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Analysis and Countermeasures of Chemical Pollution Damage Assessment in Scenic Areas

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In the transportation process of petrochemical products, oil spills and leakage accidents in the offshore area will cause catastrophic pollution to the near-sea scenic areas, indirectly affecting the economy and the environment. This paper takes the petrochemical pollution in Changdao Scenic Area of Yantai City, Shandong Province as an example to conduct an empirical study: first, this paper defined the concept of marine tourism, using relevant theories and principles of tourism economics, combining with the collection of tourism information of Changdao Scenic Area, it quantitatively evaluates and analyzes the economic loss and oil spill pollution of oil spill accidents based on the background trend curve theory; at last, this paper summarizes experience based on assessment results so as to provide favorable evidence for the cruise ship spillover claims in Changdao Scenic Area and conduct studies on future chemical pollution countermeasures. The research in this paper provides an effective reference for the evaluation of tourism resources damage in marine tourism scenic spots and chemical pollution damage and its countermeasures.

1. Introduction

Since the 21st century, the development of global trade integration has accelerated the international transportation of staple commodities such as petroleum and chemical products, and the global marine transportation industry has developed rapidly (Walker, 2016). However, with the increase in the number of international oil tankers, the rate of offshore accidents has also increased year by year. Offshore oil exploitation leakage and tanker transport leakage accidents happen frequently, due to the large destructiveness, long recovery time, and large coverage, it can cause catastrophic damage to the offshore environment, especially the offshore tourist attractions (Lima et al., 2008). For example, the oil spill accident in the oil field mined by British Petroleum (BP) in the Gulf of Mexico in 2010 had caused historic disaster to the environment of America, at the same time, BP has also received a fine of more than $4 billion.

As the impact of offshore crude oil and chemical product leakage on the marine tourism industry and fishery is difficult to estimate, the assessment and countermeasure analysis of tourism resources damage caused by marine oil spill has become a research hotspot. In 1988, Norwegian scholars established a three-dimensional model of oil and chemical leakage to simulate the environmental damage value of accidents under different ideal conditions. Some scholars in China used artificial neural networks to guide oil pollution accident assessment (Elorduizapatarietxeet al., 2010). This paper adopts the background trend method, and takes the pollution of Yantai City Changdao Scenic Area caused by “AFFLATUS” tanker stranding as an example to carry out practical researches.

Based on the full investigation of domestic and international offshore oil spill chemical pollution damage assessment techniques, this paper evaluates the tourism losses caused by oil spills in Changdao Scenic Area (Sivadas et al., 2008). The innovative method of assessing tourism loss using the background trend curve of the background trend theory takes the number of tourists and the ticket income as the research objects, it not only considers the growth trend of tourism, but also considers the cyclical fluctuation trend of tourism growth, making the evaluation result more reasonable. In addition, this paper also summarizes the countermeasures for chemical pollution and oil spill pollution. The research has realized monetized quantitative assessment of the losses caused by oil spills on offshore tourism resources, which helps to define the economic responsibility of the responsible party in the oil spill accident and provides strong evidence for the claim of the economic

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entity suffering from oil spill damage. The analysis of countermeasures for chemical pollution also contributes to the sustainable development of the Changdao Scenic Area (Yang et al., 2016; Li, 2018).

2. Definition of related concepts and explanation of theoretical basis

2.1 Definition of related concepts

2.1.1 Marine environmental pollution

Marine environmental pollution refers to the human activities that directly or indirectly discharge pollutants into the ocean, thereby causing damage to marine life, marine environment, human health, and fishery. Marine chemicals and oil spill damage are the most influential and most difficult to recover from in the marine environmental pollution, the causes include the stranding of marine vessels, blowout accidents during oil exploitation, etc. (Jambeck et al., 2015).

2.1.2 Tourism economic damage

Tourism economic damage includes the long-term accumulation of adverse factors, or incidents affecting passengers, tourist attractions, and causing damages to local tourism industry. Spillover of petrochemical products is the main cause of economic losses in offshore tourism. The impact of petrochemical pollution on offshore tourist attractions is huge. On the one hand, chemical pollution will directly affect the ticket and hotel income of the scenic areas, on the other hand, the impact on the word-of-mouth of the scenic area caused by pollution is a continuous damage.

2.2 Theoretical basis of tourism economy

2.2.1 Value classification of tourism economic resources

Figure 1 shows the general value classification of the tourism economy. It can be seen from the figure that the value of tourism resources is mainly divided into use value and non-use value (Blystad and Heiberg, 2003).

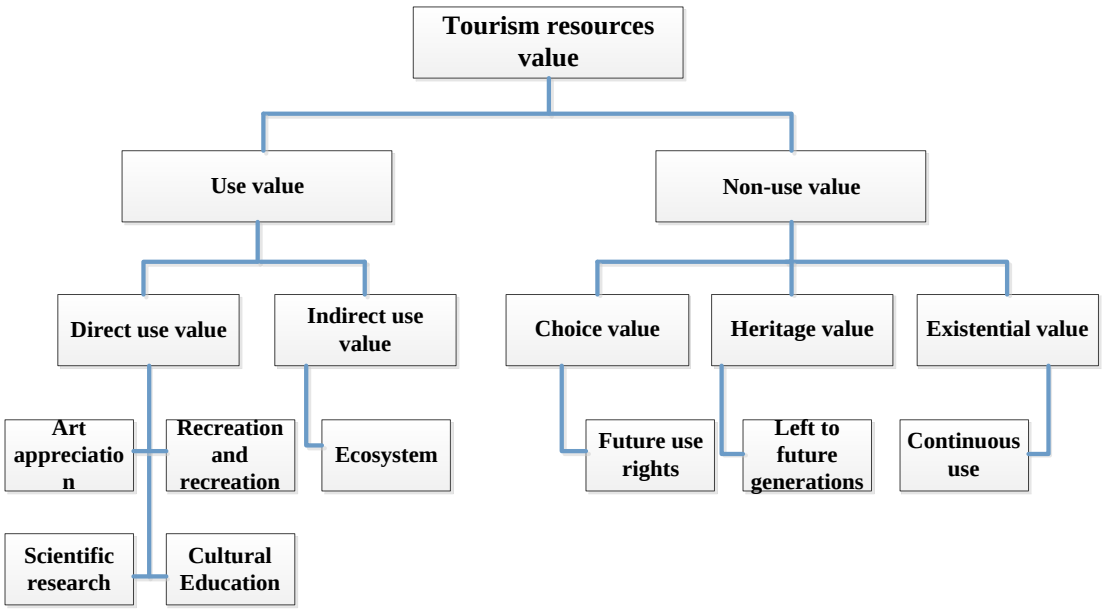

Figure 1: Value classification of tourism resources

2.2.2 Tourism background trend model

The tourism background trend model is used to predict the development trend of a scenic area that changes with the natural time, the background trend curve refers to the original inherent trend curve equation presented by the tourism industry during the normal operation and development, eliminating disturbances and shocks of serious and incidental events (both events that promote development and events that inhibit development), passenger flow and tourism revenues, it can also be called the dynamic equation (Li et al., 2013). The tourism background trend curve is regarded by the industry as a barometer of tourist attractions. The background

trend model established by combining tourism resource value classification and tourism background trend curve is often used to analyze and evaluate the tourism economic development trend of the scenic areas.
The tourism background trend curve has four basic forms, its basic form and derivative form are shown in Table 1.

Table 1: Tourism background trend curve name and basic form

Model name	Basic mode	Derivative mode
Linear growth model	$y_t = at + b$	
Linear-Logical Growth Compound Model		$Q_t = at + b + K/\ (1 + \exp(\mathrm{c} - \mathrm{rt}))$
Linear-exponential growth compound model		$\mathrm{Q_t} = \mathrm{at} + \mathrm{b} + \mathrm{y_0}\exp(\mathrm{rt})$
Exponential growth model	$Y_t = y_0 \exp(rt)$	
Index-Trigonometric Complex Model		$Q_t = Q_0 \exp(rt) + K/(1 + \exp(c - rt))$
Periodic oscillation model	$Y_t = qsin(\omega t + \varphi)$	
Linear-Trigonometric Complex Model		$Q_t = at + b + qsin(\omega t + \varphi)$
Logical growth model	$Y_t = K/(1 + \exp(c - rt))$	
Logical-Trigonometric Complex Model		$Q_t = K/(1 + \exp(c - rt) + qsin(\omega t + \varphi)$

According to the background trend theory, the main factors affecting the development of tourism include three categories: trend item, period item, and random item. Considering the development trend of tourism and the growth model, the model that conforms to the actual situation of tourism is a trigonometric function composite model. The tourism industry has many influencing factors such as the World Cup, the Olympic Games, environmental weather changes, and the international financial environment (Bütz et al., 2014). For the impact of petrochemical product spillover pollution on offshore tourism, this paper takes the background curve as the base, the actual statistical value is the actual income value of the local tourism industry, so the difference between the background curve value and the statistical value can be regarded as the damage assessment value of the oil spill accident (Wang et al., 2014). As shown in Equation 1:

$$L_{Damage\ assessment\ value} = |L_{Base\ value} - L_{Statistics\ \mathrm{value}}| \quad (1)$$

The specific steps to establish a background trend curve are as follows:
(1) Obtain the trend chart according to historical tourist numbers and income;
(2) Analyze and observe the trend chart, convert all data that is not in the trend range by linear interpolation, as shown in Equation 2:

$$Y_n = Y_a + (n - n_a) \times d \quad (2)$$

Y_n represents the revised value of tourism revenue, Y_a represents the linear interpolation starting point data, d represents the tolerance value of the linear interpolation, and n represents the year to be revised;
(3) Find a trend item model with high matching degree and determine the background trend equation;
(4) Find a periodic fluctuation item equation with high matching for calculation;
(5) Combine the trend item with the fluctuation item to obtain the background trend equation.

3. Analysis and countermeasures of chemical pollution damage assessment in Changdao Scenic Area

3.1 Development status of Changdao Scenic Area and investigation of oil spill accidents

3.1.1 Development Status of Changdao Scenic Area

The Changdao Scenic Area is located in Yantai, a coastal city in Shandong Province, China. There are 32 islands in the county with 10 islands have residents, the total area of the islands is 56 square kilometers and the coastline is 146 kilometers. Changdao Scenic Area has natural landscapes such as Fengshan National Forest Park, Yueyawan Bay, Beishan Hill and Crystal Cave, it has been listed as a national-level scenic spot and a national nature reserve, one of China's first-batch top tourist counties and one of China's top ten most beautiful islands.
The tourism industry in Changdao Scenic Area has become a local pillar industry. In order to support the development of tourism, the local government has built tourism infrastructures including transportation

facilities, accommodation, dining and shopping places, tourism services, tourism bases, and other tourism infrastructures. The unique geographical natural landscape and humanistic customs, the constantly improving tourism infrastructures, the increasingly perfect tourism service industry and a large amount of publicity investment have created a good environment for the development of Changdao's tourism industry (Gilfillan et al., 1996).

3.1.2 Investigation of oil spill accidents

Since February 2010, different black oil stains have been found on the Changdao Beach, causing damages to coastal tourism resources such as Yueyawan Bay and Wangfu Reef. Through relevant investigation and trace, the oil spill caused by the "AFFLATUS" tanker stranded on the reef near Liugong Island in Weihai is the cause of chemical pollution in the scenic area of Changdao.

The marine oil spill accident has caused great damage to the Changdao scenic area. The local government has spent a lot of manpower and material resources to complete the oil pollution cleanup in the scenic area and compensation for the tourists (Andersen et al., 2008). The impact of chemical pollution on the immediate and delayed effects of the Changdao scenic area is even more difficult to estimate. Therefore, it is necessary to use reasonable means to properly assess the direct and indirect losses of Changdao tourism industry (Kankara et al., 2016).

3.2 Analysis of chemical pollution damage assessment in Changdao Scenic Area based on background trend curve

Conduct chemical pollution damage assessment analysis according to the steps of the background trend curve in Section 2.2.2. Select the tourist time series as the primary indicator of the level and speed of tourism development of Changdao Scenic Area, and make a trend chart (Wei et al., 2015). Table 2 shows the statistics of the number of tourist receptions and ticket revenues of Changdao Scenic Area over the years.

Table 2: Long Island tourism reception and annual ticket revenue in 2001-2010

Year	Annual reception number (Ten thousand people)	Annual ticket income (ten thousand yuan)
2001	75.9	1200
2002	89	1440
2003	75	1350
2004	105	1890
2005	113	2450
2006	123	2780
2007	141	3100
2008	155	4300
2009	176	5100
2010	221	5860
2011	180.9	5327
2012	197	5765

From the data in the table, it can be seen that the historical data of 2003 does not conform to the trend curve, it's because in 2003 the SARS disaster happened in China, which had a great impact on the tourism industry. Therefore, the tourism data of year 2003 does not meet the background trend curve and needs to be revised. The results of the correction are shown in Table 3.

Table 3: The correction result

Index	Interpolation area endpoints		Tolerance Value	Interpolation equation	Corrected data/2003
	initial point	termination point			
Annual reception number	2002	2004	8	Y_{2002}+(n-n_{2002})d	97
Annual ticket income	2002	2004	225	Y_{2002}+(n-n_{2002})d	1665

According to the revised data, the trend equation for the annual number of visitors in the Changdao Scenic Area is shown as Equation 3. The ticket income is shown as Equation 4: where x is the time variable.

$$y = 79.84e^{0.099x}, R^2 = 0.991 \quad (3)$$

$$y = 990.1e^{0.178x}, R^2 = 0.993 \quad (4)$$

The data in Table 2 is de-trended and processed to obtain the trend chart, by observing, we can see that the trend chart roughly conforms to the periodic fluctuation of the varying amplitude sinusoid function. Therefore, it is easy to obtain the periodic wave equation of the tourist number and ticket income of the scenic area. By adding the trend of each indicator to the variance of the cyclical fluctuations, we can get the background trend equations of the number of tourists and the ticket income of Changdao Scenic Area, as shown in Equations 5 and 6.

$$y = 70.84e^{0.099x} - 0.6595e^{0.2724x} \times \sin(1.7287x - 6.5577), R^2 = 0.9834 \quad (5)$$

$$y = 990.1e^{0.178x} + 48.3139e^{0.1869x} \times \sin(1.6506x - 6.6381), R^2 = 0.9731 \quad (6)$$

By comparing the tourist number and ticket income of the scenic spot predicted by the background trend curve with the actual tourist number and ticket income, we can get the chemical pollution damage assessment value of Changdao Scenic Area caused by marine oil spill chemical pollution in 2011 and 2012, namely the two years after the marine chemical oil spill accident, as shown in Table 4.

Table 4: Impact of ocean oil spill on annual reception number and ticket revenue of Changdao Scenic Area

Index/Impact		Ocean oil spill 2011	Ocean oil spill 2012	Total loss of ocean oil spill
annual reception number	Base value	220.1	213.05	433.16
	Actual value	180.9	197	377.9
	Loss (ten thousand people)	39.2	16.05	45.25
ticket revenue	Base value	6600	8600	15200
	Actual value	5327	5765	11092
	Loss (ten thousand yuan)	1293	2835	4128

From the data in the table, it can be seen that, in year 2011 and 2012, due to the chemical pollution of the Changdao Scenic Area caused by marine oil spill, the loss of tourist number of the scenic area reaches 452,500, and the total ticket revenue loss of the scenic spot reached 41.28 million yuan.

3.3 Countermeasure analysis

The prevention and control of chemical pollution in offshore tourist scenic areas not only includes strengthening the environmental awareness of residents and related enterprises in the scenic areas, establishing pollution control devices with perfect system, constructing ecological function protection zones, regularly evaluating the chemical pollution risks in the scenic areas, and classifying and managing them, but also includes coping with sudden chemical pollution such as marine oil spills. An effective assessment of chemical pollution damage through objective and scientific methods can effectively protect the economy and environment of the scenic area and promote the sustainable development of the scenic area.

4. Conclusion

The damage of offshore tourist attractions caused by sudden chemical accidents such as marine oil spills is difficult to estimate. In order to better guide the claims of such accidents and indirectly protect the sustainable development of the scenic areas, this paper takes the marine oil spill accident in Changdao Scenic Area of Yantai City as an example to carry out damage assessment analysis research. The main research contents and significance of this paper are as follows:

(1) This paper briefly introduced the marine tourism economy and the background trend model, which laid a theoretical foundation for the research.

(2) This paper used background trend curve and took the Changdao Scenic Area as an example to carry out quantitative assessment of marine oil spill chemical pollution.

(3) The study provided an effective reference for the assessment of chemical accident damage in offshore tourist attractions.

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