



# Countermeasure Study on Sustainable Utilization of Tourism Resources and Tourism Environmental Pollution in Coastal Areas of the Pearl River Delta, China

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## ABSTRACT

The coastal area of Pearl River Delta in China is the most active core zone with great potential in the development pattern of China's tourism economy. However, the development of tourism in this area has caused serious pollution to the ecological environment. As a consequence, several problems, such as sea-land pollution and ecosystem imbalance, occur and affect the sustainable development of tourism. In this paper, the land, water body, biotic environment, and air pollution in the area were analysed to understand the pollution in this region and to analyse the sustainable development of tourism resources. The mechanism of the interaction between external environments (nature, economy, society) and internal environments (subjects and objects of tourism) was also investigated on the basis of the environmental carrying capacity. Results showed that tourism caused pollution at different levels. With economic growth and increased awareness on environmental protection, the amount of pollution has been reduced. The natural subsystem in external environments is more likely to be polluted, but the subsystems of economy and society can help alleviate environmental pollution. The subject of tourism in internal environments is the major cause of pollution, but the incompetence of tourism objects can affect pollution control. This study focuses on the control over environmental pollution caused by tourism in the coastal area of the Pearl River Delta. This work is of great significance for the coordinated and sustainable development of tourism and the environment.

## INTRODUCTION

With the scale effect and momentum of development in economic and social development, the industrial status of tourism in the global economy has increased. After more than 40 years since the reform and opening-up of China, the country's tourism has promoted the economy and become a leading or competitive industry that supports economic development. This area is characterized by vast land, large and dense population, developed economy, good location, broad sea coverage, and rich tourism resources, which contribute to tourism development. Given its particularly important role in national economic development, tourism in the coastal area has been the main factor influencing the tourism development pattern in China. Over the past few years, various tourism resources and tourism enterprises have become stable in this area. Thus, tourism revenue increases annually. However, tourism is easily affected by natural and man-made interferences because of the complicated and vulnerable tourism environment (Fig. 1). With further tourism development, the tourism investment in this area has increased. Several attractions, hotels, and holiday villages have been established. Consequently, the expansion of tourism industry has accelerated. This approach has improved the tourism capacity and helped promote the attractiveness of this area. However, the

disordered development of tourism real estate and the vicious competition among developers have caused various problems, such as excess running and excessive pollutant discharge, especially in tourist season. Natural disasters, such as floods, typhoon, storm surges, and red tide, with unexpected risks, including economic crisis and traffic accidents, are also severe problems. Several problems exist in the sustainable utilization of tourism resources, resource integration, industrial restructuring, and industrial space distribution, which have damaged the tourism resource system and ecosystem. As a consequence, other problems, including overload of tourism environment, imbalanced development of tourism economy, disorder in tourism market, unreasonable structure of tourism, evident negative effect of tourism, imbalance in ocean ecosystem, weak self-purification capacity of ecological environment, and weakening ability of resources to support tourism development. The area also experiences great stress and several challenges from the ecological environment and natural resources. Thus, the growth of overall competitiveness of tourism in this area is limited.

## EARLIER STUDIES

Significant achievements have been observed in studies on tourism environmental pollution and sustainable utilization of tourism resources locally and abroad. Studies have fo-

cused on carbon emissions from specific pollution types, including tourist communication, lodging, and other activities, and the sustainable utilization of resources based on environmental carrying capacity (ECC). In terms of environmental pollution, Tabatchnaia evaluated the energy needs of tourists, analysed the relationship among the energy utilization, environmental pollution, travel purpose with the “investment-production” method (Tabatchnaia et al. 1997). Kuo performed a quantitative analysis on the energy consumption and discharges of greenhouse gases, wastewater, and solid waste in tourism via life cycle assessment (LCA); the energy consumption and these discharges have exceeded the daily use (Kuo et al. 2009). An energy utilization model was set up by Kelly to measure the energy consumption and discharge in tourism destinations; carbon dioxide emissions mainly come from the tourist area, the traffic emission from tourist travel from their places of origin to their destination, and the traffic emission from commuters in the scenic spots (Kelly et al. 2007). After a systemic research on the traffic system in New Zealand, Becken found that the energy consumption in transnational tourism was as much as four times that of domestic tourism (Becken et al. 2003). Peeters analysed the traffic system in Europe and proposed that carbon emissions in tourism can be greatly reduced by reducing transcontinental tourism and air tours (Peeters et al. 2007). After measuring the traffic carbon emission from five parks in Taiwan, Lin proposed that the government should lead tourists to choose short-distance travel and public transportation via control measures, such as price (Lin 2010). The following studies were also conducted on the sustainable utilization of tourism resources. Tosun noted that tourism planning and policies are key factors that influence the sustainable development at the national macro level (Tosun 1998). Collins

believes that policies are still required to achieve sustainable tourism because the self-regulation of the market is limited (Collins 1999). Budeanu discussed the responsibility of tourism operators from the perspective of tourism enterprise operation and proposed the influence and significance of sustainable tourism (Budeanu 2005). Some measures for transforming traditional tourism into sustainable tourism were proposed by Bianchi (Bianchi 2004). Knowd (2006) studied sustainable tourism in the countryside and discussed the relationship among tourism, the community, and economic development (Knowd 2006). A series of dynamic models to describe tourist activities in a tourism economy and environment was proposed by Johnston, who introduced the concept of environmental capacity and believes that the influence of ECC on sustainable tourism must be taken into consideration (Johnston et al. 2005). The development situation of sustainable tourism was evaluated by Hunter based on the ecological footprint as an important environmental index (Hunter et al. 2007). Fennell analysed the concept of ecotourism and discussed the mutual relation between tourism and environmental protection (Fennell et al. 2005). Weaver distinguished ecotourism in the narrow and broad sense; he noted that sustainable development is needed to launch ecotourism worldwide (Weaver 2005). Most studies on the environmental pollution caused by tourism have shown that the rapid development of tourism and various problems closely after development have a negative effect on the ecological environment, thereby causing the lack of long-term driving force for tourism. This issue can be solved by some counter-measures. The literature shows that studies on sustainable tourism cover a wide range of subjects and focus on the concept, content, objectives, and developing principles of sustainable tourism. Several achievements have been made. The highly-developed

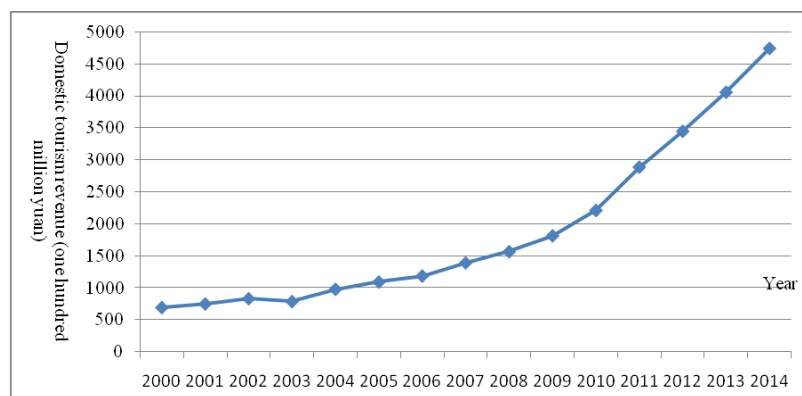


Fig. 1: Tourism income in the coastal area in oearl riverdelta (2000-2014).  
(Data are from China Tourism Statistics Yearbook (2001-2015).)

economy and the abundant good marine tourism resources distributing along the coastal line in the coastal area in Pearl River Delta make it a hot tourist destination in China. However, consequent problems, such as pollution and sustainable utilization of tourism resources, have become crucial for tourism development in this area. Studies that propose the direction and counter-measures for sustainable development of tourism in the area are of great value in theory and practice.

### ANALYSIS OF POLLUTION CAUSED BY TOURISM IN COASTAL AREAS OF THE PEARL RIVER DELTA

**Influence of tourism on land pollution:** Tourism facilities, such as hotels, restaurants, tourist resorts, tourist attractions, tourism shopping areas, and public places of entertainment, as well as public infrastructure, including airports, docks, ports, stations, parking lots, roads, and toilets, are the material carriers of the normal development of tourism. These constructions require land resources, which can also be excavated and used for other infrastructure. Given the rapid development of tourism in the coastal area of Pearl River Delta in recent years, more and more tourism projects, such as coastal holiday areas, coastal parks, marinas, golf courses, and coastal avenues, have been developed. Driven by profits, the developers continue to occupy forests, cultivated land, and coastal land for construction, thereby directly affecting the sea-land circulation system and blocking the natural movement of sea sands, which likely cause the corrosion of the coastline. Specifically, some scenic spots along the coast have become marine ecology landscape regions, thereby leaving the coastline seriously corroded. With the non-stop extension of tourism into the sea, the investment on developing maritime tourism has increased. More coastal lands have been occupied, which has introduced greater harm to land

resources along the coast. In addition, the constant growth in the number of tourists in this area (Fig. 1) leaves a large amount of rubbish because of poor awareness of environmental protection, thereby causing serious white pollution and damage to land resources.

**Influence of tourism on water body pollution:** As important vehicles of maritime tourism, boats and yachts discharge pollutants, such as rubbish, exhaust gas, wastewater, solid waste, and toxic chemical pollutants, including petroleum and fertilizers, during accidents. All these materials have a negative effect on the water body resource. Industrial sewage from restaurants, hotels, and holiday areas, and domestic sewage from tourists flow into the ocean without disposal, thereby leading to eutrophication and organic pollution, threatening the balance of the marine ecosystem, promoting the occurrence of coastal red tide, enteromorphs, and other ocean disasters, and lowering the value of the water landscape. More tourist activities are being developed; thus, water sports and amusement also exert a negative influence on water environment. The water areas with water golf, fishing, and boating are much more seriously polluted.

**Influence of tourism on biotic environmental pollution:** To taste of seafood and purchase special seafood are common objectives among tourists; thus, these products are indispensable for tourists in coastal destination. Willful exploitation, overfishing, and illegal transactions of some developers in pursuit of personal benefits have seriously damaged aquatic resources; as a consequence, the coastal ecological environment experiences an imbalance. In the area where tourism is developed, the development activities have destroyed the ecosystem of mangrove forests and estuaries. Petroleum and other hydrocarbons used in yachts can produce several pollutants, which are also unfavourable for ani-

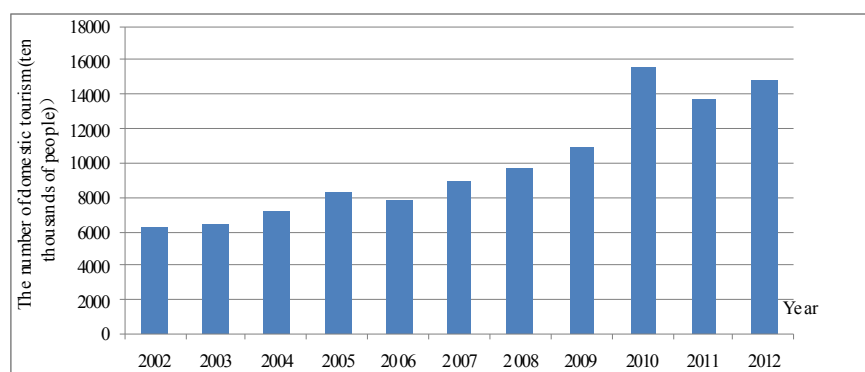


Fig. 2. Number of tourists in the coastal area of pearl river delta (2002-2012)  
(Data are from the Guangdong Statistics Yearbook (2003-2013).)

mal and plants. Tourist activities, such as leisure fishing and agriculture, island tourism, diving, and camping require unique biological resources and tourism landscapes. However, the over-development of the area by operators, poor awareness of environmental protection, vandalism, destruction of vegetation, overfishing, and over-killing of living creatures also cause the loss of living resources.

**Influence of tourism on air pollution:** Tourism activities consume energy and produce harmful gases, which cause air pollution. Chimneys, furnaces, and hearths in the tourist hotel industry and catering services for heating, water, and the energy supply, combined with activities, such as open-air barbecues and soirees, can produce sulphur dioxide, carbon monoxide, carbon dioxide, and smoke. In addition, the battery carts, sightseeing buses and steamers, buses, ships, trains, and planes taking tourists to their destinations discharge a large amount of carbon dioxide, thereby worsening the air quality of tourist destinations. If not properly handled, organic matter in solid wastes from scenic spots, restaurants, shopping centres, and entertainment venues likely attracts viruses and bacteria. The tourism in the coastal area of the Pearl River Delta gathers numerous people, materials, and trade. Transport facilities, such as boats, yachts, and buses, accommodation services, such as hotels, and tourist activities, such as barbecues and camping, can produce harmful gases that lead to air pollution. The mishandling or insufficient control of rubbish and wastewater can also produce harmful gases and worsen environmental pollution in this area.

### ANALYSIS OF THE SUSTAINABILITY OF TOURISM RESOURCES BASED ON ECC

The rapid development of tourism in the area has several problems, including the predatory development of tourism resources, eco-environmental pollution, and the disordered planning and management in scenic spots, which threaten the sustainable development of tourism. Therefore, a model for the sustainable development of tourism resources has been proposed.

Most of the domestic and foreign analyses on the sustainability of tourism resources use the ECC of tourism as an important indicator. The ECC of tourism refers to the highest threshold value of the tourism scale within a certain period and under certain conditions, where no unacceptable negative influence will be exerted on the environment, society, culture, economy, and tourist impressions in the said tourism destination. The ECC is an important standard for measuring the sustainable development of tourism resources.

#### Analysis on the External Environment

The ECC of tourism in the coastal area of Pearl River Delta

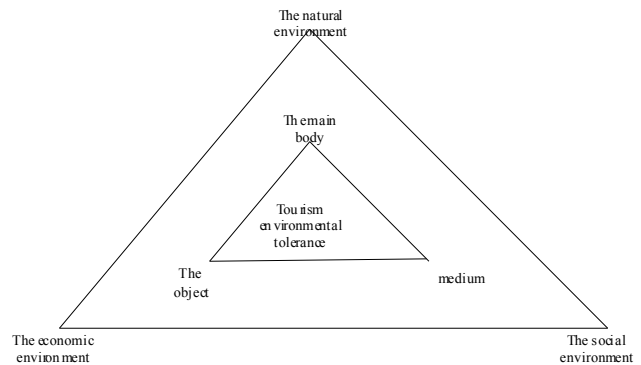


Fig. 3: Model of the ECC of tourism.

is closely related to its surroundings; thus, the external natural environment, economic conditions, and social environment enable tourism development as well as affect the implementation of forecasting and the control effects of the ECC.

**Natural environment:** The natural environment mainly includes natural resources and the ecological environment. Thus, the natural environment in this area determines the tourism resource endowment, tourism product development, and the image of the regional tourism brand. The share and spatial distribution of animal and plant resources, greenbelt resources, water resources, land resources, and wetland resources, as well as the scale and functions of sea resources, including the length of coastline, sea area, and number of islands, have a direct influence on the abundance, development potential, self-recovery, and carrying capability of tourism resources. The ecosystem is the fundamental environmental condition for developing tourism resource brands and conducting all tourist activities to protect and manage the ecosystem concerns of the sustainable development of tourism resources. Ecosystem factors, including the climate, hydrology, geographical landscape and vegetation, affect the type and features of developing tourism resources, such as when they are suitable for travel and the carrying capacity of tourist activities. Different climates, weather and landforms may generate different indexes of comfort levels, air quality, green coverage ratios and biodiversity. High environmental quality is a precondition for tourism development. The conduct of tourist activities, production, operation and management in related industries will have a negative influence on the environment. For example, industrial and domestic waste gas, water and solid waste directly affect the atmospheric environment, thereby weakening the carrying capacity of the tourism ecosystem. As one developed region, the coastal area of the Pearl River Delta is a pioneer in resource sustainability and environmental protection. The disposal of industrial waste gas, water, and solid

waste with the investment on environmental protection determine whether the development of the environment is powerfully driven, which is also crucial in promoting the carrying capacity of a tourism ecosystem. In addition, with the implementation of strategies for the rapid development of the economy and marine tourism in this area, the marine ecosystem in China faces several threats. For instance, the discharge of pollutants from urban life and industrial waste has caused seawater eutrophication, changes in the species composition of marine plants, changes in the community structure of the benthos, and even the death of marine living creatures, which creates huge stress on the marine ecosystem and threatens the carrying capacity of the tourist ecosystem. Therefore, the marine environment quality is also an obvious important factor, which influences the pre-warning analysis and regulation of tourism ECC in coastal areas.

**Economic environment:** The economic environment in this area mainly refers to the economic foundation, infrastructure conditions, tourism economic strength, and contributions to local economy. The national economic development level, speed, and percentage in the third industry per capita share and urbanization level connect with the carrying capacity of the economy to develop tourism in one region. A strong economic foundation corresponds to reasonable industrial structures, favourable investment environment, and strong carrying capacity of the tourism economy. Infrastructure is a necessary condition for the normal running of tourism, including the power supply, water supply, and traffic conditions. The construction of a sea-land-air transport network system represents the accessibility of the area, which directly affect tourist choices and preferences. Such a system is a key factor that influences the pre-warning of tourism ECC. Better transport conditions improve the carrying capacity of the tourism economy, thereby attracting more tourists. However, more stress will be introduced to the tourism environment.

**Social environment:** The tourism development in the coastal area of Pearl River Delta is closely correlated with its social environment. First, a sound development of tourism depends on good sanitary conditions, complete safety first-aid system, acute awareness of environmental protection, advanced information technology, level of science and technology, perfect educational environment, cultural heterogeneity, reasonable management and planning strategy, government's recognition and support as well as resident acknowledgement on tourism. Second, tourism brings economic benefits and job opportunity for local people but may bring some negative effect as well, such as public security chaos, negative social morality and folk culture decay. All these social influencing factors must be analysed and forecast in the pre-

warning of tourism ECC so as to reduce or remove the negative effects and to strengthen the ECC of regional society.

### Analysis on the Internal Environment

**Tourism subjects:** The subjects refer to tourists who have some motivation to travel, with free time and disposable money. Their travel, psychological perception, and capacity will change according to different purposes via different transportations at different ages, with different incomes and education levels. These differences may influence the social value, cultural tradition, and travelling cognition of the tourism destination, thereby affecting the social ECC of tourism. Furthermore, a large amount of household garbage and wastewater from travel will pollute the seawater environment if not disposed properly. During the peak season, the excessive load in scenic spots creates large pressure to the environment. In the long run, the capacity of the environment to self-renew will weaken; thus, the ecological environment will be destroyed, and the carrying capacity will also be naturally weakened.

**Tourism object:** In the coastal area of Pearl River Delta, abundant tourism resources, resource development, and geographic concentration affect the carrying capacity of tourism resources. Developed and undeveloped tourism resources are important components that determine tourism development potential. The scale, development level, economic benefit, employees, and distribution density of tourism enterprises, such as travel agencies, hotels, and scenic spots, influence accessibility, service quality, tourist reception, and carrying capacity. These factors affect the carrying capacity of tourism economic environment. Road coverage, communication media scale, and travelling route length involve the carrying capacity of transport. The size of restaurants, number of beds, rent ratio, distribution density, and facility construction in related service industries, such as culture industry and entertainment industry in the tourism destination, also influence the carrying capacity of tourism economy. The service quality of tourism staff, including guides, service staff, management staff, and transportation staff determine the regional tourism image and tourists' satisfaction level. Therefore, the training of tourism talents, their service level, and comprehensive quality direct affect service capacity.

### POLICY SUGGESTIONS

**Complete the law management system and reinforce law enforcement in environmental pollution:** Given the vulnerable tourism environment in the coastal area of the Pearl River Delta, the negative influence of tourism development on the environment, and the risk of over-carrying, complete law management must be established for tourism such that

the development of tourism will have laws to abide in and rules to follow. Thus, the environmental pollution and crisis can be effectively controlled, and the damage on the environment can be reduced to promote the harmonious integration of ecological, natural, economic, and social benefits. In this coastal area, local laws or rules on tourism resource development and construction, environmental protection, and pollution control in coastal recreational areas should be made based on the developmental situation of the tourism industry to ban the discharge of commercial waste into the sea and to call for the self-regulation of pollution. A strict reward and punishment system must be made to control pollution. The pollution-contributing enterprises must be punished according to their pollution ranking, whereas those that protect the environment must be encouraged through financial aid, tax exemption and reduction, and the special approval for managerial authority. This strategy aims to encourage more tourism enterprises to use green energy resources and to levy resource accounting and reduce the pollution of marine environment by transportation. A coastal land utilization tax should be established to control the speed, scale, and construction standards of developing real estate for tourism, to avoid over-development in hotspots, limit the coastal reclamation project, reinforce environmental pollution control, restrict the development of tourism resources, and improve management in scenic spots and preservation of historic sites, enhance the ability to forecast natural disasters, and invest more on fire safety, environmental and sanitary control, and tourism pre-warning regulation.

**Divide main functional zones for tourism and propel the coordinated development of coastal tourism and environmental protection:** Given the spatial distribution, development tendency, and influence of the ECC for tourism in this area, the tourism orientation, function, concept development, and milestones need to be identified. Likewise, plans for regulating the ECC of coastal tourism should be made to avoid an over-carrying or weak-carrying crisis. The coordinated development of land and marine resources should regulate the order of development in tourist destinations. Consequently, the overall carrying capacity in this area can be gradually improved whereas the economic and environmental benefits can be realized. More emphasis should be given to environmental protection and the optimum distribution of resources. The advantages of tourism resources and space should be fully utilized. To increase the investment on developing tourism resources, develop more specialized tourism products, and construct more tourism-related infrastructure, a convenient transportation network should be organized. The popularity and competitiveness of this area must be improved. Coordinate strategies in this area must be vigorously performed while aiming for sustainable develop-

ment. Based on resource protection and environmental pollution control, the development of tourism projects should be expanded. The tourism service system needs improvement to provide better service. An information service website should be promoted, and more tourism service centres should be constructed. The service functions in the tourist centre, guide service centre, and road sign system should be completed. Resource utilization must be made more efficient and regional cooperation must be enhanced to achieve shares in resources, information, talents, and technology. All these activities will help enhance the overall ECC and achieve the coordinated development of tourism and environmental protection in the coastal area.

**Actively promote low-carbon travel, ecotourism, and tourism environmental protection:** The relationship between tourism resource development and environmental protection should be properly addressed. Scenic spots should be developed step-by-step in a planned manner. The principles that prioritize assessment and planning over development must be followed to create a low-carbon atmosphere, attract more tourists to voluntarily participate in a low-carbon travel, construct low-carbon travel facilities, and change traditional infrastructure and service facilities emitting more carbon through low-carbon technology, such as carbon capture and the use of renewable energy sources. Solar energy, wind energy, hydrogen energy, and biomass energy should replace the traditional energy sources that cause serious pollution. Investment on the environment should be increased for the proper recycling of resources to strengthen the green management of energy and raw materials, employ clean production modes, and improve the recycling of tourism resources in terms of production and consumption. Thus, the service time of scenic spots may be prolonged. To prevent tourism products from early deterioration, further effort must be implemented to recycle waste. Solid and liquid wastes should be disposed differently to transform them to new resources. The bio-safety disposal of air pollutants and ecological wastes is an efficient method to reduce pollution and terminal management burden. Environmental pollution should be reduced and maintained at low levels.

As a global frontier in tourism development, coastal tourism greatly promotes economic growth but causes environmental pollution. In this study, land, water body, biological species, and air pollution caused by tourism in the coastal area of the Pearl River Delta in China were analysed. The interaction between external and internal environments was examined on the basis of an ECC model. Recommendations for the sustainable development of tourism resources were also proposed. As a key area of China's tourism, the coastal tourism in the Pearl River Delta has caused environmental

pollution to land, water, living creatures, and air at different levels, although the degree of pollution has decreased. The natural subsystem is easily damaged by environmental pollution. By contrast, the subsystem of economy and society plays a positive part in pollution. Tourism subjects are the major causes of environmental pollution. The incompetence of tourism objects affects pollution control. This study aimed to provide references for the regulation of environmental pollution caused by tourism and promotion of the coordinated development of sustainable tourism and environmental protection. Future studies should focus on various aspects, such as rankings of the sustainable development of tourism resources and long-term dynamic interaction between tourism and environmental pollution in this area.

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