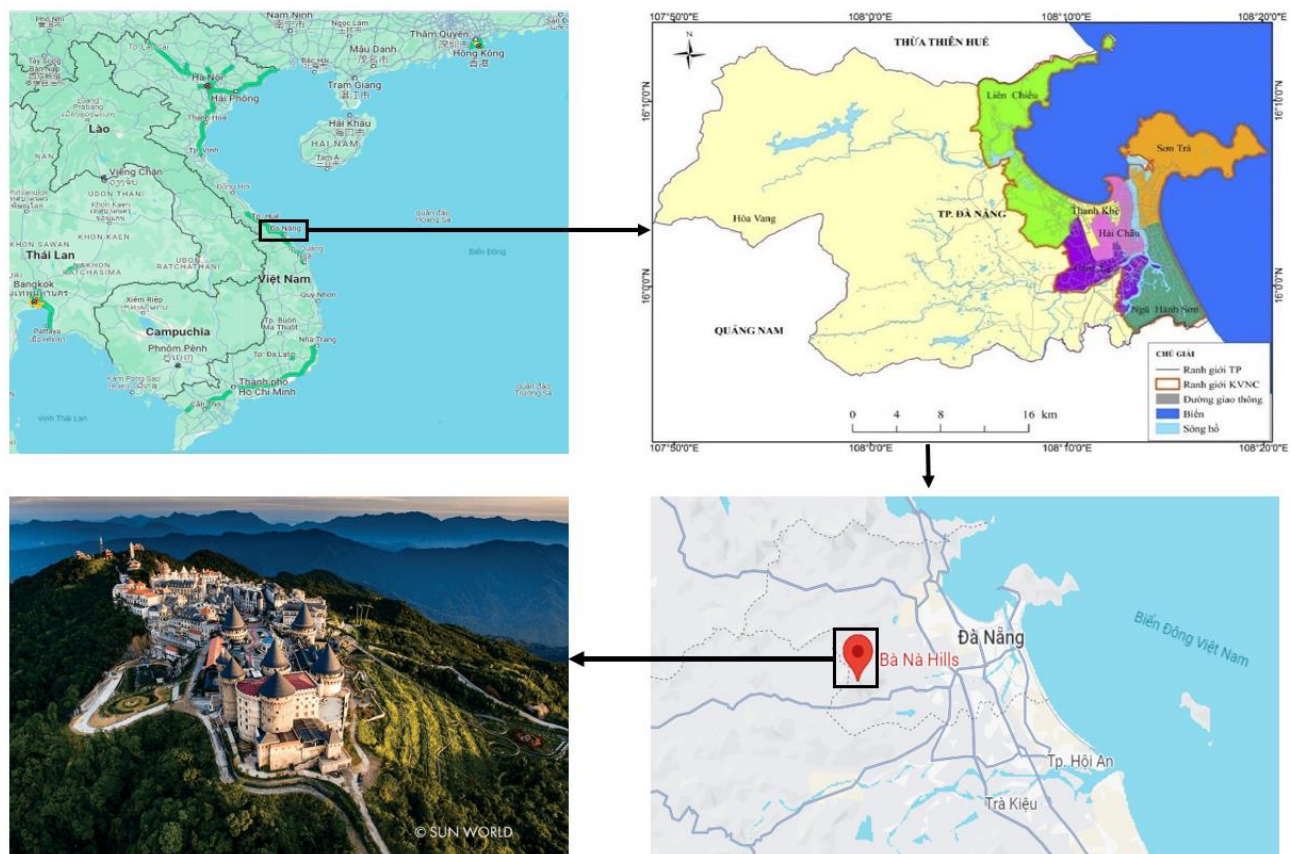


Figure 1. Research area (Ba Na tourist area, Da Nang city, Vietnam)

The number of tourists visiting and relaxing at Ba Na tourist area has increased over the years from 2017 to 2019. In 2017, the tourist area welcomed 2.7 million visitors (out of a total of 6.6 million visitors to Da Nang) and by 2018, it increased to 3.8 million visitors (accounting for about half of the number of visitors to Da Nang). In 2019, the number of visitors to Ba Na was 4.3 million (out of a total of 8.6 million visitors to Da Nang). However, by 2020, due to the impact of the Covid 19 epidemic, the number of visitors to Ba Na has decreased somewhat compared to previous years, so Ba Na tourist area has promotional programs such as ticket discounts for people in the Central Highlands and Central Vietnam, Beer Festival... to attract tourists, but the number of visitors to Ba Na still decreased by 30-50% compared to 2019 (Phuong Thao, 2023).

In 2023, Ba Na tourist area is expected to welcome more than 3.7 million visitors, double that of the same period in 2022 and was awarded the title "Asia's leading theme Park 2023" by the World Travel Awards. Along with the growth rate in the number of visitors, the revenue and profit after tax of Ba Na tourist area has also developed remarkably over the years: In the period 2015-2017, the profit after tax reached 130-188 billion VND. By 2021, it increased dramatically to 923.7 billion VND, then decreased over the years to 419.1 billion in 2022 and 516.8 billion in 2023 (Administration and human resources department, 2024).

Ba Na tourist area is increasingly becoming a resort and sightseeing area for many domestic and international tourists. However, tourism activities have caused great impacts on the environment and landscape. The necessary task is to study the impacts of tourism activities on the landscape, environment, natural resources... here to have an overview of the impacts of tourism to serve the management work and propose some solutions to protect the environment in the tourist area.

RESEARCH METHODS

Application of DPSIR model

a. DPSIR model

The most basic DPSIR model is used to identify, analyze and evaluate cause-effect relationships: causes of environmental problems, their consequences and necessary responses. The structure of the model includes five parts such as presenting the causes (Driving forces) related to economic, social and environmental development leading to pressures (Pressures), thereby, causing the current state (State) of the environment to change. This causes impacts (Impacts) that can elicit responses (Responses) from society to the causes, pressures, status and impacts.

DPSIR (Driving forces, pressures, state, impact, and response model of intervention) is a causal framework used to describe the interactions between society and the environment (Maxim, Laura et al, 2009). It seeks to analyze and assess environmental problems by bringing together various scientific disciplines, environmental managers, and stakeholders, and solve them by incorporating sustainable development. First, the indicators are categorized into "drivers" which put "pressures" in the "state" of the system, which in turn results in certain "impacts" that will lead to various "responses" to maintain or recover the system under consideration (Ness, Barry et al, 2010). It is followed by the organization of available data, and suggestion of procedures to collect missing data for future analysis (Martins, Joana H et al, 2012). Since its formulation in the late 1990s, it has been widely adopted by international organizations for ecosystem-based study in various fields like biodiversity, soil erosion, and groundwater depletion and contamination. In recent times, the framework has been used in combination with other analytical methods and models, to compensate for its shortcomings. It is employed to evaluate environmental changes in ecosystems, identify the social and economic pressures on a system, predict potential challenges and improve management practices (Malmir, Mahsa et al, 2021). The flexibility and general applicability of the framework make it a resilient tool that can be applied in social, economic, and institutional domains as well (Martins, Joana H et al, 2012).

The Driver-Pressure-State-Impact-Response framework was developed by the European Environment Agency (EEA) in 1999. It was built upon several existing environmental reporting frameworks, like the Pressure-State-Response (PSR) framework developed by the Organization for Economic Co-operation and Development in 1993 (OECD, 1993). The PSR framework simplified environmental problems and solutions into variables that stress the cause-effect relationship between human activities that exert pressure on the environment, the state of the environment, and society's response to the condition. Since it focused on anthropocentric pressures and responses, it did not effectively factor natural variability into the pressure category. This led to the development of the expanded Driving Force – State - Response (DSR) framework, by the United Nations

Commission on Sustainable Development (CSD) in 1997. A primary modification was the expansion of the concept of “pressure” to include social, political, economic, demographic, and natural system pressures. However, by replacing “pressure” with “driving force”, the model failed to account for the underlying reasons for the pressure, much like its antecedent. It also did not address the motivations behind responses to changes in the state of the environment. The refined DPSIR model sought to address these shortcomings of its predecessors by addressing root causes of the human activities that impact the environment, by incorporating natural variability as a pressure on the current state and addressing responses to the impact of changes in state on human well-being (Bowen, Robert E et al, 2003). Since its conception, it has evolved into modified frameworks like Driver-Pressure-Chemical State - Ecological State - Response (DPCER) (Rekolainen, Seppo et al, 2003). Driver-Pressure-State-Welfare-Response (DPSWR) (O’Higgins, Tim et al, 2014) and Driver - Pressure - State - Ecosystem- Response (DPSER) (Kelble, Christopher R et al, 2013).

In Vietnam, the DPSIR model is widely used in environmental impact assessments and is a tool for presenting environmental status reports according to regulations of the Ministry of Natural Resources and Environment (Ministry of Resources and Environment, 2020). In this study, the DPSIR model (Figure 2) is used to study the impact of tourism activities on the environment in Ba Na tourist area, Da Nang City, Vietnam, including: a summary description of the driving forces and pressures of tourism development activities on the environment of Ba Na tourist area, a review of the current situation, a description of the impacts and a summary of a number of policies and solutions to minimize risks from the above tourism impacts.

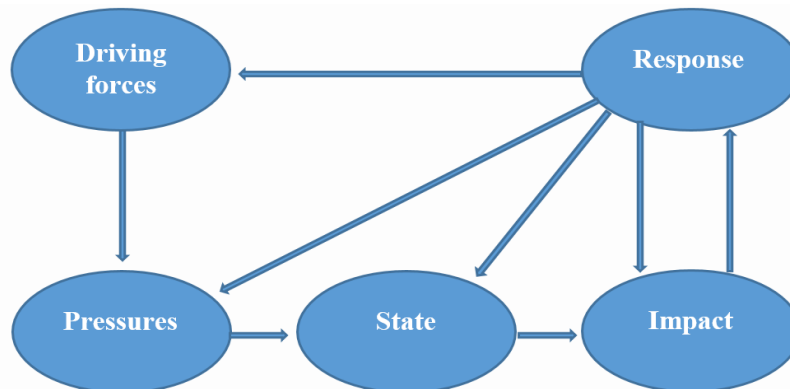


Figure 2: DPSIR composite assessment model diagram

b. Steps to implement the DPSIR model

Step 1: Collect necessary documents including: Natural conditions and tourism development status of Ba Na tourist area; documents and data related to tourism status and environmental protection work at Ba Na tourist area.

Step 2: Conduct field surveys and investigations at Ba Na tourist area according to the prepared questionnaire.

Step 3: Collect primary and secondary data on tourism development status and environmental status.

Step 4: Calculate and process analytical data.

Step 5: Prepare a report assessing the impact of tourism activities on the environmental status at Ba Na tourist area.

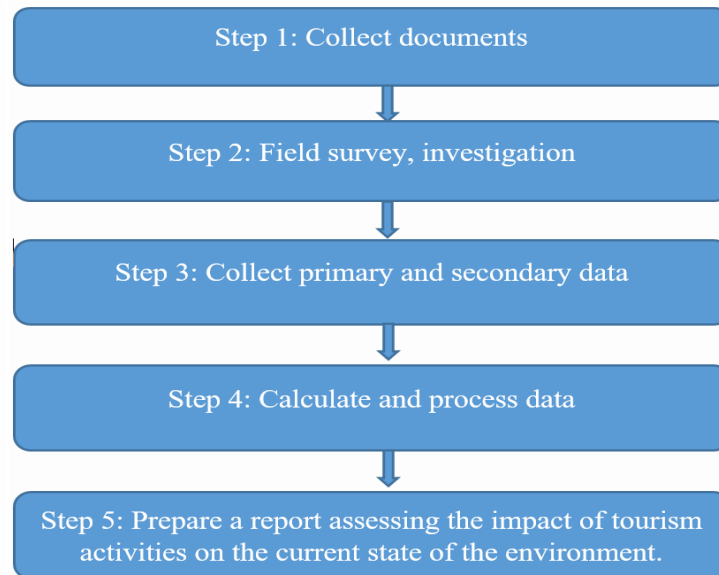


Figure 3. Steps to implement the DPSIR model

Sociological survey method

Collect information, interest, and understanding of tourists and managers about the impact of tourism activities on the environment at Ba Na tourist area through survey forms with the number of samples calculated according to the statistical probability formula: $n = N / (1 + Ne^2)$ In which: N is the total number of tourists in the research area; n is the number of forms; e is the standard error ($e = \pm 0.05$) Through the survey results, the total number of tourists visiting Ba Na tourist area in 2023 is 3.7 million visitors. So the number of survey forms is: $n \approx 400$ survey forms.

Impact matrix method

Using the quantitative matrix method. The levels of impact of tourism activities on the environment are calculated on a scale from 0 to 4, in which the convention is: (1) 0: no negative impacts; (2) 1: little negative impacts; (3) 2: moderate negative impacts; (4) 3: strong negative impacts; (5) 4: very strong negative impacts.

The higher the total score, the stronger the negative impact and will show which activities have the most serious impact on the environment. The total vertical score will show which activities have the most impact on the environment and ecosystem. The total horizontal score shows which environmental factors are most strongly impacted.

Methods of data collection, analysis and processing

Collect, compile and synthesize necessary information from documents, reports, and research works related to the research field; Inherit data on total number of tourists, tourism revenue, statistics on infrastructure, and tourism technical facilities; Analyze data from survey forms, synthesize data, and calculate data using Excel software to produce results.

RESEARCH RESULTS

Pressure from tourism development activities on the environment of Ba Na tourist area

a. Tourists

Tourists are considered one of the important driving forces for the environment and ecosystem of Ba Na tourist area. Tourist activities have created pressure on the response capacity of resources, local pollution and the risk of long-term degradation. On average, a tourist emits about 0.67 kg of solid

waste/day and 100 liters of liquid waste/day. This is one of the sources of environmental pollution from tourist activities.

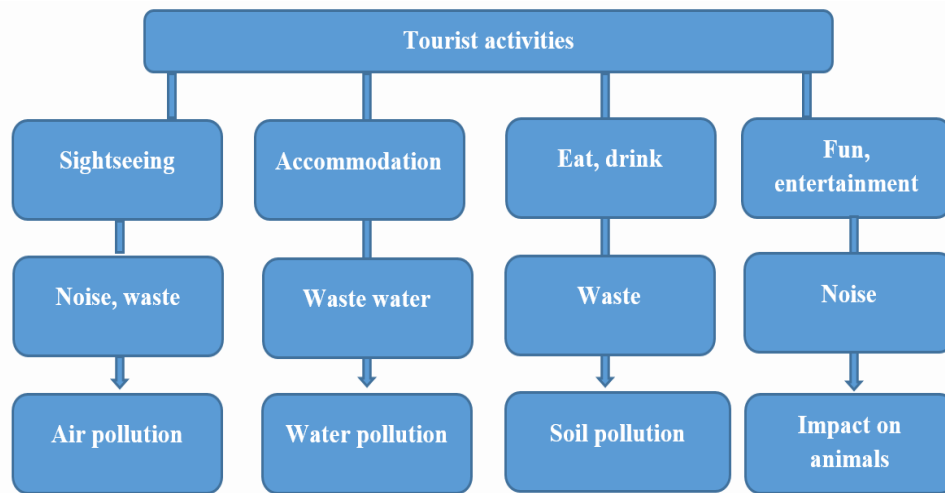


Figure 4. DPSIR chain analysis diagram for tourist motivation

b. Roads, cable cars, mountain trains, parking lots

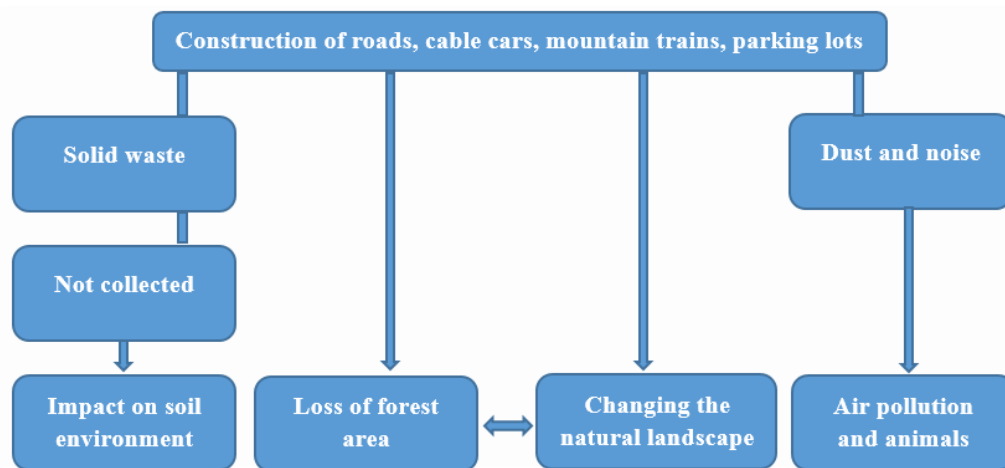


Figure 5. DPSIR chain analysis diagram for Infrastructure construction dynamics (Roads, cable cars, mountain trains, parking lots)

- Traffic system: Ba Na tourist area is located in Hoa Ninh commune, Hoa Vang district, about 25km southwest of Da Nang City center. The entire Ba Na resort complex is located on the top of Chua Mountain, 1487m above sea level. Domestic and international tourists to Da Nang can travel by road, rail, waterway and air (Da Nang is a city with a traffic system connected to the national and international traffic system). From the center of Da Nang city, you can travel to Ba Na tourist area by many means such as bicycle, motorbike, car with gateways distributed from many directions, many different localities creating favorable conditions for means of transport, there are 3 ways (3 main roads) to get to Ba Na tourist area from the center of Da Nang City. When tourists arrive at the foot of Ba Ba mountain, they will park their cars in the parking lot and buy tickets to go to Ba Na tourist area by cable car system.

- Internal traffic routes: The internal traffic system in Ba Na tourist area includes concrete, brick/stone and asphalt roads to ensure safety for tourists when traveling, walking, sightseeing and having fun in the tourist area. In particular, Ba Na tourist area has a modern cable car system to take

tourists to tourist attractions in the tourist area with a total capacity of nearly 10,000 tourists/hour. The Ba Na cable car route has a total of 12 departure and arrival stations, including 6 routes: Suoi Mo - Ba Na, Debay - Morin, Thac Toc Tien - L'Indochine, Hoi An - Marseille, Bordeaux - Louvre, Champa - Taiga Station. In addition, Ba Na tourist area also has a mountain train system (Mountain Train 1: D'amour - Le Jadin; Mountain Train 2: Gieng Than - Hang Rong) to take tourists to visit tourist attractions in the tourist area.

c. Operations of restaurants, hotels, and entertainment facilities

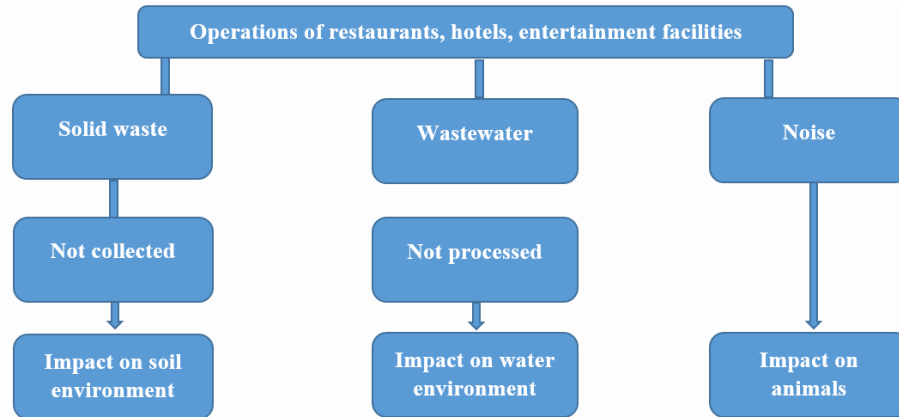


Figure 6. DPSIR chain analysis diagram for the dynamics of the activities of restaurants, hotels, and entertainment facilities

Based on the results of the tourist survey at Ba Na tourist area, the following table summarizes the analysis of factors affecting environmental quality (Table 1):

Table 1: Analysis of driving factors affecting environmental quality based on the survey from tourists at Ba Na tourist area.

No.	Motivational factors	Impact level (%)		
		High	Medium	Low
1	Number of tourists	87.5	11.25	1.25
2	Service activities	79.25	9.25	11.5
3	Infrastructure construction activities (roads, cable cars, mountain trains, parking lots)	89.75	7.5	2.75
4	Technical construction activities (hotels, restaurants, entertainment facilities)	90.5	2.25	7.25
5	Other factors	47.75	36.75	15.5

Survey results show that: Construction of technical facilities (hotels, restaurants, entertainment facilities), construction of infrastructure (roads, cable cars, mountain trains, parking lots) and the number of tourists have the greatest impact on the environment of Ba Na tourist area.

Pressure from tourism development activities on the environment of Ba Na tourist area

a. Pressure from tourists

Tourists coming to visit and relax at Ba Na tourist area in 2023 will reach 3.7 million visitors. On average, Ba Na tourist area welcomes 10,137 visitors per day. In particular, on peak days and

holidays, it welcomes about 65,000 tourists per day. When the number of tourists increases, it will also lead to problems with waste, emissions and noise for the tourist area:

- Waste: Waste is mainly plastic bags, plastic bottles, cans... from food and drinks of tourists when visiting and relaxing at the tourist area or from restaurants, hotels in resorts and tourist attractions. On weekends, holidays and Tet, the number of visitors increases dramatically, causing the cleaning, collection and management work to be overloaded, causing trash bins at tourist attractions to not be enough to contain the trash, which overflows and smells, causing an unsightly appearance.

- Emissions and noise: The means of transportation in Ba Na tourist area (Ba Na foothills area) are mainly personal vehicles such as cars, motorbikes or tourist buses. Especially in February, March and May, June, July, August of the year, the number of visitors is very large because February and March are Tet holidays and May, June, July, August are summer vacations. For the Ba Na mountain top area, there are entertainment activities, business activities of restaurants, hotels... This has a significant impact on air quality and noise in the tourist area.

b. Pressure from road and infrastructure construction

Roads, recreational facilities, land leveling, mountain wall cutting and road opening cause loss of forest area, change the landscape, and disrupt the existing ecosystem. Land leveling and transportation of construction materials change the topography and soil properties, which can easily lead to landslides when there is heavy rain. The density of roads and infrastructure systems will affect the natural ecosystem and animals, in many cases, moving vehicles can kill small animals. The construction of infrastructure and the repair of historical buildings and relics generate a large amount of construction waste, which, if dumped directly into the forest, will affect the soil environment and ecosystem. The movement of vehicles carrying construction materials also changes the soil structure, emitting large amounts of exhaust gas and dust, affecting the air environment.

c. Pressure from the activities of restaurants, hotels, and entertainment areas

Based on the results of the tourist survey at Ba Na tourist area, the author synthesizes the analysis table of factors directly affecting environmental quality as follows (Table 2):

Table 2: Analysis of pressure factors directly affecting environmental quality based on the tourist survey at Ba Na tourist area

No.	Pressure factor		Impact level (%)		
			High	Medium	Low
1	Tourist activities	Sightseeing	75.25	17.25	7.5
		Eating, staying	77.5	11.75	10.75
		Resorting, playing	80.25	16.25	3.5
		Research, studying	3.75	11.5	59.75
		Break branches, pick leaves	11.25	19	69.75
		Camping, climbing	53.75	28.25	18
2	Service activities	Restaurant and hotel activities	94.25	2.75	3
		Entertainment area activities	91.25	5.75	3
		Vehicle parking activities	81.75	3.25	12.5
		Food and souvenir sales activities	10.25	86	3.75

3	Infrastructure Construction	Road construction, parking lots	96.75	2.25	1
		Cable car and mountain train construction	97.5	0.5	2
		Other construction projects	94.75	4	1.25
4	Technical facilities construction	Hotel construction	98.25	1	0.75
		Restaurant construction	97.75	0.5	1.75
		Entertainment facility construction	97.5	1.25	1.25
5	Other activities		28	21.75	50.25

The survey results show that all tourist activities, service activities, infrastructure construction and technical facilities construction have impacts on the environment of Ba Na tourist area. In particular, activities related to infrastructure construction and technical facilities construction have the greatest impacts on the environment.

Current status of tourism services and environmental issues at Ba Na tourist area

a. Current status of tourism services in Ba Na tourist area

Ba Na tourist area consists of two main areas: the area on top of Ba Na and the area at the foot of Ba Na mountain:

The area on top of Ba Na is arranged with the following works: French Village (including 4-star and 5-star hotels on 4 floors); Family entertainment center (including Fantasy entertainment area and Club area); Castle area; Ba Na by night resort; Hotel and entertainment areas for restaurant and hotel services, entertainment services, and accompanying facilities such as conference areas, swimming pools, karaoke services, spas, massages, hot mineral bath treatment areas and health-enhancing services. Tourist apartment blocks, entertainment and multi-purpose performance houses with 3-storey high floors, 2-5-storey underground floors. Slide sports area. Beer garden to introduce beer making and organize beer drinking festivals.

The area at the foot of Ba Na mountain has the following works: Staff accommodation area with 3-storey high floors; High-class apartments and villas for sale and rent; Farm and nursery areas for vacant and ornamental plant care; Station and reception buildings serving cable car services for tourists; Canteen areas, parking lots, parks, private farms; Ba Na hills golf club area includes golf facilities.

- Ba Na tourist area includes 18 famous tourist attractions, including: Linh Ung Pagoda, Ba Temple, Linh Chua Linh Tu Temple, Linh Phong Zen Monastery, Linh Phong Zen Monastery, Thich Ca Buddha Temple, Tru Vu Tea House, Bell Tower, Linh Phong Bao Thap, Mountain Train, Debay Wine Cellar, Ba Na Flower Garden, Fantasy Park, Wax Statue Exhibition Area, French Village, Golden Bridge, Resorts, Mo Stream. In addition, Ba Na tourist area has 20 souvenir shops, 14 restaurants, 4-5 star hotels serving customers with shopping, dining and resting services.



Figure 7. Tourist route map of Ba Na tourist area

b. Current status of environmental issues at Ba Na tourist area

- Solid waste issue: Maintaining a green - clean - beautiful environment has long been an inevitable trend in the world, and is gradually becoming a common trend that tourist areas aim for. In particular, in order to preserve the beauty of the precious primeval forest at the top of Ba Na mountain, from October 1, 2018, Ba Na tourist area has applied the regulation "No food or drink allowed on Ba Na". This is also a good sign for tourism in Da Nang city, creating a good impression on tourists, especially international visitors.

Previously, Ba Na tourist area opened its doors to welcome millions of visitors each year. Visitors were allowed to bring food and drinks to use as long as they ensured cleanliness and maintained general hygiene. However, according to the assessment, the amount of waste is increasing, and waste treatment measures are not bringing maximum efficiency. Therefore, after applying this regulation, Ba Na tourist area has significantly reduced the amount of waste from tourists' eating and drinking.

Ba Na tourist area has plans to ensure environmental sanitation in the tourist area, has a system of collecting individual waste and on average every 20-30m there is at least 01 trash can with a lid along the internal traffic route so that tourists can easily dispose of waste in the right place. Waste is concentrated in an area for vehicles to transport waste to the local waste treatment facility with a

frequency of 1 time/day. In particular, the staff of the tourist area do not hesitate to bend down to pick up a piece of paper or cigarette butt on the path, even though they are not "janitors".

Regarding solid waste management: Solid waste of Ba Na tourist area mainly comes from sources such as tourism service areas, from construction works (from construction workers, machinery and equipment) and from other sources. All solid waste is brought to the collection points and collected by the city's Environmental Sanitation management units and transported to the Khanh Son solid waste treatment complex for treatment.

Table 3: Analysis of the current status of solid waste based on the tourist survey at Ba Na tourist area

No.	Solid Waste	Level (%)		
		Reasonable	Less Reasonable	Unreasonable
1	Number of bins	90.5	4.25	5.25
2	Location of bins	15.25	7	77.75
3	Solid waste classification	17.25	28.75	54
4	Solid waste collection and transportation solid	86	10.75	3.25
5	Waste treatment	91.25	6	2.75

The survey results show that: the majority of tourists believe that: the location of trash bins and the classification of solid waste are not reasonable. According to tourists, trash bins should be placed in more convenient and suitable locations, trash bins should be divided into compartments for classification immediately after use to make it more convenient for collecting, transporting and processing solid waste.

- Emissions and noise issues: Ba Na tourist area is a tourist area with fresh air, not polluted because the tourist area has few residents, the impact of traffic activities of people is insignificant. In addition, the tourist area is not affected by industrial and handicraft production facilities. The tourist area has Mo Stream flowing through it, as well as surface water sources (lakes, ponds, rivers, streams, fountains ...) that have not been polluted. Waste is collected according to regulations, not thrown indiscriminately along internal traffic routes, at tourist attractions and at surface water sources (lakes, ponds, rivers, streams, fountains). Equipment in the tourist area such as lighting, signs, monuments, miniatures ... are cleaned and sanitized. Areas selling products, souvenirs, and cuisine in Ba Na tourist area ensure general environmental hygiene throughout the tourist area. The construction areas are carefully covered to ensure the safety of tourists and staff in the resort. However, on days when there are many tourists and vehicles, especially at the foot of Ba Na mountain, the problem of exhaust fumes and noise is inevitable. However, through environmental analysis, it shows that the air environment, noise and surface water of Ba Na tourist area are still within the permitted standards.

- Wastewater problem: Ba Na foothill area: Currently, there is wastewater generated from service - tourism works. Wastewater from the works is collected by a separate system and led to centralized wastewater treatment stations for treatment. In the area, there are 02 wastewater treatment stations with treatment capacities of 940 m³/day and 141 m³/day and the current treatment capacity is about 50%.

Ba Na top area: Currently, there is wastewater generated from service - tourism trade works. Wastewater from the works is collected by a separate system and led to centralized wastewater treatment stations for treatment. In the area, there are 02 wastewater treatment stations with

treatment capacities of 1,200 m³/day and 2,700 m³/day and the current treatment capacity is about 50%. According to the actual investigation results, no negative impacts of wastewater on the environment and biodiversity have been detected.

Table 4: Statistical analysis of the current status of environmental quality based on the tourist survey form at Ba Na tourist area

No.	Environmental factors		Environmental quality (%)		
			Good	Average	Low
1	Air environment	Smell	89.5	6.5	4
		Noise	42.25	41.25	16.5
		Dust	79.25	15.75	5
2	Soil environment	Forest land (in conservation areas)	77.75	11.5	10.75
		Residential land in restaurant, hotel, entertainment areas	43.5	34.25	22.25
		Residential land in parking area	34	44.5	21.5
3	Water environment	Surface water (rivers, streams, ponds, lakes)	88.5	9.5	2
		Wastewater from restaurants, hotels, entertainment areas, tourist attractions	22.5	31.25	46.25
4	Overall environment		80.25	11.75	8

Survey results show overall environmental quality at Ba Na Tourist Area is at a good level.

Impact of tourism development activities on the environment in Ba Na tourist area

a. Positive impacts from tourism activities on the environment in Ba Na tourist area

Nature conservation: Contributing to affirming the value of Ba Na - Nui Chua nature reserve. Tourism development in Ba Na tourist area helps spread the image of Ba Na - Nui Chua nature reserve, the cultural identities of indigenous people (Co Tu people), bringing great benefits in culture, history and environmental education for generations.

Improving environmental quality: Tourism can provide initiatives for cleaning the environment through controlling the quality of air, water, soil, noise pollution, waste disposal and other environmental issues through landscape planning programs, construction design and maintenance of architectural works in tourist areas. And thanks to tourism activities, the roads, drainage systems, waste treatment, and communications of the area have been significantly improved.

Preserving forest areas and natural biological resources of Ba Na - Nui Chua nature reserve.

Making the most of the advantages of natural resources, Ba Na - Nui Chua nature reserve to develop tourism to create economic value, promote socio-economic development of Da Nang City.

Enhancing the understanding of the environment of the local community through promoting the cultural and natural values of Ba Na tourist area, making the local community proud of their heritage and associated with the protection of those tourism heritages.

Promoting the environment: The development of Ba Na tourist area is well designed, promoting the value of the environmental landscapes of Ba Na - Nui Chua nature reserve.

Local infrastructure such as airports, roads, water supply and drainage systems, waste treatment, and communications in Da Nang City are improved through tourism activities.

Enhance environmental awareness of local communities through exchanges and learning with tourists visiting and relaxing at Ba Na tourist area.

b. Negative impacts of tourism activities on the environment in Ba Na tourist area

Tourism development in Ba Na tourist area is at risk of causing negative impacts such as:

Impact on water demand and quality: Tourism is an industry that consumes a lot of water, even consuming more domestic water than the local domestic water demand.

Wastewater: If there is no wastewater collection system for hotels and restaurants, wastewater will seep into underground water tanks or neighboring water bodies, spreading many types of diseases such as worms, intestinal diseases, skin diseases, eye diseases or polluting water bodies, causing harm to the landscape and aquaculture.

Waste: Littering is a common problem in all tourist areas. This is the cause of loss of landscape, unsanitary conditions, affecting public health and causing social conflicts.

Air pollution: Although considered a "smokeless industry", tourism can cause air pollution through exhaust emissions from motorbikes and cars, especially in key areas and main traffic axes, causing damage to trees, wildlife and limestone and concrete constructions.

Energy: Energy consumption in tourist areas is often inefficient and wasteful.

Noise pollution: Noise from vehicles and tourists can cause inconvenience to local residents and other visitors, including wildlife.

Landscape pollution: Landscape pollution can be caused by hotels and restaurants with ugly and rough architecture, inappropriate tiling materials, unscientific service arrangements, excessive use of advertising media, especially ugly media, widespread electric wires and poles, and poor maintenance of construction works and landscapes. The development of chaotic, mixed and haphazard tourism is one of the worst environmental degradation activities.

Ecological disturbance: Uncontrolled tourism development can impact the land (erosion, landslides), change habitats, threaten wild animals and plants (noise, hunting, supply of wild meat, stuffed animals, insects...). Construction of roads and campsites hinders the movement of wild animals to find prey, mate or reproduce...

Based on tourism development activities in Ba Na tourist area, an impact matrix table was built to assess the negative impacts of tourism activities on the environment and ecosystem according to the following scale (Table 5): (1) 0: no negative impacts; (2) 1: little negative impacts; (3) 2: moderate negative impacts; (4) 3: strong negative impacts; (5) 4: very strong negative impacts.

Table 5: Impact matrix of tourism activities in Ba Na tourist area affecting the environment and ecosystem

No.	Main activities	Major environmental issues							
		Waste	Noise	Soil environment	Environment water	Air environment	Animals	Plants	Total negative impacts
1	Tourist reception activities	0	3	0	0	1	0	0	4

2	Shipping activities	0	3	0	0	4	2	1	10
3	Sightseeing activities	2	2	0	0	0	1	1	6
4	Dining activities	4	4	1	2	1	1	1	14
5	Accommodation activities	3	1	1	2	1	1	1	10
6	Infrastructure construction (roads, cable cars, mountain trains, parking lots)	4	4	2	2	4	4	4	24
7	Construction of hotels, restaurants, entertainment facilities, tourist attractions	4	3	4	3	3	4	4	25
Total negative impact		17	20	8	9	14	13	12	

From Table 5, it can be seen that tourism activities in Ba Na tourist area have the most negative impacts on the environment and ecosystem, including the following activities: construction of hotels, restaurants, entertainment facilities, tourist attractions; construction of infrastructure (roads, cable cars, mountain trains); dining activities and accommodation activities of tourists. The most affected objects/environments include Noise, waste, air environment and animals.

Solutions for tourism development associated with environmental protection in Ba Na tourist area

- Responding to motivation: Disseminate regulations to tourists before visiting the tourist area; provide tourists with a map of the sightseeing route when buying tickets to get on the cable car; note and warn when getting on and off the cable car is dangerous; strengthen management and control of tourist activities in the tourist area during the visit and vacation; Create maximum conditions for resorts, restaurants and hotels to operate, and strictly comply with forest protection principles, strengthen inspection and supervision. If any illegal littering and wastewater discharge is detected, a record of fines must be drawn up.

- Responding to pressure: Arrange appropriate trash bins at walking routes, entertainment areas and tourist attractions in the tourist area. Administrative sanctions for littering, breaking branches, cutting trees, and setting fires; Invest in and upgrade the wastewater treatment system in the entire tourist area; Arrange a complete fire prevention and fighting system and equipment in the office area,

restaurant, hotel, tourist attractions, reception areas, entertainment areas to handle promptly in case of fire, not allowing the fire to spread.

- Respond to the current situation: Add trash bins divided into compartments or trash bins next to each other divided into compartments for organic waste, recyclable waste and non-recyclable waste; Regulations and slogans on environmental protection need to be added in areas where tourists pass by and require tourists to strictly comply; Increase the frequency of garbage collection and transportation; Integrate environmental education into activities and services to raise awareness and responsibility of tourists when visiting the tourist area; Build a team of tour guides with sufficient quantity and expertise to explain to tourists at tourist attractions.

- Responding to the impact: Group of solutions to the Board of Directors of Ba Na tourist area: The Board of Directors needs to do a better job of managing, preserving, protecting, conserving and promoting existing cultural values, cultural - tourism works, and auxiliary works; combating negative acts that damage the Ba Na - Nui Chua conservation area. Coordinate with relevant functional departments of Da Nang City in protecting the integrity of the Ba Na - Nui Chua conservation area, controlling deforestation and forest burning; Organize specialized training courses on tourism service management, cultural services, legal regulations on forest environment management in general, forest environment; Closely coordinate with people in the buffer zone and businesses in forest protection; Prioritize the development of projects with little negative impact on the environment, research and application of science and technology, use of alternative energy; save energy and water; Strengthening the guidance, supervision and inspection of tourism activities for business establishments, garbage and wastewater discharge points of restaurants and hotels to promptly detect sources of negative impacts on the environment; Strictly handling violations of the law on forest protection and management, forest product management and violations in the field of forest environmental protection; Solutions for tourism destination management: Well managing business activities, selling at the listed price, with the right quality of products as committed, avoiding overcharging in tourist areas. Paying more attention to security, order and safety for tourists; regularly propagating and signing commitments with business households in tourist areas to ensure a cultural and civilized trading environment; regularly beautifying the landscape and environment, especially promoting the construction and completion of construction items to soon put them into use to better meet the needs of tourists; Organize the space of the tourist area in harmony with the characteristic elements of the natural landscape, in harmony with the terrain conditions in the area, limit changes in the natural terrain and architectural forms that are contrary to nature. Encourage development in association with trees, reasonably exploit the natural landscape to create aesthetic value, connect amenities, improve the efficiency of space use and protect the environment of the tourist area.

Group of solutions to the local community: Develop and organize environmental education programs for people living near Ba Na - Nui Chua conservation area (Co Tu people), schools in Da Nang City to improve understanding of forests, love of nature, forest protection laws; Orient people living around the tourist area in occupations such as business, hiring people to work in the tourist area.

Group of solutions to units using Ba Na - Nui Chua nature reserve: All investment projects must prepare an environmental impact assessment report or environmental protection plan before construction, assess the environmental impact of the project during construction and when the project comes into operation; Environmental impact assessment is integrated with climate change response scenarios, providing environmental solutions, policy mechanisms, resources, to minimize damage in case of natural disasters or major environmental changes occurring during the development and implementation of tourism activities; All projects must comply with policies and laws on forest environmental protection and have a separate environmental protection plan when the project is in operation; Use environmentally friendly materials, increase recycling and reuse, save

energy and water; Business units need to coordinate with the Board of Directors and local people in protecting heritage, environment and ecosystems, and contribute ideas for sustainable tourism development.

Group of solutions for tourists: Arrange a certain number of tour guides to explain and serve tourists at the tourist attractions of Ba Na tourist area. Implement support services for deaf tourists. At the same time, build an information room equipped with computers connected to the internet for tourists to search for information about the tourist area. Train and arrange staff in the tour guide and customer care department who are good at foreign languages, especially Chinese and Korean to meet the requirements of serving foreign tourists, especially tourists from these two countries; Raise tourists' awareness of environmental protection and the importance of developing tourism associated with environmental protection; Increase the level of tourists' contributions to have funds for environmental protection, conservation of natural resources and cultural and historical values.

Group of solutions to preserve and develop cultural tourism: Develop a plan to preserve and support the Co Tu ethnic group in their livelihoods; Cooperate with local authorities in preserving and maintaining the traditional culture of the Co Tu ethnic group living around Ba Na tourist area, creating a tourist attraction for traditional culture.

CONCLUSION AND RECOMMENDATIONS

Based on the results of a survey of 400 votes for 400 visitors to Ba Na tourist area, the study identified the pressures on the environment of Ba Na tourist area as: solid waste, emissions and noise. The positive impacts of tourism activities on the environment of Ba Na tourist area include Tourism development contributes to affirming the value and preserving the nature of Ba Na - Nui Chua reserve; preserving forest areas, cultural and historical values of the Co Tu ethnic group; developing infrastructure systems, creating economic value to improve people's lives and having great value in environmental education. In addition, tourism activities in Ba Na tourist area also cause some negative impacts on the environment including direct impact on the environment of land, water, air, organisms and ecosystems. The study has proposed a number of solutions to develop tourism in Ba Na tourist area in a sustainable direction, responding to the factors of Driving forces (D), Pressures (P), State (S), Impacts (I). On that basis, the proposed framework for assessing environmental impacts from tourism activities is given in Table 6 below (Hoang Dao Cam, 2022):

Table 6: Proposed framework for assessing the environmental impact of tourism activities

No.	Impacts of tourism activities on the environment		Environmental issues of concern	Severity	Measures to eliminate/minimize impacts
1	Waste pressure	<ul style="list-style-type: none"> - From tourist service establishments - On eco-tourism routes 	Collection of solid waste and wastewater	High	<ul style="list-style-type: none"> - Have a system for collecting, transporting/treating waste - Arrange trash cans, toilets, raise awareness
2	Water Resources	Water resource use	Overexploitation of water resources	Low	Use water from Suoi Mo and other streams
3	Land resources	Land resource use	Use of land in nature reserves.	High	Do not arrange functional areas in nature reserves.

4	Landscape	<ul style="list-style-type: none"> - Natural landscape - Building design 	<ul style="list-style-type: none"> - Location of tourist facilities - Architectural design 	High	<ul style="list-style-type: none"> - Low density, low floor buildings - Design suitable for natural landscape
		Construction materials	Use of construction materials	Average	
5	Natural terrain	Construction activities	<ul style="list-style-type: none"> - Natural terrain changes - Landslides 	High	<ul style="list-style-type: none"> - Arrange the works in suitable locations - Environmentally friendly construction solutions
6	Air environment, noise, vibration	<ul style="list-style-type: none"> - In the construction of service facilities - Motor transport - In tourist activities 	<ul style="list-style-type: none"> - Vibration, noise during construction - Dust pollution - Motor vehicles - Noise from tourists 	High	<ul style="list-style-type: none"> - Construction of small-scale projects - Appropriate construction solutions - Dust prevention measures during construction - Use of new equipment or electrical equipment during construction - Reasonable traffic organization - Regulations and awareness of tourists
7	Use of energy and natural resources	Electricity – Water	Overuse of natural resources	High	<ul style="list-style-type: none"> - Increased use of renewable energy - Energy and water efficient design - Employee and visitor awareness
8	Biological environment	<ul style="list-style-type: none"> - Waste - Accommodation arrangements - Sightseeing activities in nature reserves. 	<ul style="list-style-type: none"> - Waste affects the natural environment - Accommodation affects nature reserves. - Visitor activities affect vegetation and wildlife habitats 	High	<ul style="list-style-type: none"> - Arrange appropriate waste collection points. - Do not exploit local specialties and souvenirs if there is no sustainable solution for input materials. - Accommodation areas are arranged in accordance with nature reserves, low construction density

		Souvenirs, local specialties	Exhaustion of some local products	Average	<ul style="list-style-type: none"> - Apply measures to control the number of tourists in nature reserves. - Have regulations on the behavior of tourists and staff - Have tools and activities to monitor and assess environmental impacts.
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In addition, it is necessary to regularly check and evaluate environmental impacts in order to adjust the scale and nature of tourism activities of Ba Na tourist area appropriately according to time and space.

REFERENCES

Administration and human resources department (2024), "Report on revenue and number of tourists over the years", Ba Na cable car service joint stock company, Da Nang, Vietnam.

Hoang Dao Cam (2022), "Impacts of tourism activities on the environment and orientation for sustainable tourism development in Son Tra Peninsula, Da Nang", Institute for Tourism Development Research, Hanoi, Vietnam.

Kelble, Christopher R et al, (2013), "The EBM-DPSER Conceptual Model: Integrating Ecosystem Services into the DPSIR Framework". *PLOS ONE*. 8 (8).

Malmir, Mahsa et al, (2021). "A new combined framework for sustainable development using the DPSIR approach and numerical modeling". *Geoscience Frontiers*. 12 (4).

Martins, Joana H et al, (2012). "A review of the application of driving forces – Pressure – State – Impact – Response framework to fisheries management". *Ocean & Coastal Management*. 69: 273–281.

Maxim, Laura et al, (2009). "An analysis of risks for biodiversity under the DPSIR framework". *Ecological Economics*. 69 (1): 12–23.

Ministry of Natural Resources and Environment (2020), National state of the environment report 2019, Hanoi, Vietnam.

Ness, Barry et al, (2010). "Structuring problems in sustainability science: The multi-level DPSIR framework". *Geoforum*. 41 (3): 479–488.

OECD (1993), OECD core set of indicators for environmental performance reviews, OECD Environmental Directorate Monographs No.83.

O'Higgins, Tim et al, (2014), "Achieving good environmental status in the Black Sea: scale mismatches in environmental management". *Ecology and Society*. 19 (3).

Prime Minister (2012), Decision No. 1216/QĐ-TTg of the Prime Minister: Approving the National Environmental Protection Strategy to 2020, with a vision to 2030, Hanoi, Vietnam.

Rekolainen, Seppo et al, (2003). "A conceptual framework for identifying the need and role of models in the implementation of the water framework directive". *International Journal of River Basin Management*. 1 (4): 347–352.

Phuong Thao (2023), "Internship report on business activities of Ba Na cable car service joint stock company", Da Nang, Vietnam.

