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WORLD MARITIME UNIVERSITY

Dalian, China

**POLLUTION CAUSES AND PREVENTION
MEASURES IN BOHAI SEA**

By

WANG YIQIAO

The People's Republic of China

A dissertation submitted to the World Maritime University in partial
Fulfillment of the requirements for the award of the degree of

MASTER OF SCIENCE

In

Maritime Safety Environmental Management

2019

DECLARATION

I certify that all the materials in this research paper that is not my own work have been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

Signature: Wang Yiqiao

Date: June 28, 2019

Supervised by: Fan Zhongzhou

Professor

Dalian Maritime University

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ABSTRACT

Title of Dissertation: **Pollution Causes and Prevention Measures in Bohai Sea**

Degree: **MSc**

The 21st century is known as the ocean century, and the relationship between mankind and the ocean is increasingly close. With the growth of the population, the development of the economy and the continuous enhancement of the exploitation and utilization of the ocean, the resources and environment of the ocean have been seriously damaged. As the only inland sea in China, the Bohai Sea is the most seriously damaged. The ecological environment of the Bohai Sea has been severely damaged, which not only affects the growth of marine life in the Bohai Sea, but also further harms people's health. At the same time, it will also have a negative impact on the economic development of coastal areas. The pollution level in the Bohai Sea is very serious. If it is not treated in time, the Bohai Sea may become the Dead Sea.

The paper first puts forward the significance and reasons for the study of pollution prevention in the Bohai Sea, then gives a brief introduction to the general situation of it, and illustrates the seriousness of pollution in the Bohai Sea and the necessity of treatment through data. After that, based on the successful experiences of the West Lake in Hangzhou and the Seto Inland Sea in Japan, three feasible suggestions for the prevention and control of pollution in the Bohai Sea are put forward.

KEY WORDS: Bohai Sea, pollution prevention, general situation of the Bohai Sea

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LIST OF ABBREVIATIONS

Bulletin	China Marine Environmental Quality Bulletin
BWM2004	Convention on Ballast Water Management
COD	Chemical Oxygen Demand
CLC1969	International Convention on Civil Liability for Oil Pollution Damage 1969
FC1971	International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage
IMO	International Maritime Organization
MEPC	Marine Environment Protection Committee
MARPOL	International Convention for the Prevention of Pollution From. Ships, 1973 as modified by the Protocol of 1978
ppb	The Negative Ninth Power of 10
SOA	State Oceanic Administration
UN	United Nations
UNCLOS	United Nations Conference on the Law of the Sea

CHAPTER 1

Current Situation of International Pollution Prevention

Today is a new era of global investment and development of marine resources. Effective research and utilization of marine resources are the key to solve the problems of stable economic and social development, increasing new forces and sharp reduction of resources. However, with the rapid development of technology, exploitation and utilization of marine resources in various countries, the activities of exploiting marine resources and polluting marine resources have increased dramatically. International marine environment is suffering from pollution which is more and more serious inevitably. The global ecology and our living environment are gradually declining, which makes the quality of the international marine environment deteriorating increasingly. The resources of the international oceans, which were rich decades ago, are gradually exhausted. It has harmful effects on human health and species resources. In addition, the pollution of domestic sewage, industry, agriculture, chemical substances, seabed development, ships and oil field accidents in the coastal areas of the world are shocking, leading to the gradual loss of self-cleaning ability of some sea areas. This causes frequent occurrence of red tides, mass death of fish, discoloration and odor of sea water, and a large number of bacteria breeding in the international sea; The deterioration of the marine environment has also led to climate change in coastal cities of various countries directly.

The ocean is the precious wealth of sustainable economic and social development, an important channel for the smooth development of maritime trade around the world, and an important platform for international political, economic, military, scientific, technological competition and cooperation. Marine resources have become an indispensable partner of humanbeings, played an irreplaceable role in the development of human society and the balance of natural environment.(Ji, 2017) In the future, the attention of most of the people will surely turn to the vast ocean. How to transform the vast ocean into productive forces for people to use, how to protect the marine environment, and what specific measures to protect the marine environment have become a new topic that countries around the world have been trying to explore since the 21st century. In order to improve the marine environment of the world, the International Maritime Organization (IMO) has issued many international anti-pollution conventions and invented technology.

1. 1 International Convention on Pollution Prevention

Since the 1950s, offshore oil drilling, production and transportation have increased dramatically, and oil pollution has become serious increasingly. (Bu, 2014) A catastrophic oil tanker spill shocked the world and promoted the publication of relevant international conventions objectively.

The International Convention for the Prevention of Marine Oil Pollution, signed in 1954, is the first agreement on marine environmental protection in the international community.

In 1969, the International Convention on Civil Liability for Oil Pollution Damage and the Convention on International Intervention in Oil Pollution Events were signed. The Convention mainly stipulates the liability for compensation or oil pollution

damage of ships at that time, while subsequent conventions stipulate the liability and obligation for international intervention.

Due to the huge amount of compensation for oil tanker pollution, the Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage was signed in 1971.

In order to prevent the dumping of wastes from ships and aircraft into the sea, the Convention on the Prevention of Marine Pollution was signed in 1972.

In October 1973, the IMO held a meeting to discuss and adopt the International Convention for the Prevention of Marine Pollution from Ships. This Convention not only provides for the prevention and control of marine pollution caused by oil, but also of all harmful substances polluting the oceans except the dumping of land-based waste. MARPOL did not come into force in 1973 due to the problems of anti-fouling equipment and receiving facilities.

In February 1978, IMO convened the Conference on the Safety of Tankers and the Prevention of Marine Pollution, at which the 1978 Protocol to the 1973 International Convention for the Prevention of Marine Pollution Caused by Ships was formulated and adopted. It is the most comprehensive and stringent international convention on the prevention of pollution from ships up to now. It has played an important role in the design and operation of oil tankers, raised the standards oil tanker fleet of the world and reduced pollution of ships to the sea greatly.

The United Nations Convention on the Law of the Sea, signed in 1982, provides detailed and specific provisions on pollution from ships and requires states to

formulate international rules and standards through competent international organizations and general diplomatic conferences.

In 1989, IMO presided over the signing of the Convention on International Rescue for wrecked ships aiming at preventing pollution from ships and protecting the marine environment.

In 1990, the International Convention on Oil Pollution Preparedness, Response and Cooperation was signed to promote cooperation among countries in dealing with major oil pollution accidents. (Wang, 2012)

The Convention on Ballast Water Management (BWM 2004) was promulgated in 2004.

Without the requirements of these mandatory conventions, 8 to 10 million tons of oil would be discharged into the ocean every year directly due to the discharge of ship washing water and ballast water. Thus, these conventions play an important role in preventing pollution from ships.(Ji, 2017)

1. 2 International Pollution Prevention Technology

With the development of ocean transportation, ocean exploitation and ocean utilization, the pollution of the marine environment is becoming more and more serious, and the protection has been paid more and more attention by all countries in the world. International anti-pollution Conventions and Resolutions are constantly being revised and implemented in a unified manner. Among all, the IMO has created many effective resolutions in the field of pollution prevention. For example, there are resolutions for ships, such as MEPC. 76 (40) and MEPC. 93 (45) for marine

incinerators, MEPC. 159 (55) for marine domestic sewage treatment devices and MEPC. 107 (49) for bilge water separators. These Resolutions have clear provisions and requirements for ship emissions, and updated Regulations have been issued and will be implemented. For MEPC.244(66) of marine incinerator, the heat capacity of incineration treatment will be increased from 1500 kW to 4000 kW, and for MEPC.227(64) of marine domestic sewage treatment device, the nitrogen and phosphorus emission targets of passenger ships in special sea areas will also be increased. (Pan, 2015)

1. 3 Research Significance

The Bohai Sea is next to Dalian, where serious pollution of the Bohai Sea has occurred. It is imperative to prevent and control the pollution of the Bohai Sea. In the following chapters, I will introduce the specific situation of the Bohai Sea, the seriousness of pollution and the necessity of pollution prevention and control. Finally, three suggestions for prevention and control of pollution are put forward.

CHAPTER 2

Overview of Bohai Sea

2. 1 Location and Scope of Bohai Sea

The Bohai Sea is the inland sea which is in the north of the mainland in China. Unlike other sea areas, it is surrounded by land on three sides and sea on one side. The specific location is 37 degrees 07 to 41 degrees 00 in the north latitude and 117 degrees 35 to 121 degrees 10 in the east longitude. The Bohai Sea is adjacent to Liaoning Province in the north, Hebei Province and Tianjin City in the west, Shandong Province in the south, and the Yellow Sea in the east. The maritime boundary between Bohai and the Yellow Sea is the connection between Liaodong Peninsula Laotie mountain west corner and Penglai peninsula of Shandong peninsula. The Bohai Sea is composed of five parts: the western Bohai Bay, the southern Laizhou Bay, the northern Liaodong Bay, the Bohai Bay and the central basin. The Bohai Sea covers an area of 77,284 square kilometres, with a land-sea coastline of 2668 kilometres, an average water depth of 18 metres and a maximum water depth of 70 metres. (Liu, 2002)



Figure 2.1 Location of the Bohai Sea

Source: <https://image.so.com/view>

2.2 Factors affecting the quality of Bohai Sea

The change of marine water quality is affected by many factors. The factors of Bohai Sea water quality can be divided into two categories: natural factors and human factors. Natural factors include coastal and submarine geology, current, runoff, climate and island distribution.



Figure 2.2 Scenery of Bohai Sea

Source: <https://image.so.com/>

The coasts of the Bohai Sea are divided into three types: bedrock coast, sandy coast and silt coast. Among all, the north coast of Shandong Peninsula and the west coast of Bohai Sea north of Liaodong Peninsula are mainly bedrock coast, the west coast of Bohai Sea north

of Luanhe estuary is mainly sandy coast, while the north coast of Liaodong Bay, Yellow River Delta and Bohai Bay are mainly silty coast. The water quality around the three coasts is different. Generally speaking, the water near the bedrock coast is the cleanest, while near the silty coast is the most turbid, and the sandy coast is in the middle. (He, Li, Zhu, & Zhang, 2002)

Ocean current has an important impact on the quality of seawater, it is also affected by many factors, including the tide, diversion, rivers and climate of Kuroshio. Due to the influence of the rivers and tidal currents of the Kuroshio, the Yellow Sea body flows into the Bohai Sea from the north of the Bohai strait, and after the cycling in Bohai Sea, it enters into the Yellow Sea from the inside of the Bohai strait. The suspended sediment concentration of the output water body reaches the order of 0.01kg/m^3 and it is much higher than that of the input water body. The ocean current reduces the suspended sediment concentration of the Bohai Sea greatly. There are 50 rivers flowing into the Bohai Sea, including the Yellow River, Haihe River, Liaohe River and Luanhe River. Among them, there are 19 rivers along Laizhou Bay, 16 rivers in Bohai Bay and 15 rivers in Liaodong Bay. These rivers carry a large amount of sediment and various substance into the Bohai Sea, affecting the circulation pattern. Among them, some rivers carry a large amount of industrial wastewater, which pollutes the environment and affects the water quality of the Bohai Sea. (Zhao & Kong, 2000)



Figure 2.3 Bohai coastal fishing boats

Source: <https://image.baidu.com/>

There are many islands in the Bohai Sea, including Xizhong Island, Miaodao Islands and Chrysanthemum Island. These islands affect the circulation of sea water. At the same time, these islands play an important role in the management of sea water and hydrological monitoring, and are often used as bases.

With the continuous enhancement of human activity capacity, the impact of human on the quality of the Bohai Sea is increasing. People breed marine organisms, exploit mineral resources and ships sail, many of these activities will destroy the environment of the Bohai Sea and affect the water quality. Just like there are oil drilling platforms, if an accident occurs on the oil drilling platforms, it will cause oil leakage and pollution of sea water.

2. 3 Resources and development activities in the Bohai Sea

In the past, the rich fisheries, ports, oil, tourism, sea salt and other resources of the Bohai Sea and its pleasant natural environment conditions gave infinite vitality to the economic development of the Bohai Sea Region. At the same time, the vigorous development of the primary industry has also led to the development of secondary and tertiary industries, such as marine chemical industry, shipbuilding, aquatic processing, petrochemical industry, textile industry and so on. In addition, the beach near the Bohai Sea is very wide, with an area of 5100 square kilometers and an increasing silting area of 20 square kilometers per year. The abundant beach resources provide a vast space for survival and development to solve the contradiction between the large number of people and the small amount of land in coastal areas.(Jiu &Tang , 1998)

The Bohai Sea was once rich in prawns, swimming crabs, halibut, yellow croaker, loach, jellyfish, squid and so on. It is not only famous for great economic value, but also for its marine organisms' large size, delicious meat, abundant food and rich nutrition.

In addition to fisheries, ports, oil, tourism and sea salt are the four main resources in the Bohai Sea.

Bohai port has the advantages of high distribution density, large number of large-scale ports and export ports, good physical and geographical conditions, developed economy, vast hinterland as well as abundant resources. It is an important sea line for foreign trade in northern China, with more than 100 ports which have been built and are suitable for construction. Although many ports have brought many benefits, people have to pay attention to the environmental protection problems.

The Bohai Sea is rich in oil and gas resources. Abundant oil and natural gas resources have been found and exploited in the Bohai Sea, and the number of oil production is increasing year by year. The whole Bohai Sea area is a huge oil-bearing structure. Shengli, Dagang, Liaohe and offshore oilfields are linked together. So, the Bohai Sea has become the second oil-producing base in China.

At the end of the year, Penglai Oilfield, China's largest offshore oil field, was put into operation, and Bohai offshore oil field production accounted for one fifth of total oil production of China, becoming a new main force of national energy. In 2006, the annual output of Bohai oil reached 15.61 million cubic meters, which surpassed the South China Sea oil field to become the largest oil field block in China's offshore. By

2010, the annual oil and gas production of Bohai Oilfield are expected to reach 30 million cubic meters per year, accounting for more than half of China's total offshore oil production.(An &Ma, 2002)

At present, there are 15 offshore oil fields, 69 offshore platforms, 6 FPSO, and more than 100 related operational ships in Bohai Sea. There' s no doubt that the oil field which rich in reserves offshore oil pollution led to hidden dangers.

The natural scenery along the Bohai Sea is beautiful and there are many scenic spots and historic sites, which fully possess the temperate seashore tourism and vacation resources with the theme of sunshine, sea water, beach, botany and animals. The famous scenic spots include Beidai River, a summer resort, Penglai Pavilion, a mirage in the sea. However, due to pollution, the tourism industry in Bohai Sea has also been affected to a certain extent.

There are many salt fields along the coast of Bohai Sea, which is the largest salt production base in China. The sediment and climate conditions are very suitable for salt production. Among the four major sea salt producing areas in China, there are three bays: Changlu Bay, Liaodong Bay and Laizhou Bay in the Bohai Sea, and Changlu Salt Farm which in the west bank is the most famous. Laizhou Bay has abundant underground brine reserves, amounting to 7.6 billion cubic meters, equivalent to more than 800 million tons of salt.(Zhang L.&Wei H., 2002) It is a rare liquid salt field with large reserves, shallow burial with high concentration. However, when toxic pollutants enter the sea, sea salt sunned through coastal salt farms loses its edible value.

Marine development activities around the Bohai Sea can be expressed by the changes

in the output value of various marine industries. It can be seen that in the decades, rich and high-quality fisheries, ports, oil, landscape and sea salt resources have made the economy of the region develop rapidly.

Although the development of Bohai Sea resources has brought us many benefits, due to the lack of attention to the overall coordinated development, it has increased the pollution of the Bohai Sea, and restricted the development of the economy seriously.

2. 4 Wetland and compound ecosystem of the Bohai Sea

Rivers carry a large amount of sediment and deposit in three bays every year when entering the Bohai Sea, changing the seabed and coastal landforms. While Liaohe River, Haihe River and Yellow River were flowing along the Bohai Sea coast, a wide range of Liaohe Estuary Delta Wetlands, Haihe Estuary Delta Wetlands and Yellow River Estuary Delta Wetlands are formed at the top of the three bays.

There are many kinds of wetland organisms, such as reed, scallion, alkaline suaeda, trigonum and algae, and more than 150 kinds of birds. Liaohe Estuary Delta Wetland and Haihe Estuary Delta Wetland are the main producing areas of reeds in China, where reeds are clustered, providing a large number of high-quality raw materials for the paper industry in China every year.

In addition to the estuarine delta wetland ecosystem, there are three estuarine ecosystems mentioned above and the deep-water ecosystem in the central part of the Bohai Sea. The interaction between the three ecosystems of the Bohai Sea and the provinces and cities around the Bohai Sea constitutes a complex ecosystem in the Bohai Sea Region. In this complex ecosystem, economic development and environmental pollution have become prominent contradictions increasingly. And the

solution of this contradiction cannot be separated from the benign interaction of this complex ecosystem.(Cai&Wang, 1999)

CHAPTER 3

Historical facts and predictions of Bohai pollution

The pollution of Bohai Sea has a history of its formation. In this chapter, we analyze the formation process; predict the development trend and serious consequences of Bohai pollution, as well as the impact of marine environmental protection on the development of Bohai Economic Circle.

3. 1 Historical facts of Bohai pollution

With the economic activities of coastal areas and the exploitation and utilization of marine resources in the Bohai Sea, the resources and ecological environment have been greatly damaged at the same time. Since 2001, the State Oceanic Administration observed of the quality of marine environment systematically of China, and made the annual ‘China Marine Environmental Quality Bulletin’ , hereinafter referred to as the ‘Bulletin’ . The evaluation categories of marine environmental quality include marine pollution area, the pollution level, total amount of pollutants entering the sea, types of pollutants, the amount of pollutants contained in marine biomass, the number of red tides which are found of, cumulative area, air quality, marine sediment quality, ecology, the basic situation of the area monitoring, the use of marine dumping areas, the environmental conditions of oil and gas areas, seawater infiltration land area and marine debris.(Egli, 2010) This paper would show the main performance of the pollution of the Bohai Sea below.



Figure 3.1 Picture of Bohai Sea Pollution

Source: Diao J, & Ding L. (2013). Thoughts on Business Ethics Caused by Marine Pollution.

3.1.1 Increasing of total amount pollution

The industrial wastewater and domestic sewage of coastal towns, such as Liaoning, Hebei, Tianjin and Shandong Province are pouring muddy water into the Bohai Sea day by day. Pollutants from more than 50 rivers such as the Yellow River, Haihe River, Xiaoqing River, Daliao River and Weihe River along the Bohai Sea are infused into the Bohai Sea. By 2004, the annual average runoff was about 79.2 billion cubic meters. From the dozens of sewage outlets on the coast to 217 in 2004, more than 90 percent exceeded the standard, and a large amount of inorganic nitrogen, inorganic phosphorus, petroleum, oxygen-consuming organic matter and heavy metals entered into the Bohai Sea. According to official Chinese statistics of the Bohai Sea, the heavy metal content has exceeded the normal level by about two thousand times. There is no fish living within a few nautical miles near the sewage outlet. From 2005 to 2006, the Tianjin Marine Bureau's monitoring data on 15 sewage outlets and their adjacent sea areas showed that 93.3% of the sewage outlets exceeded the standard, and the water quality of the sewage outlets was polluted seriously. Some fishermen reported that the pollution of rivers entering into the sea was very serious, and the whole river was black or red when the floodgate was opened and discharged during the flood season.(Wang&Zhou, 2009)

The phenomenon of excessive discharge into the sea does not only occur in Tianjin. According to the 2008 China Marine Environment Quality Bulletin, there are 54, 31 and 75 excessive outlets in Liaoning, Hebei and Shandong Province, accounting for 71.1%, 65.6% and 98.1% of the monitored outlets respectively. According to the 2014 Bulletin, more than 80% of the sewage outlets adjacent to the sea are inferior to the fourth category of seawater quality standards.(Wang, 2006)

3.1.2 Increasing area of pollution in the Bohai Sea

In 1992, the contaminated area of the Bohai Sea was 16473 square kilometers, accounting for 21.2% of sea area in China. In 1996, it increased to 39,232 square kilometers, reaching 51% of sea area in China. As a result, the contaminated area has increased by 2.4 times over that of five years ago.

According to the 2005 Bulletin, compared with 2003, the area of the Bohai Sea with serious pollution, moderate pollution and slight pollution increased by 280 square kilometers, 2060 square kilometers and 2470 square kilometers, respectively.

The present situation of Tianjin sea area can reflect the pollution situation of Bohai Sea in an all-round way. In 2005, the pollution situation in Tianjin coastal waters was more serious than in 2004. The area of slightly, moderately and severely polluted waters increased by 190 square kilometers, 580 square kilometers and 300 square kilometers, respectively. According to a survey conducted by the Oceanic Administration in the first half of 2006, the pollution situation is still not improving. There are about 3,000 square kilometers in Tianjin's coastal waters, none of them can meet the water quality standards of clean sea areas. The Bohai Bay near Tianjin, known as a fishpond, has even no fish to catch now.

According to the 2008 Bulletin issued by the Beihai Branch of the State Oceanic Administration, the quality of sea water in the central of Bohai Sea was good in 2008, but the pollution in the coastal waters was serious. The main pollutants in seawater are inorganic nitrogen, active phosphate and petroleum. The quality of the sea water in the Bohai Sea is good in summer. The polluted sea area is about 13810 square kilometers, accounting for 17.9% of the total area of the Bohai Sea. The quality of seawater is worse in autumn, while the polluted sea area is about 23680 square kilometers, accounting for 30.8% of the total area of the Bohai Sea. The area of coastal polluted sea areas in Shandong, Liaoning and Hebei accounted for 24%, 22% and 20% respectively.(Liu, 2017)

In 2012, the first category of seawater quality standards in the Bohai Sea has been reduced to about 47%. In 2017, the area of the fourth and inferior sea water quality standards increased by 20% compared with the same period in 2011, reaching 3770 square kilometers.

3.1.3 The degree of pollution is gradually deepening

Organic contamination in seawater can usually be expressed by Chemical Oxygen Demand (COD) in milligrams per liter of oxygen, indicating the amount of oxidant consumed per liter of water. In 2006, the average value of COD in the Bohai Sea was 1.63 ppm (ppm is the negative sixth power of 10). Among the parts of the Bohai Sea, the COD of Laizhou Bay is the highest, reaching 2.08ppm, followed by Liaodong Bay and the lowest is in the central of Bohai Sea. There' s no doubt that the COD has reached the standard in Laizhou Bay, northern Liaodong Bay and Luanhe Estuary, and some of them have exceeded the standard, such as 1.0 ppm in Liaohe Estuary.

The Bulletin issued by the State Oceanic Administration in the first half of 2015 shows that the phenomenon of excessive discharge from land-based sewage outlets into the sea has increased, the quality of seawater near the sewage outlets has been deteriorate continuously, and the pressure of emission reduction along the Bohai Sea coast is particularly prominent. In 2015, 100 outlets were monitored along the coast of the Bohai Sea, and the proportion of outlets exceeding the national standard was still the highest, reaching 91%. By 2016, the monitoring results showed that the proportion of discharge outlets exceeding the standard along the Bohai Sea coast was reduced to 83.3%.

Heavy metal pollution is an important component of industrial waste water. Heavy metals mainly refer to mercury, cadmium and lead. The concentration of mercury in Liaodong Bay is the highest, with an average value of 0.05 ppb (ppb is the negative ninth power of 10), and that in other areas of the Bohai Sea is about 0.01 ppb. Cadmium is also mainly carried by rivers, with higher concentrations in Liaodong Bay and Bohai Bay. The average concentration of lead in the Bohai Sea is 2.95 ppb.(Li&Miao, 1996)

Now, the mortality rates of shellfish, fish and shrimp are very high. Thirty percent of the fishing boats have stopped production and the breeding base has been abandoned (Liu, 2017) . From September 2001 to January 2008, billions of cubic meters of sewage have been discharged into the Bohai Sea through the Zhangweixin River. Through monitoring, 80% of the water quality of the survey sites exceeds the four categories of seawater quality standards, and the polluted area of the sea area is about 10 to 15 nautical miles. Since September 2000, dissolved oxygen in the river has been zero, and the most viable yellow-eyed crabs have disappeared.

In July 2016, Shandong Marine Environmental Quality Bulletin said that the pollution areas were mainly located in the southern Bohai Bay and Laizhou Bay. The main pollutants are inorganic nitrogen, active phosphate and petroleum. Nearshore ports, Yellow River, Xiaoqing River, Zhangweixin River estuaries and other surrounding waters are heavily polluted by sewage of coastal enterprises. The offshore marine ecosystem is relatively fragile, the ecosystem of Laizhou Bay is in an unhealthy situation, while the ecosystem of the Yellow River Estuary is in a sub-healthy situation, which is mainly manifested in the imbalance of nutrients in the water body, the abnormal structure of biological communities and the change of ecological environment.

3.1.4 Frequent occurrence of red tide

When eutrophication occurs in water body, the water body often appears blue, red, brown or milky white due to the large number of plankton reproduction. The outbreak will turn the water red, so it is called 'red tide'. Since 1980, the Bohai Sea has been experiencing increasingly terrible dark red tides. The algae are stinky and poisonous, and fish are not edible. Algae shelter the sunlight, so that submarine plants are blocked by photosynthesis and die. After decomposition, nutrients, such as nitrogen and phosphorus, are released for algae utilization. It will cause a vicious circle, algae proliferation, water quality deterioration and fishy odor, causing more fish deaths in such a long period of time.

In recent years, algae have exploded and prolonged on a large scale in succession, and red tides occur frequently. There are no less than 10 times a year. The cycle is getting shorter and shorter, and the area is getting larger and larger. So far, the total

number of red tides has exceeded 330. The longest one lasted 72 days. From August to October in 1989, a large area of red tide occurred in Hebei Province, which affected Liaoning, Shandong and Tianjin, covered an area of 1300 square kilometers, with a loss of more than 300 million yuan. In 1990, red tide occurred in Laotieshan waterway, covering an area of 1000 square kilometers.



Figure 3.2 Red Tide Picture in the Bohai Sea

Source: <https://image.so.com/view>

Continuous monitoring by Tianjin Oceanic Bureau shows that the average area of red tide disasters in Tianjin sea area from 2002 to 2018 is 750 square kilometers per year. Most importantly, the red tide has caused a fatal blow to the growth of aquatic organisms such as fish, crab, shrimp and shellfish in the Bohai Sea.(Su, 2001)

According to the Bulletin, there were 17 red tides occurring in the Bohai Sea and the Yellow Sea in 2003, covering an area of 870 square kilometres; 25 red tides occurred in the Bohai Sea and the Yellow Sea in 2004, totaling 7340 square kilometres, 3340

square kilometres more than in 2001. Among them, two large-scale toxic red tides occurred in the Bohai Sea.

In 2004, the number of red tides in the Bohai Sea was the same as which in 2003, but the cumulative area increased 13 times. In 2005, the Bulletin also said that 9 red tides occurred in the Bohai Sea, covering an area of 5320 square kilometers. Although this figure is slightly less than that in 2004, there were high-frequency and large-scale outbreaks, it is still much higher than that from 2000 to 2003.

In 2016, there were 10 red tides in the whole year, covering an area of 740 square kilometers. In 2017, there were 12 red tides in the whole year, covering an area of 342 square kilometers.

The Bohai Sea was a piece of closed inland sea in northern China, which is known as ‘fish warehouse’ , ‘salt warehouse’ and ‘oil warehouse’ . However, this sea, which has brought huge wealth to the people of China's coastal cities, is being destroyed by people's own excessive actions.(Pan, 2010)

Next, according to the key evaluation indicators of marine environmental quality, we analyze the pollution situation of the Bohai Sea in detail, and predict the development trend of pollution in the Bohai Sea, as well as the serious consequences. The pollution prevention and control in the Bohai Sea plays an important role in supporting the development of the economic circle around the Bohai Sea.

3. 2 Prediction of Pollution in Bohai Sea

The aggravation of pollution grade and the increase of marine pollution area as well as the total amount of pollutants entering the sea will inevitably lead to the increase of the number and area of red tides, the deterioration of atmospheric quality and marine biological quality. Therefore, the core of pollution in the Bohai Sea is the level of marine pollution and the size of its area.

In the pollution level, the cleaner sea area refers to the sea area that meets the first category of the national seawater quality standards. It is suitable for aquaculture area, seawater bathing area, seawater sports and entertainment area where human body contacts seawater, and industrial water area related to human consumption directly.

The slightly polluted sea area refers to the sea area that meets the second category of the national seawater quality standards and it is suitable for general industrial water areas.

The moderately polluted sea area refers to the sea area which meets the third category of the national seawater quality standards and it is only applicable to the sea port waters and the marine development operation areas.

The severely polluted sea area refers to the sea area which is inferior to the fourth category of sea water quality in the national seawater quality standard.

	Second Category	Third Category	Fourth Category	Less Fourth Category	Total
2009	8970	5660	4190	2730	21550

2010	15740	8670	5100	3220	32730
2011	14690	8950	3790	4210	31640
2015	23160	10300	6430	7200	47090
2016	11660	6670	2340	3050	23720
2017	15710	8300	4780	3690	32480

Table 3.1 The volume of water except the first category in the Bohai Sea

Source: China Marine Environmental Quality Bulletin

By 2030, except for the current waters pouring into the Bohai Sea from the Yellow Sea, the areas where the Bohai Sea can be polluted will have been polluted. By that time, the Bohai Sea would become a garbage dump full of inorganic nitrogen, phosphate, lead and mercury pollutants.

It can be said that at that time, the aquatic life in the Bohai Sea will face a fatal threat. The human living environment around the Bohai Sea will be suffering increasingly serious damage and affecting people's health. If the pollution will not cured in time, the Bohai Sea will soon become a stagnant pool.

If we pay attention to the importance of environmental protection work and take timely and effective measures, we will be forced to reduce the amount of pollutants discharged into the Bohai Sea, prevent the expansion of the pollution area in the Bohai Sea, conserve and recover more marine resources, create a good living and working environment for the people of the economic circle around the Bohai Sea, and make greater contributions for the people of China and the whole world.(Zhang ,2014)

CHAPTER 4

Types, Characteristics and Consequences of Pollution in Bohai Sea

Following the definition of marine pollution by the United Nations, the definition of pollution in the Bohai Sea is ‘substances or energy brought into the marine environment in a direct or indirect way by human activities around the Bohai Sea result in or cause damages to marine living resources possibly, human health problem, impeding fishing and other legitimate activities, impairing the normal use value of the sea water and reducing the quality of the marine environment. Ocean damage caused by natural factor such as soil erosion, submarine volcanic eruption and natural disasters does not belong to marine pollution. (Li, 2007)

Besides through human activities in the ocean, pollutants generated by human activities on land or other areas will eventually enter the ocean through rivers or precipitation processes such as atmospheric diffusion, rain and snow. There are many ways which could cause marine environmental pollution. The most common forms are land-based pollutant discharge, discharge of marine resource exploration, ship pollutant discharge and pollution caused by ship accidents. This chapter will illustrate the seriousness of pollution in the Bohai Sea from three aspects: types, characteristics and consequences.

4. 1 Types of Pollution in Bohai Sea

Generally speaking, the concentrations of phosphorus and nitrogen in the coastal zone of the Bohai Sea are much higher than that in the general seawater. At the same time, the concentrations of phosphorus and nitrogen of petroleum products hardly exceed the standard relatively. Therefore, it can be inferred that the main problems of water quality and eutrophication in Bohai Sea are mainly caused by nutrient nitrogen and phosphorus. In addition, the concentrations of phosphorus and nitrogen in the central part of the Bohai Sea are relatively stable, and their changes are gentle. While in the Liaodong Bay, the Bohai Bay and the Laizhou Bay, the changes are intense every year.

With the weak transport of material in the ocean current, most of the polluted sea areas are near the coastal zone, especially in the estuary area. The reason for this situation is that the coastal zone is more susceptible to land-based activities than the central Bohai Sea. In different sea areas and different time periods, land activities posed the impact in varied frequency and degrees. Therefore, land activities should be considered as the main factor of water quality decline and eutrophication in the central Bohai Sea. Water quality decline in the central Bohai Sea is basically the result of mixed diffusion of pollutants from the coastal zone.(Jiang,2006)

Officials from the State Oceanic Administration pointed out that the pollution of domestic water, industrial waste water, pesticides and fertilizers around the Bohai Basin was three main land-based sources of pollution. The most important link in the Bohai Sea that needs to be harnessed is the land sources of pollution as the land-based pollutants account for more than 80%. There are more than 50 rivers flowing into the Bohai Sea all year round. Many rivers are trans-provincial, municipal and county-level. Urban sewage and industrial waste water are discharged into these basins and eventually flow into the Bohai Sea. Among them, the Yellow

River, Haihe River and Liaohe River are among the top four seriously polluted rivers in China.

In addition to liquid pollution, manual dumping of solid waste also causes considerable pollution. Up to now, the ocean is still regarded as a big dustbin and the waste is dumped arbitrarily into it.

4.1.1 Pollution of terrestrial industrial waste water

According to the investigation, it is quite common for high-polluting enterprises to discharge waste water into the Bohai Sea and its tributaries arbitrarily.

Shuigou Village, Wudi County, Shandong Province is located at the port of Zhangwei New River. In the past, there were abundant fish resources, but nowadays there are no fish or shrimp in the village, which are caused by pollution from paper mills and fertilizer factories upstream.

The pollution caused by Shandong enterprises is only a microcosm of enterprise pollution. Tianjin, Yongding, New River, Ziya New River, Canglang canal and other rivers are polluted seriously. The water is sauce oil color with a layer of oil flower and foam material in the surface, emitting a foul smell, and the embankment is dyed black and red, with floating white powder. (Diao&Ding, 2013)

At the exit of Sanli River into Luanhe River, urban sewage from Qianan City and waste water from enterprises, such as Huafeng Paper Mill flow through Sanli River into Luanhe River. In January 2001, the COD of sewage reached 1433, which exceeded the national standard of discharge by more than five times.

Nearly 90 percent of the monitored sewage outlets around the Bohai Sea have exceeded the emission standards. At present, nitrogen, phosphorus and heavy metals in sewage are the main pollutants in the ocean. These pollutants are mainly produced by industries around the Bohai Sea.

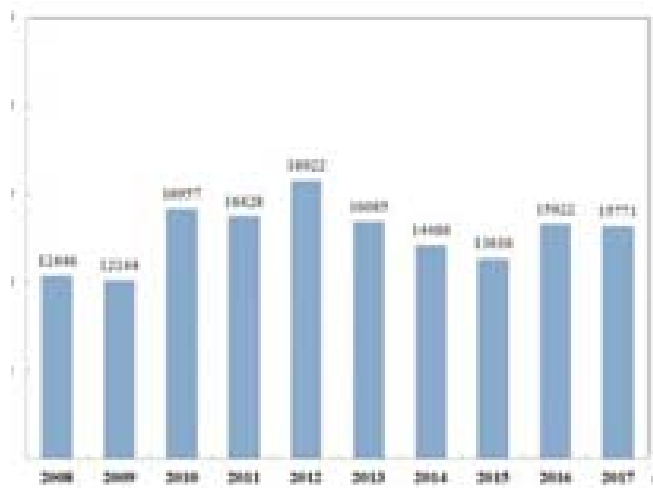


Table 4.1 A thumbnail map of the amount of waste dumped in the Bohai Sea from 2008 to 2017

Source: China Marine Environmental Quality Bulletin

4.1.2 Pollution of Fertilizer, Feces and Sewage in Farmland

In order to promote plant growth and increase the yield of agricultural products, people often use more nitrogen and phosphorus fertilizers, which can flow into river during rainfall or irrigation easily.

Poultry and livestock will produce a large amount of excreta which is rich in nutrients and bacteria. They easily pollute the water of lakes and rivers through surface runoff. In addition, excessive use of livestock manure in farmland can also cause nutrients in manure to run off from the surface, thus polluting the water.

(Zhang, 1985)

Sewage, as a reliable source of water and cheap fertilizer, is used to irrigate farmland. It is an advocated way of to utilize sewage in agriculture. The purpose is to purify sewage through the purification of soil and the absorption of nutrients by crops. However, some waste water has high nutrient content, which often causes soil and surface water pollution.

4.1.3 Municipal Sewage

Urban pavement is mostly impervious surface, and nitrogen and phosphorus nutrients in urban sewage mainly enter surface water through its runoff. Nitrogen and phosphorus nutrients in cities and towns mainly come from human domestic waste, domestic sewage, some industrial and commercial waste water.

4.1.4 Ship pollution

First of all, oil pollution from ships. This kind of pollution can be classified into discharge ship pollution and accident ship pollution. At present, the number of ships entering and leaving Bohai Sea coastal ports is tens of thousands each year, with a total tonnage of several million tons. The leakage of petroleum products and domestic sewage caused by ships will also pollute the Bohai Sea.



Figure 4.1 Schematic diagram of oil spill pollution range in Penglai Oilfield

Source: Liu X.B. (2013). Environmental pollution and its control in the Bohai Sea.

4.1.4.1 Pollution of Ship Discharge

Pollution of ship discharge are caused by the normal operation and dumping of ships. The first kind of pollution is quite common in navigation. It is mainly caused by the intentional or negligence of ship workers. For example, some ship workers discharge waste water containing harmful substances into the sea intentionally, or discharge fuel into the sea by mis-opening valves due to their weak responsibility. The second kind of pollution source mainly comes from the ships that pass situation and dump deliberately production waste generated from the land factories, domestic garbage, and sewage sludge with pollutants generated by polluted channel and riverway while cleaning into the ocean. (Hu, 2018)



Figure 4.2 Pictures of marine pollution of ship discharging

Source: Jiang Y.Q. (2000). Marine Ship Pollution Prevention

4.1.4.2 *Pollutio nof Ship Accidents*

Pollution of ship accident is caused by marine accidents, such as collision, stranding, striking a reef and other accidents, which cause various pollutants spill, leakage and other pollution to the ocean. Pollution of ship accidents is an important cause of marine environmental pollution. Although it is not domain in the whole marine pollution, it has great impact and harm.

In addition to oil pollution, toxic liquid substances from ships also pose a hazard to the Bohai Sea. These substances can be classified into four categories, including A, B, C and D. Among them, category A is the most serious pollution and category D is the least one. If these toxic liquid substances, or ballast water, washing water containing

such substances, or their residues and mixtures are discharged into the sea, irreversible effects on the environment of the Bohai Sea will be made unless they fully meet the discharge conditions of MARPOL Annex II for special areas or within special areas.

2. MARPOL Annex II: Pollution categorization

Previously there were 5 pollution categories within Annex II:

- categories A, B, C, D and an Appendix III
- Appendix III listed products to which the IBC Code did not apply

As of 1st January 2007 we have 3+1 pollution category system:

- X, Y, Z and OS
- OS or Other Substances - includes apple juice, clay slurry, coal slurry, dextrose solution, glucose solution, kaoline slurry, molasses and water
- Vegetable oils now upgraded from Appendix III (of the IBC Code) to Pollution Category Y
- Oil like substances no longer exist (xylene, toluene, pentanes now require CoF and can no longer be carried on product tankers)

Figure 4.3 MARPOL Annex II

Source: <https://wenku.baidu.com/view>

Ships also produce garbage that pollutes the oceans. MARPOL Annex IV points out that garbage refer to the waste of various food, daily necessities and work supplies produced during the normal operation of ships.

4.1.5 Atmospheric deposition

Atmospheric deposition is not only one of the sources of suspended particulate matter and harmful gases, but also one of the sources of nitrogen. When the fuel burns, nitrogen enters into the air in the form of its oxides, and falls on the surface of

the soil or water with rain and snow, polluting the surface water source.

4.1.6 Artificial aquaculture

Many water bodies are not only water sources, but also places for artificial breeding. With the development of aquaculture, bait and fish excrement bring a large amount of nitrogen and phosphorus, which is the another reason of eutrophication.(Waldichuk., 1973)

4.1.7 Pollution from offshore oil exploration and development

Petroleum is one of the most abundant pollutants, and its pollution is harmful to marine biological resources. Oil is easy to form thin film on water surface, which prevents air exchange and reduces dissolved oxygen in seawater, so oil pollution can cause large-scale anoxia. Oil film and its block can stick a large number of fish eggs and juvenile fishes, causing them to suffocate and die, and it can also lead to the deformity of egg-shaped juvenile fishes, resulting in accumulation of some carcinogens in fish and shellfish. (Chen&Li, 2003)

4. 2 Characteristics of Pollution in Bohai Sea

Due to the particularity of the ocean, there are many differences among marine pollution and air pollution as well as land pollution.

First, there are wide ranges of sources of pollution, which we have already mentioned.

Second, the ocean is the lowest terrain on the earth. It cannot reduce or even eliminate pollution through a rainstorm or a flood season just like the atmosphere and

rivers do. When pollutants enter the ocean, they are difficult to transfer out. The more insoluble and non-decomposable substances accumulate in the ocean, and they will be transmitted through the concentration of organisms and the food chain, thus posing a potential threat to human being.

Third, the range of pollution in the Bohai Sea is too wide. It can be observed that the range of pollution in the Bohai Sea extends from estuary area to the whole coastal zone, and even increases obviously due to the influence of ships. Even if the concentration of pollutants does not change much, the contaminated area of the Bohai Sea is almost expanding year by year.

Global oceans are interconnected as a whole. Pollution in the sea area tends to spread to the surrounding sea areas, even to the adjacent oceans. Some later effects will also spread the whole world. For example, after the ocean is polluted by oil, the surface of Bohai Sea will be covered by a large area of oil film, which hinders the normal exchange between the ocean and the atmosphere, and may affect the global or local climate anomalies. In addition, petroleum which enters into the sea, after various physical and chemical changes, eventually forms black asphalt balls, which float on the sea for a long time, and also has a serious impact on the marine environment.

Fourth, prevention and control is difficult and harmful. The Bohai Sea is a semi-enclosed inland sea in China, with an area of nearly 78,000 square kilometers and a coastline of more than 3700 kilometers, rich in fisheries, sea salt, oil and other resources, and nearly 100 coastal commercial and fishing ports. (Pan, 2010) At present, with the rapid economic development of the Bohai Rim, the ecological environment of the Bohai Sea is deteriorating day by day, and the pollution situation is becoming increasingly serious.

Marine pollution has a long accumulation process. Once pollution is formed, long-term treatment is needed to eliminate the impact, and the cost of treatment is high. The harm will spread to all aspects, especially the harm to human body, because it is difficult to clean up completely.

4.3 Serious consequences of pollution in the Bohai Sea

4.3.1 Water eutrophication

Eutrophication is a phenomenon of water pollution caused by the excessive plants with nitrogen and phosphorus and other contents. The process of water eutrophication is closely related to the volume of nitrogen, phosphorus. In general, if phosphorus and inorganic nitrogen are 20 mg/m³ and 300 mg/m³ respectively, it can be considered that the water body is in an eutrophic state. (Peng&Chen, 1988)

The specific hazards caused by eutrophication are mainly reflected in the following aspects:

First, aquatic organisms, especially algae, will multiply rapidly, making the space for fish activities smaller and smaller. Thus the number of species of organisms changes, the ecological balance of the original water bodies is destroyed, aquatic ecosystems is in disturbances, aquatic species reduces. This led to the destruction of diversity.

Second, the harmful gas generated by the decomposition of organic matter accumulated under the eutrophic water in anaerobic conditions, as well as the biotoxins produced by some plankton can also damage aquatic organisms, causing some marine organisms to lose their limb function and reproductive capacity, so the

number of certain marine organisms has fallen sharply and they are in danger of extinction.

Third, in eutrophic water, algae species are gradually reduced, and diatoms are mainly converted into cyanobacteria by green algae, and many species of cyanobacteria have colloidal membranes, which are not suitable for fish bait.

In eutrophic water, algae species are gradually reduced, and diatoms and green algae are mainly converted into cyanobacteria, while cyanobacteria have many kinds of glial membranes, which are not suitable for fish bait. (Hu, 2000)

Fourth, the red tides occurs, the consequences of which have been mentioned in the previous section and will not be repeated here.

4.3.2 Destroy the ecological environment

At present, the Bohai Sea mainly faces three ecological problems:

First, the ecological water is decreasing. Land-to-sea ecological fresh water, such as the Haihe River, the Weihe River, the Yellow River, and the Liaohe River, is reducing. The eutrophication of polluted water causes algae to produce toxins containing nitrites. If humans and animals drink such water with harmful substances exceeding a certain standard, they will end in poisoning and disease.

For example, the water in the Wuli River along the Bohai Sea is polluted seriously, the villagers along the river can only spend money to buy pure water. In addition, due to the heavy fishy smell, the ecological water is reducing significantly. The Water

Resources Department of the Tianjin Water Resources Bureau confirmed that in addition to the introduction of Luanhe River water into Tianjin, the water in other rivers is basically four category of water.

Second, with the increase in the surrounding areas of Bohai Sea and its own development, the sources and scope of pollution have increased, the degree of pollution has intensified, which causes serious damage to people's production activities, living environment, and tourism environment. If serious ship pollution, especially oil pollution, occurs due to improper management or operation, there will be an appearance of foam, scum or extremely disgusting odor, which will destroy the beautiful natural landscape and make the local region lose tourism value.(Hu, 1979)

Third, some of the fine shorelines and beaches in the Bohai Sea are gradually decreasing, and the area of the polluted beaches is getting larger and larger. Liaodong Bay, the Yellow River Delta, Hebei Province and other places had many wetlands in the past. In recent years, the area has been greatly reduced for human and natural factors. The Liaohekou wetland has deteriorated more than half in 20 years, and the Yellow River Delta wetland has lost more than one-third.

The oil-to-standard rate in the Liaodong Bay waters reached 75%, while Jinzhou Bay reached 100%. Industrial toxic and hazardous wastes have also been moved toward Jinzhou Bay at a speed of 10 meters per year. Since 1992, more than two square kilometers of beaches have been abandoned.

4.3.3 Threaten human health

Since the toxic substance in various pollutants in the Bohai Sea is eaten by marine

organisms, they are a part of the food chain. When people eat these marine organisms, the toxic substances from them will endanger people's health. According to statistics, these marine organisms with toxic substances have caused the test values of mercury, lead and arsenic in the hair of fishermen in some areas to exceed normal test values, and the incidence of cancer has increased significantly.

Except for Hebei Province, the mortality rate of fishermen with malignant tumors in other provinces and cities around the Bohai Sea is higher than other areas. Hundreds of people died of cancer in the 1980s in Yudongfu Village, Shandong Province. More than half of the children were found to have large liver. The content of arsenic and mercury in the hair of Huludao fishermen is much higher than normal content. In addition, the deterioration of water quality caused by pollution, coupled with the decay and odor of marine life, will also affect the health of local residents. (Hu, 2010)

4.3.4 Causing Huge Economic Losses

In order to control pollution in the Bohai Sea, China has spent a large amount of money every year, and the Bohai Plan which is a plan to prevent the pollution of Bohai Sea in China costs more than 50 billion Yuan. (Wang, 2013)

In addition, pollution from ships and drilling platforms, especially the direct loss of material wealth, the indirect costs of preventing and mitigating pollution damage, are quite alarming. Its direct loss is about tens of thousands of tons oil flowing into the Bohai Sea every year, and the government pays much more money on actions to eliminate the damage.

The pollution crisis in the Bohai Sea is not isolated. The environmental crisis caused by pollution in the Bohai Sea and the survival crisis of people, animals, plants, and other lives have threatened the survival environment and sustainable economic development of coastal areas such as Beijing and Tianjin, will then create the development crisis of a country. Therefore, it is absolutely necessary to make great efforts to control pollution in the Bohai Sea.

CHAPTER 5

The Referential Experience of Pollution Governance in Bohai Sea

The pollution control effect of Bohai Sea is not significant, but it doesn't mean there is no prevention and control measures for Bohai pollution. China's Hangzhou West Lake and Japan's Seto Inland Sea are very effective in sewage control, and the three sea areas are very similar. So if researchers do some analysis and references, we will increase our confidence in Bohai Sea pollution prevention and sort out the idea of Bohai Sea pollution control.

5.1 Successful Experience in Prevention and Control of Pollution in Hangzhou West Lake

The following is the specific pollution control process and the measures to reduce pollution in Bohai Sea obtained from the process of pollution control of West Lake in Hangzhou.



Figure 5.1 West Lake Scenery in Hangzhou

Source: Study Group on Ecological Environment of West Lake Basin. (2002).

First, publicize the concept of New West Lake as far as possible. The West Lake Comprehensive Protection Engineering Group has introduced the construction method of New West Lake for six times. By increasing the degree of transportation convenience and implementing the free opening of scenic spots, the water area has been expanded. With the increase of public green space in scenic spots, the appearance of the West Lake is getting newer and newer, and the ecology will become better and better. However, the comprehensive large-scale projects cannot be accomplished overnight. Drawing lessons from the successful experience of the West Lake, our propaganda on pollution control in the Bohai Sea should also be constantly revised. Only propaganda for the West Lake governance, the government has used high-tech means, physical, model, film or multimedia combination mode, or employed museums, exhibitions, on-site experience and other modes to display and communicate, continuously improving people's understanding of the governance of the West Lake. Obviously, the propaganda of 'New Bohai Sea' failed to reach this level.

Second, technical protection, such as Hangzhou Xixi Wetland Comprehensive Protection Project. The first National Wetland Park in China was born after the implementation of this project. Through comprehensive protection, the natural ecology of Xixi Wetland has been well restored, biodiversity has been further appeared, greening function has been further enhanced, while the cultural context of Xixi Wetland has been inherited. There are also many wetlands in Bohai Bay. So it is a good suggestion to build wetland parks, plant trees, graze sheep and develop special tourism projects over there.

Third, people must pay attention to cultural development and protection. Through comprehensive protection of the Hangzhou Canal, a large number of historical and

cultural relics, such as bridges, docks, shipyards, granaries and residential houses, has been protected and repaired. Likewise, the product culture of the Canal, and its civilization of waterscape, opera, temple fair market, and customs have been rescued and inherited. Among them, there are two landscape corridors and walkways along the river on both sides of the canal, up to 21 kilometers long. In the management of the river leading to the Bohai Sea, we can also open up the market for multi-cultural inheritance in order to promote comprehensive protection.

Fourth, the river regulation technology is very important, and its key aspect is the organic renewal of the river. Through river dredging, water distribution and other means, the protection of old urban areas and the improvement of dilapidated houses are carried out to realize the perfect combination of history protection and fashion. We can also make organic updates of the rivers leading to the Bohai Sea so as to make the environment normal and improve the quality of people's life who live along the coast.

Fifth, the key river harnessing technology should be implemented as soon as possible. Hangzhou has implemented the Qiantang River Basin Governance and Implementation Plan for the ecological protection of the Qiantang River system. Through relocating industrial enterprises, building large-scale sewage treatment plants and commissioning the sewage collection networks, the discharge of pollutants from the source can be controlled. In addition, Hangzhou has established a series of measures to improve the water quality management and publicity system of the boundary section of jurisdiction, and worked together with neighboring cities to control the pollution.(Cheng, 1979)

Sixth, staff in all regions should jointly build and share governance tools.. Hangzhou

has committed to the principle of people-oriented, co-construction and sharing. Firstly, Hangzhou adheres to ecological priority, protection first, and the firm establishment of the concept of everyone's responsibility, thus forms a benign interaction among government, media, experts and citizens. Secondly, through linking the whole line around the West Lake and opening the scenic spots free of charge, the goal of joint governance can be achieved.



Figure 5.2 West Lake Scenery in Hangzhou

Source: Study Group on Ecological Environment of West Lake Basin. (2002).

Seventh, the employment of biological treatments, natural purification of pollution control technology is crucial. With diverting water from high places to the west and long-distance natural purification, the quality of water has been obviously improved. At the same time, take the bioremediation technology to optimize the ecosystem, and improve the quality of water and environment. As a result of that, the West Lake and Xixi wetland have become the habitats for a host of creatures. Pollution control in the Bohai Sea can also adopt the technology of biological control and natural purification in suitable areas, and conduct a self-optimization of ecosystem with low cost and high efficiency.

From the successful cases of harnessing the West Lake, we can generally analyze

three operational measures to reduce pollution in Bohai Sea. First, we can delineate the control areas and implement the measures of relocation or other ways to eliminate pollution sources. Second, the polluted beaches and waters should be enclosed half or all within a reasonable size and shape in order to avoid cyclic pollution. Third, the pollution that cannot be treated locally should be harnessed manually by guiding the sewage into the areas, and then let the clean water flow out.

Next, let's look at how the Seto Inland Sea, Japan, which has more similarities with the Bohai Sea, has managed pollution successfully.

5. 2 Successful Experience in Preventing Pollution in Seto Inland Sea

The Seto Inland Sea of Japan, as shown in the picture, is also almost a semi-closed inland sea among Honshu, Shikuo and Kyushu, Japan, and used to be a natural fish barn, which the Japanese call the richest bay. Covering the area of 9500 square kilometers, its east-west length is about 440km, and the north-south width is 5-55km. Moreover, the general depth is 20-40 meters. The climate is characterized by a lack of rain and dryness.(Ma&You, 2008)

By the end of 1940s, Japan began to develop its economy with all its strength after the defeat of the war. The industrial layout gradually concentrated along the coast. Seto Inland Sea coast became the most important industrial base in Japan, and it soon became the garbage pool of these industrial sectors. The factories discharged untreated industrial waste water into the Seto Inland Sea at random, with surprisingly high levels of heavy metals, such as copper, lead and mercury.



Figure 5.3 Scenery of Seto Inland Sea

Source: Shi P. (2006). Records of Inland Sea Regulation in Seto.

After 1955, the pollution of the Seto Inland Sea became increasingly serious. The red tide developed to dozens of times a year once a decade later. In that process, Minamata disease, which shocked the world, occurred. It has aroused the panic and serious concerns of the Japanese government and people. Since the 1970s, Japan has begun to harness the Seto Inland Sea, and it has taken them nearly 30 years to restore the Seto Inland Sea to a basically clean sea area. The following is a description of Japan's methods for harnessing the Seto Inland Sea.



Figure 5.4 Waste of Seto Inland Sea

Source: Shi P. (2006). Records of Inland Sea Regulation in Seto.

First, Japan advocates the use of law to control marine pollution. In addition to promulgating and implementing laws of universal binding significance, such as the Law on the Prevention of Marine Pollution and Marine Disaster Prevention and the Law on the Prevention Water Pollution, for the Inland Sea, Interim Measures Order for Environmental Protection in the Seto Inland Sea has also been launched. Its main content is to limit the load of industrial wastewater discharged into the Seto Inland Sea and its adjacent sea areas, requiring that the discharge of industrial wastewater reduced by half. Within three years, the pollution load related to industrial wastewater should be gradually reduced to a prescribed level. The law also stipulates that enterprises must apply to the local government in advance if they want to set up facilities for discharging sewage into public waters. After receiving the application, the local government should immediately publish its outline and provide relevant written materials for public reading. At the same time, the local government should inform the departments concerned with the environment and seek their opinions. In this process, the government may at any time refuse to approve the application for the facility because it does not comply with the relevant legal provisions . (Shi, 2006)

Although in China, regulations on controlling pollution in Bohai Sea have been issued by some departments or local authorities, such as the Maritime Administration's Regulations on Lead Sealing Management of Marine Sewage Disposal Equipment in Coastal Seas, as a whole around the Bohai Sea; we still do not have detailed and complete stipulations for pollution control. As a large marine country, China should speed up the pace of marine environment legislation, further improve the legal system of marine environment, and formulate laws specifically related to the governance of the Bohai Sea, so that the issue of total emission control index of pollutants can be solved from the principle provisions to the specific implementation. It is also necessary to standardize all localities in the form of laws

and regulations, strictly implement the double control system of the total amount of pollutants entering the sea and the discharge of sewage up to the standard, raise the rate of sewage treatment, and increase the punishment for illegal discharge of sewage enterprises exceeding the standard and local environmental protection inaction.

Second, Japan has made a clear division of responsibilities among government departments at all levels. Marine environmental protection work throughout the country is coordinated by the Department of Environment, and marine pollution shall be handled by the Maritime Security Department. Likewise, other provincial departments and local governments at all levels are also responsible for pollution monitoring under their respective jurisdictions.

The responsibility of pollution control of governments and related departments at all levels in China has also made a corresponding division of labor. However, the problem of uncoordinated work between departments cannot be ignored, and the joint force of comprehensive governance cannot be formed. In addition, there are three provinces (including Hebei, Liaoning, Shandong) and two cities (including Tianjin and Dalian), as well as other 13 coastal cities and giant enterprise groups (including Sinopec, CNOOC and Shenhua etc.). As they do not belong to each other and have their own interests, China has to scientifically determine the Bohai Sea environmental protection organization, clarify the functions of various departments, and decentralize the rights and responsibilities of comprehensive governance of the Bohai Sea to local provinces, municipalities and other levels of governments, so as to publicize and mobilize the whole people, removing obstacles to environmental law enforcement in the Bohai Sea.

Third, Japan has also established a system of environmental protection work

meetings attended by mayors of coastal cities in the region, which plays a very important role in the prevention and control of marine pollution.

China has also established the Bohai Sea Marine Pollution Emergency Interaction and Cooperation Mechanism, but that is mainly designed for the Maritime Bureau and the professional emergency response force system, far from replacing the entire Bohai Rim region or its parts of its pollution control work conference system. If there is such an all-sided system, the pollution control of Bohai Sea is not only a point, line or partial action, but a comprehensive one.

Fourth, Japan has made great efforts to strengthen its investment in environmental investigation and surveillance in the Seto Inland Sea. In the 1970s, Japan set up hundreds of observation stations throughout the whole Seto Inland Sea, and all kinds of automatic monitoring equipment can observe continuously. Many comprehensive surveys of marine pollution have been carried out. As a result, the pollution control organizations have a clear understanding of pollution status of Seto Inland Sea.

At present, when it comes to establishment of observation stations, we still have inefficient and wasteful phenomena. Marine administrative department and the state environmental protection department of China has a set of marine environmental monitoring network respectively. Each of them requires at least 2 million Yuan investment plus an annual operating cost of 40 thousand Yuan in average. The duplicate construction of the two monitoring networks causes huge waste, and there is also a phenomenon of inconsistent monitoring data in the Bulletins of both sides, which are the problems that the government should pay attention to.(Jiang, 2000)

Fifth, Japan has established scientific research institutes such as the Institute for the

Prevention of Water Pollution in Seto Inland Sea and the Institute for Marine Biological Environment. Many other provinces, departments and local government institutes, as well as universities and civil society organizations are also engaged in environmental scientific research related to the prevention of marine pollution. These related scientific research institutions have provided tremendous technical support for marine ecological protection.

Sixth, Japan's semi-official Inland Sea Environmental Protection Association has also played an important role, and non-governmental environmental protection organizations were born in large numbers, ranking first in the world. All sectors of society are publicizing the importance and necessity of protecting the Seto Inland Sea.

Seventh, and most importantly, in order to cut off the source of pollution, the Japanese government has removed the chemical plants which produce severe pollutants from the Seto Inland Sea, and greatly reduced the area of reclamation. Most areas of the Seto Inland Sea have been planned as national parks and more than 800 wildlife reserves have been established. By the early 1980s, the water quality of the Seto Inland Sea had basically returned to a good condition, with marine catches exceeding those of the 1950s. So far, the resources and environment of the sea area and coastal areas have been restored and developed, and the economic growth of the Seto Inland Sea has surpassed the level of 1960s. In this regard, in order to cut off pollution sources in the Bohai Sea, we should shut down polluting enterprises with low social benefits, and merge and transfer the factories which are prone to pollution.

Above all, we have analyzed the successful experience of harnessing the West Lake and Seto Inland Sea. Since both the West Lake and the Seto Inland Sea can be well

harnessed, so can the Bohai Sea. In the next chapter, the paper will discuss three ways to prevent pollution in the Bohai Sea.

CHAPTER 6

Prevention of Pollution in Bohai Sea

Prevention and control of marine pollution is a diversified process, and we have to work hard in many ways. Here are three crucial points, namely to raise the public's attention, to improve regional legislation and to strengthen the coordination mechanism. I will state that how to prevent and control pollution in the Bohai Sea from above three points. (Du, 2018)

6.1 Strengthening propaganda work on pollution prevention and control in Bohai Sea

In light of the experience of governance of West Lake and Seto Inland Sea, it is very important to strengthen publicity and education. Raising awareness is a subjective prerequisite for the prevention and control of marine pollution. The following is mainly about ways to raise the awareness of environmental protection, statement of the relationship between economic development and environmental protection, and how to play the role of public supervision of pollution in the Bohai Sea. (Yang A.Q.&Han Y.L., 2006)

6.1.1 Enhancing the awareness of environmental protection

There is no doubt that many professionals have realized the seriousness and urgency of pollution in the Bohai Sea, but the problem has not been solved that key people

and the public have not realized that. The key people here refer to the environmental protection leaders at all levels in the Bohai Rim Region. If they don't fully understand the seriousness and urgency of pollution in the Bohai Sea and don't pay more attention to the prevention and control of pollution, it is almost impossible to achieve pollution control in the Bohai Sea.

Therefore, China's propaganda department should use all available forms of text, pictures, videos, and meetings to make all people, especially key groups aware of the harm of pollution in the Bohai Sea, to raise the awareness of marine pollution and environmental protection of them, to establish the concept of environmental protection, to promote technological progress and to reduce pollutant emissions and dumping.

6.1.2 Strike a balance between development and environmental protection

With an overall standpoint and long-term historical view, environmental protection and economic development should be coordinated, and with the requirement of final political situation, economy cannot be developed at the cost of environmental damage. On February 14, 2006, the State Council issued The Decision of the State Council on Implementing the Scientific Outlook on Development and Strengthening Environmental Protection. It stresses that China should solve environmental problems while developing its economy, promote the fundamental transformation of economic restructuring and mode of economic growth actively, and change the situation of 'polluting first, preventing next' and 'preventing while polluting'. The Decision puts environmental protection in a more important strategic position. Economic and social development must be coordinated with environmental

protection. We should guide environmental protection with the Scientific Outlook on Government and establish a long-term mechanism to improve environmental protection.

But there is a big problem on enterprises. Enterprises survive on profits. If environmental protection standards are strictly enforced, a considerable number of enterprises will come into depression or even close down. The problems of employment, finance and even society caused by it are unbearable for any local government. Of course, both economic development and environmental protection are what we need, but when contradiction between them emerges, it's better to slow down the economic development, or even stop the development. The environment cannot be destructed even at the cost of economic retrogress.

There is no doubt that the Bohai Rim is an important area for coal, steel, thermal power, petroleum, chemical and paper industries in China. I think if these industries is on the decline for ignorance of governance, it is a historical choice, and we must accept it.

Government staff should publicize this idea with people so that everyone can be influenced imperceptibly. In this way, a stride will be made in the prevention of pollution in Bohai Sea.

6.1.3 Give full play to the supervisory role of the masses in the Bohai Sea

It is necessary to intensify the publicity of public opinion, enhance the awareness of environmental protection of people, arouse the enthusiasm of the public for marine environmental protection work, give full play to the role of supervision of the masses,

strive for the attention and support of the society for marine environmental protection , and do its utmost to reduce pollution to the Bohai Sea.

Among the numerous pollution, the marine pollution caused by oil spill from ships is characterized by great contingency and unexpectedness, which is difficult to detect. But once a pollution accident happens, the loss will be huge. In Marine Environment Protection Law of the People' s Republic of China, Chapter I Article IV stipulates that all departments and individuals have the obligation to protect the environment, and have the right to supervise and report illegal action and dereliction of duty of the departments and individuals who pollute and damage the marine environment. (Qu& Yu, 2008)

Therefore, it is important to realize and understand the importance of protecting the marine environment, strengthening education of safety, possessing environmental awareness, and making efforts on reporting for managers and front-line operators of ports and shipping enterprises.

Publicity and education are not omnipotent, and coercive law are often indispensable. Therefore, in order to protect the environment of the Bohai Sea, all people in China should understand and comply with all established and reasonable laws, regulations and systems. Some laws should be corrected and improved, and should be completed as soon as possible. Only in this way can the pollution in the Bohai Sea be decelerated and the aim of eliminating pollution in the Bohai Sea be achieved ultimately.

6. 2 Improving Pollution Prevention and Control Legislation in Bohai Sea

6.2.1 Brief Introduction of International Convention on Pollution

Prevention and Control and Domestic Related Laws and Regulations

The legislation of marine pollution prevention and control in China cannot be separated from the international legislation of marine pollution prevention and control. Relevant international legislation can be divided into different types according to different sources of pollution. For example, International Convention for the Prevention of Pollution from Land, International Convention for the Prevention of Pollution from Ships, International Convention for the Prevention of Pollution from Seabed Activities, and International Convention for the Prevention of Pollution from the Atmosphere. Of course, some conventions are not only about one source of pollution. Most of the international anti-pollution conventions are introduced in Chapter 1-1. Next, I will talk about the current situation of domestic legislation.

6.2.2 Current Situation of Domestic Pollution Prevention and Control

Legislation

China has actively participated in international cooperation of the protection of the marine environment and the prevention and control of pollution, and has successively acceded to the following Conventions: International Convention of Civil Liability for Oil Pollution Damage in 1969 and its protocol in 1976, Convention on the Prevention of Marine Pollution from the Dumping of Ships and Aircraft in 1972, MARPOL in 1973 and its protocol in 1978, UNCLOS in 1982, International Convention On Oil Pollution Preparedness, Response And Co-operation in 1990, and the BWM 2004, which China acceded to on January 22, 2019.

Since the 1970s, China has paid attention to the means of laws to prevent pollution from ships and protect the marine environment. In 1974, the State Council promulgated the Provisions for Preventing Pollution in Coastal Waters. In 1979, the Trial Implementation of the Environmental Protection Law was promulgated, which stipulates principle provision for the protection of our environment and the prevention and control of pollution, including ship pollution. Many provisions were also made in the 1982 Constitution. Then in 1989, Environmental Protection Law of the People's Republic of China was promulgated. In view of the serious pollution of the marine environment in China, the basic law for the protection of the marine environment, Law of the People's Republic of China on Marine Environmental Protection, was promulgated and implemented in 2000. Chapter IV stipulates "Preventing pollution damage to the marine environment by ships".

In 2006, China ratified and adopted 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Material. Generally speaking, domestic laws and standards should not be less effective than similar international rules and standards.

China's legislation on marine environmental protection has played an extremely important role in promoting the protection of marine environmental resources, preventing pollution damage from ships, protecting ecological balance, safeguarding human health and promoting the development of marine industry.

However, it is undeniable that our country still lacks complete anti-pollution laws and regulations system for enterprises, towns and ships, resulting in more and more problems in anti-pollution management. For instance, there are gaps in the definition of some illegal acts, some legal provisions are not available yet, and there is a lack of

mandatory measures that illegal acts can comply with.

We will explain the shortcomings of legislation and suggestions for improvement in the following two sections.

6.2.3 Filling in the Legislative Blank of Pollution Prevention and Control in Bohai Sea

First of all, in the international area, there is an urgent need to achieve anti-pollution in the Bohai Sea, but the Bohai Sea is not one of the ‘special sea areas’, which is defined as ‘sea areas where ships are prohibited from discharging waste under the Convention’ in MARPOL Annex II. As the Convention provides additional protection to the marine environment of the sea area, the anti-pollution requirements in the Bohai Sea therefore are extremely urgent. The failure to list the Bohai Sea in ‘special sea areas’ is naturally not conducive to making the international and domestic related populations pay full attention to the anti-pollution of the Bohai Sea. Therefore, relevant people should actively promote Bohai Sea to become one of the special sea areas in MARPOL. The Bohai Sea pollution prevention requirements are extremely urgent. Failure to include the Bohai Sea in ‘special sea areas’ is naturally not conducive to attracting the full attention of relevant international and domestic people to the pollution prevention of the Bohai Sea. Thus, those responsible for environmental protection should actively promote the Bohai Sea to become one of ‘special sea areas’ in MARPOL.

Secondly, in China, there are no comprehensive laws and Regulations on pollution prevention regarding Bohai Sea in China. The lag of Marine Environmental Protection Law and its supporting laws and regulations is one of the important

reasons affecting marine environmental protection.

Thirdly, there are deficiencies in existing laws and regulations. Except for the provisions of Chapter VIII of Marine Environment Protection Law of the People's Republic of China, Environmental Protection Law of the People's Republic of China, Law of the People's Republic of China on the Prevention and Control of Water Pollution, Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution, Law of the People's Republic of China on the Prevention and Control of Solid Waste Pollution, Law of the People's Republic of China on the Prevention and Control of Noise Pollution and others also have provisions on pollution prevention of ships. However, the provisions of these articles are mostly defined according to the types of pollution, and these laws mostly are implemented early. The provisions on the prevention and control of ship pollution are in a shortage, and there is inconsistency among them.

China should legislate regionally on the prevention and control of environmental pollution in the Bohai Sea. At present, the opponent is that there is no need for regional legislation. The key problem of pollution control in the Bohai Sea is law enforcement. Although the nation has relevant laws, but the law have not been implemented for the law enforcement which is not in place. Moreover, the Bohai Sea is a cross-basin and cross-administrative region, which covers a wide range of areas, and is too difficult to coordinate with existing laws, regulations and local regulations. So it is not easy to legislate separately for pollution control in the Bohai Sea. Obviously, this is a more conservative view. The affirmative view is that the Bohai Sea is both regional and comprehensive, and the existing laws related to oceans are not perfect. The current law only supplements the implementation of the parent law, so it is impossible to solve the problem of the Bohai Sea fundamentally. Therefore,

only some special legislation aiming at the Bohai Sea Region is the most effective. China's current environmental protection laws are basically universal and general, but they are unable to deal with such individual and special environmental protection problems of Bohai Sea.

Therefore, the prevention and control of environmental pollution in the Bohai Sea is arduous and complex, and the existing laws and regulations cannot meet the needs of environmental pollution in the Bohai Sea. So China urgently needs to make separate legislation for this special area.

6.2.4 Improving the legislation of ship pollution prevention and control

The main problems in the existing legislation of ship pollution prevention and control are that our country lays particular stress on administrative legislation. The past legislation cannot meet the needs of the situation, and the civil legislation is imperfect.

First of all, there are differences between the provisions of Marine Environmental Protection Law and those of international Conventions on the exemption of shipowners. In the prevention and control of ship pollution, maritime agencies sometimes draw on the management concept of international conventions or effective management experience and methods to deal with the anti-pollution management of domestic ships that are not applicable to international conventions. Although it fills some vacancies in the domestic anti-pollution management of ships, the principle of imputation of ship pollution tort is different from that of general tort in civil law.

However, the principle of liability for ship infringement is different from the

principle of liability for general infringement in civil law. The principle of ship pollution infringement rule is usually the principle of ‘no fault liability’ , which makes the management matters set up often conflict with national laws. At the same time, the owners of oil tankers in China are facing huge compensation when oil pollution damage occurs, which is not conducive to the development of offshore oil transportation. According to civil law, oil pollution victims cannot get proper compensation, especially the compensation for the cost of cleaning up pollution, resulting in the failure to recover the marine environment in time.

Moreover, the biggest beneficiary of oil transportation does not pay the oil pollution fund, which is not conducive to compensation and pollution control. China's current law does not require compulsory insurance for oil tankers of less than 2,000 tons. For ships of domestic routes of more than 2,000 tons, they are only required to hold the ‘Credit letter for Civil Liability of Oil Pollution.’ This makes the owners of China's oil tankers unable to bear the responsibility for cleaning up and the huge liability for compensation, and of course it is not conducive to the protection of the marine environment.

With the development of China's shipping economy, ship renewal and capacity adjustment, the safety and anti-pollution of domestic shipping has basically met the requirements of international conventions and has made great progress. Therefore, in order to make the owner, operator and crew of domestic vessels bear the corresponding anti-pollution obligations, it is necessary to gradually integrate with the international standards and internationalize the international conventions, so that the polluting shipping companies are able to pay compensation without bankruptcy. In addition, China's legislation on toxic substances, ship waste water, garbage and other aspects is relatively at a shortage, and has not participated in the corresponding

international conventions, such as Convention on Liability for Damage of Hazardous and Toxic Substances Related to International Maritime Transport.

Legislation cannot keep up with the needs of the situation, which is also reflected in the fact that the past small sum of fines is still used. Article 73 of Marine Environment Protection Law of the People's Republic of China stipulates that ‘If any of the following acts are committed in violation of the relevant provisions of this Law, the Department under the power of supervision and management of the marine environment in accordance with the situation stipulated in this Law shall order it to make corrections within a time limit and impose a fine. First, discharging pollutants or other substances prohibited by this Law into the sea. Second, those who do not discharge pollutants into the sea in accordance with the provisions of this Law, or discharge pollutants beyond the standards. Third, there are dumping wastes into the sea without obtaining a permit for marine dumping. Fourth, due to accidents or other unexpected events, marine environmental pollution accidents are caused, and no immediate measures are taken to deal with them. Whoever commits one of the first or third acts mentioned in the preceding paragraph shall be fined not less than 30,000 yuan but not more than 200,000 yuan. Any person who commits one of the second or fourth acts mentioned in the preceding paragraph shall be fined not less than 20,000 yuan but not more than 100,000 yuan. Ten years later, the economic level has been risen, the amount of fines should be amended which at least can make up for the losses as far as possible.

IMO attaches great importance to the marine environment problems caused by ship ballast water. Since the early 1990s, IMO has put the problem of ship ballast water on the agenda of Maritime Environmental Protection Committee (MEPC) and has conducted a comprehensive study.

In order to guide the control and management of ship ballast water, IMO has adopted many guiding documents or resolutions of meeting successively. European and American countries have begun to implement the regulations. For example, ships sailing to the United States from African ports where malaria mosquitoes are transmitted must clean the ballast tank with clean sea water during the sailing.

These guiding documents or resolutions will play a positive role in protecting the environment and reducing the spread of marine organisms and pathogens. In my opinion, although China has joined BWM 2004 in the beginning of this year, China should also strengthen legislation in this aspect and resolutely eliminate the pollution of the Bohai Sea caused by ship ballast water so as to protect the environment of the Bohai Sea.

6.3 Improving Pollution Prevention and Control Organization in Bohai Sea

In the following section, I will take into account the actual situation to analyze the main problems and solutions in the administrative organization and operation of pollution prevention and control.

6.3.1 Establish a integrated and coordinated mechanism

The Bohai Sea is a victim of pollution for many rivers entering into the sea. Upper reaches of rivers are also responsible for protecting water from pollution. However, due to the large investment in pollution control and the fact that rivers flow through many provinces, it is difficult to identify pollution liability. Moreover, the provinces and municipalities located in the upstream are often less urgent in the protection of water resources than those in the downstream which are plagued by water pollution.

Therefore, this has caused a situation, the downstream province is making efforts on environmental protection and pollution prevention work, while the upstream province focuses on economic protection at the cost of pollution. Therefore, an important reason for the difficulty in controlling land-based pollution is the lack of effective coordination and united command between the upstream and downstream provinces and municipalities in the basin.

Our country needs to attach great importance to the overlapping parts of the respective functions of the relevant government departments, so as to avoid the weak links in the joint parts. To prevent marine pollution, the key is to control the discharge of pollutants strictly. At present, the situation of pollution control in the Bohai Sea is not optimistic. On the one hand, it shows that the interests of various departments have exceeded the overall interests of the country. On the other hand, it also shows that the management is not conducive. The following table shows the marine management agencies at all levels along the Bohai Sea in Liaoning Province.

Liaoning Provincial Department of Ocean and Fisheries
Dalian City ic Bureau
Jinzhou City Ocean Fisheries Bureau
Panjin City Ocean Fisheries Bureau Ocean Office
Yingkou City Marine Fisheries Bureau Marine Resources Management Office
Huludao City Science and Technology Commission Ocean Management Office
Pulandian City Science and Technology Commission Ocean Office
Wafangdian City Science and Technology Commission Ocean Office

Gaizhou City Marine Fisheries Bureau
Panshan County Science and Technology Supervision Bureau Ocean Office
Yuzhong County Marine Fisheries Bureau Ocean Office
Xingcheng City Land Resources Bureau Ocean Office
Dawa County Science and Technology Commission Ocean Office

Table 6.1 Marine management agencies at all levels along the Bohai Sea in Liaoning Province

Source: Pan S.C. (2010). Prediction and prevention of pollution in the Bohai Sea. (Doctoral dissertation, Dalian Maritime University)

Zhangwei New River is the boundary river between Cangzhou in Hebei Province and Binzhou in Shandong Province. The sewage discharged into Zhangweixin River mainly comes from three aspects: the water coming from the Wei Canal in the upper reaches of Henan Province, the industrial and domestic waste water in Linqing City and Dezhou City in Shandong Province, and the waste water from the paper mills in Guantao City of Hebei Province and Xinglong Paper Mill in Linxi City. The pollution of Shandong and Hebei Province in the lower reaches of the Wei Canal mainly comes from Linqing and Dezhou, Shandong Province with 230,000 tons of sewage per day. Henan Province is the main source of marine pollution in Cangzhou, followed by Linqing City and Dezhou City, Shandong Province. So it belongs to a cross-provincial pollution problem. It can be said that although we want to prevent and control pollution mentally in the Bohai Sea, the corresponding anti-pollution system has not been established yet. Because of local protectionism, some places in the upper reaches of the Haihe River are only interested in interests and do not invest in pollution control, resulting in more and more sewage. In order to break down the obstacles of law enforcement and to improve the coordination and supervision ability

of regional water environment effectively, we should divide the districts which need to arrange their own water resources management and protection tasks respectively. Our country should establish a coordinated mechanism of land-sea integrated pollution prevention and a joint law enforcement mechanism based on river basins, and coordinate the establishment of regional pollution reduction system, detection system and assessment system.

In order to make the Bohai Bay clear, we must break down local protectionism and solve the problem of cross-provincial pollution in the Bohai Bay as soon as possible. For example, establishing an overall coordination group for environmental protection in the Bohai Sea so as to ensure that the pace of pollution prevention and control between the upstream, downstream provinces and municipalities in the relevant watershed is consistent.

The Marine Environmental Protection Law stipulates that the environmental protection administrative department of the State Council is the unified supervision and management department of the national environmental protection work, which guides, coordinates and manages the marine environmental protection work. Supervise national marine environmental protection work, be responsible for national environmental protection work, and prevent pollution damage to the ocean caused by land-based pollutants and coastal engineering construction projects. Therefore, different departments involved in pollution prevention and control should obey offices and departments that the competent department of environmental protection administration under the State Council manages unitedly in order to carry out the program of pollution control.

The establishment of coordination mechanism can refer to the joint economic

meeting of mayors in Bohai Rim, which has been established for many years. It can also refer to the coordination mechanism signed by the maritime bureaus of three provinces and one city in Bohai Rim, which establishes the coordination mechanism characterized by unified command, resource sharing, information sharing, complementary advantages and rapid coordination for emergency response in the jurisdictions of the maritime bureaus around Bohai Sea.

Although this is a good mechanism, the pollution around the Bohai Sea is far from the pure pollution caused by ships. Both marine operating platforms and sewage from the estuaries are sources of pollution. Therefore, pollution control in the Bohai Sea is an integral program. The coordination mechanism should be established as well as possible.

One of the important forces of establishing coordination mechanism is the Maritime Bureau of the Ministry of Transport, such as Yantai Oil Spill Emergency Technology Center, Qinhuangdao Oil Spill Emergency Treatment Center of Hebei Maritime Bureau and Cnooc Environmental Protection Service Co.Ltd. It is absolutely necessary for the pollution control departments of other systems to join in and expand the scope of emergency pollution control. At the same time, satellite remote sensing, air surveillance, water cruise, underwater exploration, land monitoring emergency response technology can be used into the mechanism and this is favorable for promoting their applications.

6.3.2 Divide well the corresponding responsibilities of the organizational system

In August 2006, the Vice Premier of the State Council in China stressed that all

relevant departments should earnestly perform their duties, cooperate closely and make joint efforts at the Bohai Sea Environmental Protection Work Meeting. Relevant departments of the State Council should perform their duties, cooperate closely, increase support and strengthen guidance and cooperation. The competent department of environmental protection administration under the State Council is the main force of enforcing environmental protection law. It needs to have the right of command and take the responsibility of commanding. One of its responsibilities is to improve the national environmental monitoring network in conjunction with relevant departments, standardize the release of environmental information, and establish a law enforcement network under command in other relevant departments.

The departments concerned with the sea should weaken the interests conflicting with the overall interests and work together to control pollution in the Bohai Sea. The development and reform departments should strengthen the guidance, coordination and supervision of pollution control from the aspects of industrial policies, investment construction and clear production. The environmental protection department shall strengthen the supervision of the pollutant discharge resources, do a good job in guiding, coordinating and supervising the environmental protection work in the Bohai Sea, strictly implement the discharge system that meets the standards, and strictly limit the total amount of pollutant discharge into the sea.

According to the specific conditions of the area and waters around the Bohai Sea, the marine departments should do a good job in the supervision and management of the marine environment, ensure the limits for carrying pollutants in the Bohai Sea, control the discharge of marine dumping wastes, and timely focus on the investigation, monitoring, accession, supervision of marine engineering and construction of relevant protected areas. Maritime industry, fishery, transportation

and transportation departments should take strict measures to prevent, mitigate and prevent marine environment from pollutants of ships and ports. Among them, the Maritime Bureau should further focus on the division of functions, optimize and integrate supervision resources, improve the management system and operation mechanism of maritime law enforcement, strengthen on-site law enforcement, improve the efficiency and level of supervision, improve the quality of maritime law enforcement team, meet the needs of fully developing law-based maritime management functions, gradually form a long-term supervision mechanism for maritime traffic safety., and reform maritime law enforcement management in depth according to the situation of each bureau.

For the crew, there is an important fact that the pollution accident about oil spill is caused by human, so we should carry out professional ethics education and legal education for every crew. Although most of the crew obey the discipline, law and professional ethics, many ship pollution accidents indicate that a considerable number of seafarers should deepen their understanding of the seriousness of marine pollution and the urgency of pollution prevention and control, and they should not take an indifferent attitude and assume that their superiors should take all responsibilities. Therefore, we should raise the legal and environmental awareness of the crew, improve the crew's professional training, and establish an assessment system and incentive mechanism for the crew. Finally, the law enforcement should be strengthened for the illegal pollution making of seafarers, and their civil or criminal responsibilities should be investigated accordingly if necessary.

In a word, all departments should clearly establish the coordination mechanism of the provinces and municipalities around the Bohai Sea under the unified and coordinated organization of the central government, and establish special institutions to clarify

their responsibilities and powers. By delving the powers and responsibilities of the comprehensive management step by step to the local provincial and municipal governments around the Bohai Sea and fully mobilizing the enthusiasm and creativity of all sectors of society, various related entities can make joint efforts, cooperate with each other and protect the ecological environment of the Bohai Sea.

CHAPTER 7

Conclusion

This paper examines the history and present situation of pollution in the Bohai Sea from various aspects, forecasts the pollution, analyses the causes, characteristics and consequences of pollution, and the problems existing in the process of pollution prevention and control, and puts forward a series of measures to prevent pollution in the Bohai Sea. In a word, in order to keep the Bohai Sea clean and the sustainable development of the economic circle around the Bohai Sea, we must do a good job in propaganda and mobilization in the prevention and control of pollution in the Bohai Sea. We should not only sum up the successful experience, but also formulate the corresponding theoretical guidance and pollution prevention plan on the basis of scientific demonstration or empirical verification of feasible technology, but also have perfect pollution prevention legislation, adequate financial guarantee and suit measures to local conditions. The organizational system adapted to time and the support of scientific research work. Of course, these work contents are not only independent, but also linked intrinsically. They complement each other and should not be neglected.

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