WATER ENVIRONMENT POLLUTION IN ZHUANGHE CITY AND CONTROL SOLUTIONS

Applied Policy Project Prepared for Zhuanghe City's Eco-Environmental Branch

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Client overview

The client for this APP report, Zhongguo Zhang, deputy director of Zhuanghe City's Eco-Environmental Branch, has always regarded Zhuanghe's water environment monitoring as the focus of his daily work. He needs to pay close attention to the water quality changes in the coastal waters of Zhuanghe City. If there is an environmental pollution problem, environmental protection department which he is working for must provide a solution in the first place. Zhang's main responsibility is to implement relevant laws and regulations, and to supervise the company's pollution discharge. At the same time, he is also responsible for drafting relevant bills at the meeting of the Zhuanghe City Government and promoting the passage of these bills.

My client's unit is the Environmental Protection Bureau of Zhuanghe City. This is an agency affiliated to the Zhuanghe Municipal Government, which is mainly responsible for monitoring environmental pollution, investigating and punishing enterprises that pollute the environment, and controlling the pollution that has been caused.

At present, the participating departments of Zhuanghe City mainly include the environmental protection department under the government, the law enforcement and judicial department, and the financial department. The environmental protection department is mainly responsible for monitoring ocean water quality and putting forward response plans and solutions when there is a pollution problem. The environmental protection department has supervision and part of the law enforcement power in marine environmental protection. The procuratorate[1] and the court represent the law enforcement and judicial departments. These two departments are respectively responsible for prosecuting individuals and companies that cause severe environmental pollution. The law enforcement and judicial departments supplement and ultimate deterrent to the environmental protection department on environmental pollution issues. The finance department is responsible for the approval and appropriation of the fiscal budget. At the beginning of each year, the financial department is responsible for estimating the possible expenditures for environmental pollution control. At the same time, the necessary expenditures in the prevention of environmental pollution and the financial support required for corresponding solutions after the occurrence of environmental problems are also approved and allocated by the financial department.
According to Article 34 of the Environmental Protection Law of the People's Republic of China, the State Council and coastal local people's governments at all levels shall strengthen the protection of the marine environment. The discharge of pollutants into the ocean, dumping of wastes, and construction of coastal and marine engineering shall comply with laws, regulations and relevant standards, and prevent and reduce pollution

[1] The procuratorial organ is a judicial or administrative organ that exercises procuratorial powers on behalf of the country. Its main duties are to investigate criminal responsibility, initiate public prosecutions, and implement legal supervision. Those who exercise procuratorial powers and statutory duties within procuratorial organs are called prosecutors. The procuratorate is usually responsible for reviewing the case submitted by the law enforcement agency and deciding whether to prosecute the arrested person in the end. The Procuratorate of the People's Republic of China is an independent institution.

and damage to the marine environment.

In fact, the Zhuanghe Environmental Protection Bureau is primarily responsible for implementing laws and regulations promulgated by the central government. Although local governments will also issue corresponding policies, these policies are often the refinement of some pollution determination standards.

Acknowledgements

Thanks to my client, Zhongguo Zhang, who agreed to be my client. He provides me with a lot of first-hand information and gave me a lot of constructive advice on my report writing. I also appreciate that he always finds time to discuss my research with me, even though he is in China and I am in the US and we have to overcome the 12-hour time difference.

I thank my two APP professors, Raymond Scheppach and Jim Wyckoff, for their meticulous and patient help with my thesis writing. Even though I knew I was a little behind in the class, the two professors continued to help me with this final report.

I would also like to thank Kristine Nelson and Amanda Crombie for helping me with my life and my studies, big and small. Whenever there is something I don't understand, they always help me in a timely manner. It is because of their help that my two years at Batten have been so smooth and I was able to complete the final report of the APP.

Finally, I would like to thank my parents. Although they were far away from China and they didn't know much about the content of my study, they still encouraged me when I encountered setbacks and difficulties, helped me overcome the fear, and finally completed the project study in Batten.

Disclaimers

The author conducted this study as part of the program of professional education at the Frank Batten School of Leadership and Public Policy, University of Virginia. This paper is submitted in partial fulfillment of the course requirements for the Master of Public Policy degree. The judgments and conclusions are solely those of the author, and are not necessarily endorsed by the Batten School, by the University of Virginia, or by any other agency.

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Executive summary

As a city along the Yellow Sea, Zhuanghe City has been vigorously developing aquaculture. Without much heavy industry foundation, through the development of aquaculture, the economic level of Zhuanghe City has been greatly improved. Since the end of the last century, the aquaculture industry in Zhuanghe has been developing rapidly, and it has been developing for nearly 30 years so far. However, extensive development over the years has led to serious marine environmental pollution problems. The clear coastal waters in the past have become turbid and even emit foul odors, a large number of marine lives has died, and serious pollution such as water blooms and red tides frequently occur. These serious water pollutions have severely restricted the development of the aquaculture industry in Zhuanghe City, which has caused economic problems such as a decrease in aquatic product output, a decrease in quality, an increase in aquaculture costs, and a decrease in economic benefits.

The aquaculture industry in Zhuanghe City has caused serious pollution to the surrounding waters, and the deterioration of the water environment in turn restricts the further development of the aquaculture industry in Zhuanghe City.

For the Zhuanghe Municipal Government and my clients, it is necessary to deal with the deterioration of the water environment in the Zhuanghe offshore waters as soon as possible, so as to ensure the healthy development of the aquaculture industry in Zhuanghe City and the health of the residents. In this report, I offer my clients four possible solutions:

1. Continuously improve the level of marine environmental monitoring;
2. Realize the advanced structure of marine industry;
3. Promote the process of industrialization of marine environmental protection technology;
4. Strengthen the construction and management of marine pollution control experimental areas and environmental protection zones.

After analysis, I think the Zhuanghe municipal government should take the second solution, that is, realizing the advanced structure of marine industry. This method can reduce the water pollution of Zhuanghe City to the greatest extent, and can ensure the healthy development of aquaculture industry in Zhuanghe City in the future. Because for my client, how to reasonably take the solutions mentioned in option 2 will be the focus of his next work.

Problem Statement

The waters surrounding Zhuanghe City have become severely polluted. Among them, the most serious pollution is water pollution. Because Zhuanghe City is a coastal city mainly focusing on aquaculture, the vigorously developed aquaculture industry has also caused serious seawater pollution. The aquaculture industry in Zhuanghe City has caused severe pollution to the surrounding waters, and the deterioration of the water environment, in turn, restricts the further development of the aquaculture industry in Zhuanghe City.

As a city along the Yellow Sea, Zhuanghe City has been vigorously developing aquaculture. Without much heavy industry foundation, through the development of aquaculture, the economic level of Zhuanghe City has been dramatically improved. Other coastal cities in China also have more or less environmental problems of water pollution. In this article, we choose Tianjin, China as the comparison city, and have a more intuitive impression of the water pollution in Zhuanghe City through comparison.

Zhuanghe City is located in the northeastern part of China and is a coastal city. Zhuanghe City is close to China's neighboring countries such as North Korea, South Korea, Japan and Russia. Zhuanghe City has a population of about 900,000, and its economic development level is relatively high among similar cities in China. The population of Zhuanghe has been on a slow upward trend in recent years. There are no large industrial enterprises in the whole city, and aquaculture is the main economic growth point of Zhuanghe City.

The GDP of Zhuanghe City in 2005 was 16.483 billion yuan, and in 2020 it was 46.24 billion yuan[2]. Since the end of the last century, the aquaculture industry in Zhuanghe has been developing rapidly, and it has been developing for nearly 30 years so far. However, extensive development over the years has led to severe marine environmental pollution problems. The clear coastal waters in the past have become turbid and even emit foul odors. Marine life has died in large numbers, and severe pollution such as water blooms and red tides have frequently occurred. For example, in 2005, two red tides were discovered in the waters of Heidao and Nanjian, which belonged to Zhuanghe City. The two red tides were relatively large in area and lasted for a long time.[3] These serious water pollutions have severely restricted the development of the aquaculture industry in Zhuanghe City, which has caused economic problems such as a decrease in aquatic product output, a decrease in quality, an increase in aquaculture costs and a decrease in economic benefits[4].

Aquaculture is the current pillar industry in Zhuanghe City, and the extensive

[2] https://gdp.gotohui.com/data-431

[3] http://www.nmdis.org.cn/c/2011-05-19/57874.shtml

[4] http://dlzh.gov.cn/html/index.html

development of aquaculture has, in turn, affected the further development of the aquaculture industry[5]. Therefore, the key to the problem lies in solving the current aquaculture industry in the coastal waters of Zhuanghe City. Green development will enable the aquaculture industry in Zhuanghe City to achieve considerable development.

Literature Review

A comprehensive analysis of the pollution status and sources of the coastal waters of Zhuanghe City revealed six factors including marine aquaculture pollution, livestock and poultry breeding pollution, domestic sewage pollution, fertilizer and pesticide pollution, industrial wastewater pollution and improper sewage treatment.

1. Pollution from mariculture[6]

In marine aquaculture, it mainly targets shrimp and crab pond culture, fish pond culture, and shellfish culture, due to the high aquaculture density. A large amount of bait is used, the utilization rate of bait is low, and the output of organic and inorganic pollutants is large, which has a greater impact on the marine environment. Among them, the environmental pollution caused by shellfish farming and fish pond farming is the main one. Almost all the oil and environmental pollution load comes from fishing ports and ship pollution.

2. Poultry breeding pollution

The development of aquaculture in the offshore waters of Zhuanghe City is concentrated and large in scale, which has a greater impact on the water environment. The main reasons are as follows: First, the organization and management of the breeding plant are not in place, scientific and non-standard, and the planning layout is not reasonable; second, the supporting environmental protection facilities of the breeding plant are not sound, and no special epidemic prevention system has been established. Although some manufacturers have anti-epidemic systems, they still have the problem of inadequate implementation of the systems; third, large-scale farms have not implemented standardized aquaculture, and so on. These series of factors have caused the pollution of the water environment by livestock and poultry breeding.

3. Domestic sewage pollution

Domestic sewage refers to the various types of sewage mixtures that people have in their daily lives. These pollutants include many kinds, such as washing water, or human and poultry feces and urine. This is also a key factor in causing water pollution. one. In Zhuanghe City, most of the domestic sewage produced by urban residents eventually flows into rivers, lakes and other freshwater resources without any treatment, which

[5] http://dlzh.gov.cn/html/index.html
[6] http://dlzh.gov.cn/html/index.html

causes serious pollution to the water body.

The first is washing pollution. The rural population in Zhuanghe City is relatively simple and direct in the use of water sources, so the clothes and bedding that are changed every day are washed directly in the river. This causes the dirt produced by washing to melt directly in the river, injecting more nitrogen, sulfur, and phosphorus into the water in the river. When these components reach a certain concentration, due to the action of anaerobic microorganisms, a large amount of hydrogen sulfide and mercaptans are produced, which in turn causes the river water to be black and smelly. Ponds near many villages have strong smells and muddy waters, and the main culprit is washing pollution.

Second is the fecal contamination of humans and poultry. There is a big gap between rural areas and cities in terms of infrastructure construction, and many public facilities are not in place. At the same time, most of the livestock raised in farmers' homes are free-range and can be seen everywhere, which leads to the waste of these livestock. It can be seen everywhere, scattered in every corner of the countryside. Many rural areas also have open-air toilets. When it rains continuously for many days, the toilet feces are prone to overflow, which will lead to water pollution. It is not uncommon for domestic sewage to pollute water sources in river sections where the population is relatively concentrated.

4. Fertilizer and pesticide pollution

In the process of agricultural cultivation, farmers use a lot of pesticides in order to prevent insect pests, and use a lot of chemical fertilizers to make crops grow better. This has led to a large number of pesticides remaining in the cultivated land and agricultural products, which pollutes the rivers, and these rivers eventually flow into the ocean, causing pollution of the offshore waters of Zhuanghe City. In practice, irrational fertilizer structure is not uncommon, which leads to chemical fertilizers that do not perform their original functions. Most of them do not work on crops. Instead, they enter rivers with the land, causing multiple pollutions such as soil, air, and rivers.

5. Industrial wastewater pollution

With the requirements of industrial organization adjustment, Zhuanghe City vigorously develops township and village enterprises. A large number of technologically backward tertiary industries have settled in township industrial and industrial parks. Due to the decentralized operation, small scale and extensive management of metallurgical, building materials, chemical and food processing industries, a large amount of industrial wastewater is directly discharged without treatment. Affect the surrounding ecological circle of the area. Industrial wastewater pollutants have the characteristics of complex composition and poor natural degradability, which are likely to cause the water quality to be rich in oxidation and the accumulation of toxic substances through the food chain, which endangers the rural water environment and the life safety of villagers. At present, the urban industrial wastewater pollution in Zhuanghe City mainly includes

starch wastewater pollution and papermaking wastewater pollution.

There are many township enterprises in Zhuanghe City. While the prosperity and development of township and village enterprises has driven the recovery and rise of the regional economy, some industrial wastewater produced by enterprises in the production process of low energy efficiency, high emissions, and high consumption, such as chemical, refining, paper making, and processing, has not been treated. Rivers that are directly discharged into the sea have caused pollution in the offshore waters. In recent years, the top four industries that discharge oxygen content in industrial wastewater are papermaking, food processing, chemical manufacturing, and textiles. At the same time, the Zhuanghe township government lacks effective management measures and attention to water quality and environmental management, and the self-discipline of heavy polluting enterprises such as chemical industry, papermaking, and steel is limited. The government generally has a low level of supervision and management of their pollution, which indirectly boosts the industry. Extensive discharge of wastewater causes water pollution. High-polluting enterprises located in towns and villages, in addition to their low technical content, still rely on small profits but quicker sales for most of their profits, and often lack investment in sewage treatment equipment and technology. In the later period, rural environmental improvement and ecological restoration still require tens of thousands of times more investment than the output value of enterprises.

6. Improper sewage treatment

Zhuanghe City currently needs to improve and refine the sewage disposal management system. It adopts a stepped charging standard for factories, enterprises, residents and other users to effectively alleviate waste of resources, ensure the collection of sewage treatment fees and increase awareness of conservation. The government supports the establishment of special funds for sewage treatment plants to invest in regional sewage treatment; introduce scientific management of third-party cooperation agencies, strengthen the maintenance and repair of sewage treatment plant facilities and equipment, and extend the service life.

Background on the Problem

Zhuanghe City is a city located in Northeast China, which belongs to Dalian City, Liaoning Province. It is a beautiful and peaceful seaside city. For a long time, Zhuanghe City has developed aquaculture as its main economic pillar industry. The main seafood products in Zhuanghe City include a series of marine crops such as yellow croaker, clams, shrimps, crabs and so on. Relying on this pillar industry, in the past 20 years, the economy of Zhuanghe City has been developing continuously, and the residents' income has increased significantly. Therefore, the Zhuanghe Municipal Government is

very concerned about the healthy development of the mariculture industry. Because it is related to the income level and employment of residents, and also related to the future development of Zhuanghe City.

Problems followed, however. In order to increase the output of aquatic products, many fishermen use excessive nitrogen fertilizers and other fertilizers for feeding, resulting in eutrophication of water bodies in the coastal waters, and red tides have occurred frequently in recent years. In addition, deteriorating water bodies have led to a decline in seafood production year after year. In order to increase production, fishermen have to increase the use of fertilizers, thus forming a vicious circle. While the water pollution problem in Zhuanghe City has become more and more serious, the development of the pillar aquaculture industry has also been threatened.

In response to this problem, the Zhuanghe Municipal Government has also tried a variety of solutions. Including intensifying inspections, regularly monitoring the water quality of offshore waters, and punishing individuals and enterprises that cause serious pollution to marine waters. However, these methods are either limited by the inability to form institutional measures, or due to their ineffectiveness, they cannot truly solve the problem of marine pollution currently faced by Zhuanghe City.

In response to this problem, I hope to use what I have learned to provide some feasible suggestions for my client, the deputy director of the Environmental Protection Bureau of Zhuanghe City. In order to help him better protect the marine environment of Zhuanghe City in his work, and improve the quality of aquaculture in Zhuanghe City.

Factors that contribute to the aquaculture pollution problem are mainly as the follows:

1. Eutrophication of water quality

Because intensive freshwater aquaculture adopts high-density stocking methods such as net enclosure intensive breeding, and large amounts of exogenous feed are fed, a large amount of residual bait and aquatic animal excrement has a more significant impact on the water environment[7]. The feed utilization rate of freshwater aquaculture in Zhuanghe City is low, and the proportion of residual bait is high[8]. In addition, nitrogen and phosphorus are dissolved in the water body through feces and urine. Therefore, it is likely that the self-purification ability of the water body using cages and net enclosures is relatively low. Poor eutrophication of the water body has caused pollution to the water environment.

2. Drug contamination

Chemical drugs are often used to prevent and control diseases in aquaculture in Zhuanghe City. Due to the irregular use of drugs or the characteristics of the drugs

[7] https://www.epa.gov/sites/default/files/2015-11/documents/caap-aquaculture_eeba_2004.pdf
[8] http://dlzh.gov.cn/html/index.html

themselves, the drug residues in the breeding waters exceed the standard, which will cause harm to the water ecosystem.

3. The sediment is enriched and polluted

The survey[9] showed that the content of carbon, nitrogen, and phosphorus in the bottom sludge of the aquaculture zone in Zhuanghe City was significantly higher than that in the surrounding water. In this way, microorganisms in the bottom sludge participate in denitrification and sulfur reduction reactions to produce hazardous substances.

Consequences of the problem

Since Zhuanghe City is a small city, most of the data is missing, and the relevant departments of Zhuanghe City Government have not released corresponding statistics. Therefore, in terms of cost estimation, I mainly selected data from another Chinese city, Tianjin. According to the volume comparison between Zhuanghe City and Tianjin City, I appropriately scaled down the data of Tianjin City in proportion. At the same time, some of the data comes from my client, he is the leader of the environmental protection department of Zhuanghe City, so he gave me some internal statistics. Thanks for his help.

Pollution of the water environment in the relevant waters of Zhuanghe City will cause various costs. Taken together, it is mainly divided into the following categories, direct cost, indirect cost and opportunity cost. These three costs together constitute the total social cost of this environmental problem. Below I will analyze the social costs that may arise from these three aspects in turn.

1. Direct Cost

Water pollution will have a serious impact on human health, resulting in a series of external costs. There are 900,000 residents in Zhuanghe City, and about 20,000 people need to go to the hospital for treatment every year due to water pollution[10]. Among them, 15,000 go to the hospital to see a doctor and get medicines, and the average cost per person is 200 yuan per year. Then the cost of this part is 15000*200=The other 5000 people will have more serious physical discomfort and need to be hospitalized. The average daily expenditure in the hospital is about 500 yuan, and the average length of hospital stay is about 28 days. Then this part of the cost is 500*28*5000=70 million.

[9] http://agrilife.org/fisheries2/files/2013/09/NCRAC-Publication-Aquaculture-Effluents-and-Waste-By-Products-Characteristics-Potential-Recovery-and-Beneficial-Reuse.pdf

[10] Environmental Cost Estimation of Water Pollution in Tianjin

1) Impact on agriculture.[11]

Due to the pollution of the coastal waters of Zhuanghe City, the groundwater resources in Zhuanghe City have also been polluted. Groundwater resources are indispensable for agriculture, animal husbandry and urban domestic water use. Therefore, the water environment pollution in Zhuanghe City has affected all walks of life in the city and the production and life of citizens in all aspects.

The annual economic loss of grain production is about 2 million yuan, the economic loss of vegetable production is about 4 million yuan, the economic loss of grain price reduction is 400,000 yuan, and the economic loss of vegetable price reduction is 20 million yuan. The economic loss caused by the reduction of agricultural production is 6 million yuan, and the economic loss of the price reduction is 20 million yuan[12]. As a result, the total annual loss of water pollution in Zhuanghe City to agriculture is 2 million + 4 million + 400,000 + 20 million + 6 million + 20 million = 32.4 million yuan.

2) Impact on the aquaculture industry.

The impact of water pollution on fisheries shows ups and downs, which may be due to the instability of fishery production every year, so the size of the impact varies. Therefore, a rough estimate is selected here, which is about 10 million yuan per year[13].

3) Impact on the livestock industry.

Due to the lack of relevant information on animal husbandry, only an estimate is made here, which is about 5 million yuan per year.

4) Impact on urban domestic water.

The annual domestic sewage discharge in Zhuanghe City is 30 million tons, and the domestic sewage treatment cost is 0.2 yuan/ton, and the domestic water loss caused by water pollution is 30 million * 0.2 = 6 million yuan.

[11] The following data calculations are based on the estimation of the water pollution situation in Tianjin, China, so there may be inaccuracy.

[12] Environmental Cost Estimation of Water Pollution in Tianjin

[13] Environmental Cost Estimation of Water Pollution in Tianjin

2. Indirect Cost

Impact on tourism.

Zhuanghe City vigorously develops tourism. However, due to the pollution of the water environment, the local ocean and river landscapes have been greatly damaged, resulting in a decline in the number of people willing to visit Zhuanghe, which has affected the overall income of Zhuanghe City. The number of tourists dropped by about 50,000 each year[14]. On average, each tourist will spend two days in Zhuanghe City, spending an average of 500 yuan a day. Then the cost of this part is 50,000*2*500=50 million yuan.

3. Opportunity cost

Pollution is harmful to human health, resulting in a decline in the health of residents, and the cost of social and economic benefits caused by missing work and absenteeism due to going to the hospital for medical treatment or even hospitalization is also very high. As mentioned above, 15,000 people in Zhuanghe City go to the hospital for treatment every year. 10% of these people will miss work, which in turn will cause an average of 8 hours per person 2 days a year economic loss. A resident will have an average output of 25 yuan per hour, so the opportunity cost at this time is 8*25*2*15000*10% = the same, another 5000 people need to be hospitalized, and the average length of hospitalization is about 28 days. Rest two days a week, the opportunity cost at this time is 5000*25*8*(28-8) =20 million yuan[15].

The health hazards caused by water pollution have reduced the life expectancy of urban residents. If the expected output of a resident per year is 20,000 yuan per year. After his retirement, his output dropped to 2,000 yuan per year. Due to water pollution, the average life expectancy of urban residents has dropped by 0.1 year. Then the opportunity cost at this time is 900,000*0.1*2000=180 million yuan.

To sum up, the three parts of social costs caused by water pollution in Zhuanghe City are 53 million + 70 million + 6 million + 32.4 million + 10 million + 5 million + 6 million + 50 million + 20 million + 180 million = 432 million Ten thousand yuan. Approximately US$67 million[16].

[14] Estimated by data collected

[15] Environmental Cost Estimation of Water Pollution in Tianjin

[16] This figure is obtained by adding up the costs of the various parts analyzed above, and part of it is a guess based on the data given to Tianjin, China.

Evidence on potential solutions to the problem

1. Japan

Although Japan is one of the most developed fishery countries in the world, it has to face the problem of resource decline due to overfishing, environmental deterioration of marine fisheries, and reduction of marine fishery resources. Japan has realized the proliferation of marine fishery resources through the proliferation and release of fish, setting up artificial reefs, protecting seabed algae fields, and setting up national festivals. Regulations, such as the Fisheries Law and the Basic Fisheries Law, etc., provide institutional guarantees for the proliferation of marine fishery resources. In addition, Japan holds national and regional enrichment fishery conferences every year to exchange information on fishery resources, the implementation of enrichment and release, the evaluation of release effects, and related research.

Japan has always been committed to the development of marine resources and marine environmental protection. Like many countries including China, land-based pollution is the main cause of marine pollution in Japan. The control of land-based pollution in Japan has gone through the rugged process of "pollution first, then control". Only after nearly half a century of control has the goal of pollution control been achieved, and Japan has become a developed country with a more significant effect on land-based pollution control. Since the 1950s, the Japanese government began to pay attention to the control of land-based pollution, and implemented land-based pollution control policies mainly through comprehensive means such as law, administration, economy, and education. In addition, Japan has formulated a scientific and complete environmental quality standard system, and stipulated strict and specific requirements for some water areas such as the environmental quality compliance period and standard limit. According to changes in environmental conditions and water pollution, the scientific judgment Based on the revision of standard values, monitoring items are added or deleted, so that the revision of environmental quality standards is routinely operated. The adjustment of various standard values is very timely and standardized, which greatly improves the efficiency of monitoring work.

2. U.S.

1) The power of water pollution control has changed from decentralization to concentration.

The introduction of amendments to the Federal Water Pollution Control Act in 1972 changed the local pattern of water pollution control laws in the United States. For the first time, the law surpassed state legislation and became the main law in the field of water pollution control. Polluters no matter what state they are in, they must abide by the unified discharge limits set by the federal government, apply for a national pollution

discharge permit, and accept the jurisdiction of the federal Environmental Protection Agency. The law also endows the federal government with the power to formulate national unified water pollution management regulations, standards, etc. and the absolute law enforcement power to punish illegal sewage; Demonstration projects provide solid federal funding backing: state legislation is required to be formulated on the basis of federal legislation.

2) The three powers work together to formulate and implement water pollution control policies.

The United States is a country that implements the separation of executive, legislative and judicial powers. Under the threat of serious water pollution, the US government, Congress and courts in the 1960s and 1970s unanimously adopted an attitude of supporting water pollution control, making this period the most important period in the history of water pollution control in the United States.

3) The command-and-control model gradually dominates.

The United States is the first country in the world to adopt a command-and-control model to control water pollution. This model in the United States was initially formed in the five revisions to the Water Pollution Control Act from 1956 to 1970 and the gradual expansion of the federal government's power to control water pollution. Amendments to the Federal Water Pollution Control Act of 1972 established the command-and-control model in the dominant role of water pollution control in the United States. The 1977 amendment further strengthened the federal government's coercive power to control water pollution, brought many illegal acts into the scope of the federal government's jurisdiction, and expanded the scope of the federal government's prosecution.

Governance

According to the "Water Pollution Prevention and Control Law of the People's Republic of China":

Article 4 The people's governments at or above the county level shall incorporate water environmental protection work into their national economic and social development plans. Local people's governments at all levels are responsible for the quality of the water environment in their respective administrative regions, and shall take timely measures to prevent and control water pollution.

Article 5 Provinces, cities, counties and townships shall establish a river chief system, and organize and lead the work of water resources protection, water coastline

management, water pollution prevention and control, and water environment management of rivers and lakes within their respective administrative regions.

Article 6 The state implements a water environmental protection target responsibility system and an assessment and evaluation system, and takes the completion of water environmental protection targets as the content of the assessment and evaluation of local people's governments and their responsible persons.

Article 9 The competent department of environmental protection of the people's government at or above the county level shall conduct unified supervision and administration of the prevention and control of water pollution. The maritime administrative agency of the competent transportation department shall supervise and manage the prevention and control of water pollution by ships. The departments of water administration, land and resources, health, construction, agriculture, and fishery of the people's governments at or above the county level, as well as the water resources protection agencies of important rivers and lakes, shall supervise and manage the prevention and control of water pollution within the scope of their respective duties.

Article 10 The discharge of water pollutants shall not exceed the national or local water pollutant discharge standards and the total discharge control indicators of key water pollutants.

Article 83 Anyone who violates the provisions of this Law and commits any of the following acts shall be ordered by the competent environmental protection department of the people's government at or above the county level to make corrections or be ordered to restrict production or stop production for rectification, and impose a fine of not less than 100,000 yuan but not more than 1,000,000 yuan ; If the circumstances are serious, it shall be reported to the people's government that has the power to approve, and ordered to suspend business or close down:

1) Discharging water pollutants without obtaining a pollutant discharge permit in accordance with the law;
2) Discharging water pollutants in excess of the water pollutant discharge standards or exceeding the control indicators for the total discharge of key water pollutants;
3) Using seepage wells, seepage pits, fissures, karst caves, privately setting up hidden pipes, tampering with or forging monitoring data, or operating water pollution prevention and control facilities abnormally, etc. to evade supervision and discharge of water pollutants;
4) Failing to carry out pretreatment in accordance with regulations, and discharging industrial wastewater that does not meet the requirements of treatment technology to centralized sewage treatment facilities.

Methodology

The purpose of this report is to evaluate the possible solutions proposed to meet the urgent needs of the Zhuanghe Municipal Government to solve marine environmental pollution and promote the healthy development of Zhuanghe's aquaculture industry. The next section of the paper presents the four different dimensions of criteria used to evaluate solutions. The following sections provide a brief overview of the selection of concepts, explanations, and evaluations using comparative methods. After identifying each step and evaluating the result, the paper turns to the advantages and disadvantages of the decision by directly comparing the results. These options will be prioritized based on the evaluation criteria outlined below. The last part of the report will include suggestions for my clients and Zhuanghe City to figure out what can be done to solve this problem.

Alternatives

In view of the increasingly serious water pollution problem in Zhuanghe City, the following four solutions are optional:

1. Continuously improve the level of marine environmental monitoring;
2. Realize the advanced structure of marine industry;
3. Promote the industrialization of marine environmental protection technology;
4. Strengthen the construction and management of marine pollution control experimental areas and environmental protection areas.

Policy Alternative 1: Continuously improve the level of marine environmental monitoring

Description: The application of high-tech in the development of new instruments for marine environment detection is mainly reflected in two aspects, namely, aquatic detection technology and satellite remote sensing technology. The emergence of Acoustic Doppler Current Profiler (ADCP) is the latest development of aquatic detection technology. The detection methods include ship-mounted, towed, bottom-mounted, self-contained, direct-reading, etc., with a high degree of automation. It can measure the distribution of ocean currents on a vertical profile and is widely used in modern marine environment detection. Satellite remote sensing can obtain relevant information such as ocean surface temperature, water color, sea level, waves, and currents, and is widely used in marine environmental monitoring and scientific research. The application of satellite positioning technology has further developed an on-site observation technology system. In addition, the application of other new technologies

has also promoted the development of marine field detection technology. For the prevention and control of marine pollution in Zhuanghe City, it is very important to use modern monitoring methods and technologies to supervise the marine environment, detect violations in time, protect the marine environment, and monitor red tides.

Policy Alternative 2: Realize the advanced structure of the marine industry

Description: Optimizing the marine industrial structure includes two aspects: One is to optimize the overall marine industrial structure of Zhuanghe City. Different marine industrial structures depend on marine resources and have different impacts on the environment. From the marine primary industry, secondary industry to the tertiary industry, the degree of dependence on marine resources and the degree of impact on the environment are gradually weakening. For many years, the marine industrial structure of Zhuanghe City has always been based on the marine primary industry. In the future, the proportion of the secondary and tertiary industries should be increased. In the process of realizing the sustainable use of marine resources and the environment, the marine industrial structure of Zhuanghe City Continuous optimization and upgrades. The second is to optimize the industrial layout in the coastal areas of Zhuanghe City. Most of the "three kind of wastes" produced in coastal areas flow directly into the sea, river water, surface runoff, acid rain, etc., flow into the coastal waters, affecting the environment of the coastal waters, and the environmental conditions of the coastal waters, especially the changes in the industrial layout. Correlation. From the general situation of "three kinds of wastes" emissions, industrial waste water and waste gas account for about 50% of all pollutants, so the secondary industry has the greatest pressure on the environment. The coastal area is currently a highly industrialized area in Zhuanghe City, and the coastal area is mainly dominated by the secondary industry. This industrial layout seriously affects the coastal sea environment of Zhuanghe City, and should be further adjusted to make it continuous Local optimization and upgrade.

Policy Alternative 3: Promote the industrialization of marine environmental protection technology

Description: Marine environmental protection technology refers to various technologies to prevent or reduce marine environmental pollution and ensure marine ecological balance. It includes marine environment monitoring and early warning information technology, such as detection equipment, data buoys, unmanned stations, satellite remote sensing, etc.; pollutant control technology, such as waste treatment technology, oil spill accident treatment technology, dumping technology, etc.; environmentally friendly Chemical technology or clean production technology, such as comprehensive utilization of resources, less waste or no waste process technology and product technology with the goal of preventing pollution; marine ecological restoration and remediation technology, etc. Marine environmental protection industry is a type of economic industry developed on the basis of marine environmental protection technology, including marine monitoring and early warning information services,

marine environmental protection equipment manufacturing, sewage treatment plants, garbage treatment plants, marine dumping sites and other marine pollutant treatment Enterprises and industrial departments and units such as the recycling of resources for the prevention of marine environmental pollution. In the process of marine environmental governance in Zhuanghe City, if actively using environmental protection technology and cultivate related industries, we can get twice the result with half the effort.

Policy Alternative 4: Strengthen the construction and management of marine pollution control pilot zones and environmental protection zones

Description: The purpose of establishing the pollution control experimental area is to strengthen the remediation and management of key polluted sea areas, and to have a certain demonstration effect on the future pollution control of Zhuanghe City. Since marine pollution is highly complex and has a large cumulative effect, and the self-purification capacity of different sea areas is different, it is necessary to consider how to obtain the maximum pollution control effect with the least capital investment. The marine pollution control pilot area is to seize the main pollutants, the main polluted sea areas, and the main pollution sources under the premise that Zhuanghe City currently lacks environmental protection funds. Trying is a key link in the current treatment of marine pollution. It is possible to select one or several small offshore areas where the ecological environment has been damaged and environmental pollution is relatively light for pilot projects, establish a management agency for the test area, set up an environmental monitoring system, develop a system for paid use of the sea area, and develop pollutant transfer and prevention technologies. And gradually promote it. Regarding the remediation and management of key polluted sea areas, the government should take the lead, establish a remediation timetable, and incorporate it into the economic planning of Zhuanghe City. Based on the economic development of Zhuanghe City, the implementation of "whoever develops, who protects", "who pollutes, who compensates", and formulate a series of pollution discharge fee systems. With government funding, the polluted sea areas will be rehabilitated in stages and in a planned way.

Each proposed solution will be evaluated according to fixed criteria to find the best solution to the problem of water pollution in Zhuanghe City. The choice of policy should be based on the ability to maximize the improvement of the water environment pollution in Zhuanghe City, promote the sustainable development of the aquaculture industry in Zhuanghe City, and thus promote the green development of the economy of Zhuanghe City. At the same time, the policy must be recognized and approved by the Zhuanghe Municipal Government. To obtain the approval of the Zhuanghe Municipal Government, it mainly depends on the effectiveness of the policy and the level of cost. The lower cost can reduce the financial pressure of the Zhuanghe municipal government, thereby reducing the financial burden of the government. Taking the above considerations into account, I have developed four criteria to evaluate solutions.

Criteria for Evaluation

Cost Effectiveness (weighted at 50 percent)

When choosing different solutions, cost is a point we must consider. In addition, under the current limited budget of the Zhuanghe City Government, the reasonable control of environmental pollution costs has become a more important measurement standard. The cost-benefit analysis is the most important of the four evaluation criteria. The cost-benefit mainly compares and analyzes the various costs required for policy formulation, the improvement of the water environment in the coastal waters of Zhuanghe City and the improvement of Zhuanghe fishery benefits within ten years after the policy is formulated.

Since the latest data available comes from 2017, I choose 2017 as my base year. In addition, I define the result as fishery production in Zhuanghe City in 2017. Considering the current development situation in China, I think the discount rate is 10% more appropriate.

Equity (weighted at 10 percent)

The policy will measure the fairness of each policy, mainly reflected in whether the impact of each policy on fishers is within their acceptable range. At the same time, policies should be formulated to ensure that different groups receive roughly the same impact to prevent unfair policy influence. What's more, because the policy primarily affects fishermen and groups of residents close to the sea, an assessment of the potential adverse impact of the policy must be made. Equity will be assessed in terms of how each policy generates High, Medium, or Low equity.

Political Feasibility (weighted at 10 percent)

In terms of political feasibility, since China is a government-led political system, and the governance of environmental pollution must also be solved by the government, whether these alternative solutions are politically feasible is also critical measurement standard. Each policy alternative will be measured as having High, Medium, or Low feasibility.

Ability to Implement (weighted at 30 percent)

This standard mainly measures the complexity and difficulty of policy implementation. Although many methods are effective, they are subject to factors such as the government budget, the possibility of passing the bill and the lack of corresponding high-end technical talents in Zhuanghe City, and many alternative solutions are not really implemented. The main considerations are as follows:

1) Is there sufficient cash flow
2) How supportive are fishermen and coastal residents to the policy?

3) Whether it is possible to successfully master the technology of pollution control and whether it needs a lot of technical investment and the introduction of high-end talents
4) How many government agencies will be involved and how many social enterprises will be involved

Outcome Matrix

	Solution1	*Solution2*	*Solution3*	*Solution4*
Cost Effectiveness	Low	High	High	Low
Equity	Low	High	High	Low
Political Feasibility	Low	High	Low	High
Ability to Implement	Low	High	Low	High

From the table above, we can see that the solution that performs well in all dimensions is the second approach. If the second method is adopted, the Zhuanghe Municipal Government will establish a long-term mechanism to solve the problem of marine pollution, and finally realize the healthy development of the aquaculture industry in Zhuanghe City.

Recommendations

From the above analysis, it can be seen that among the four alternative options, the most effective option is the second option. That is to optimize the industrial structure of aquaculture in Zhuanghe City through industrial upgrading. In the long run, this plan can effectively improve the fineness of the development of aquaculture in Zhuanghe City, and promote the rapid and high-quality development of aquaculture industry in Zhuanghe City while continuously improving the marine environment of Zhuanghe City.

Conclusion

In the foreseeable future decades or even decades, the pillar industry of Zhuanghe City will be aquaculture. Therefore, it is very important to solve the environmental pollution problem that Zhuanghe City is currently facing, which is related to the long-term stable and healthy development of the economy of Zhuanghe City.

The suggestions I put forward can help my clients and the Zhuanghe Municipal Government to achieve the final solution to the problems of water pollution in Zhuanghe City and the development of aquaculture by continuously upgrading the industrial structure.

In terms of potential impacts, it is foreseeable that if the Zhuanghe Municipal Government finally adopts the second plan, as the technology continues to mature, Zhuanghe City will not only manage the marine environment, but also promote economic development, and ultimately achieve economic benefits and social benefits. Efficiency at the same time.

Appendix

Worksheet for Estimating Cost-Effectiveness

1. The Outcome: In order to compare the effectiveness of various pollution treatment methods, in 2017, Zhuanghe City completed the output of 584,000 tons of aquatic products, and achieved a total fishery economic output value of 22.593 billion yuan ($35.5 billion). Designated Result: Fishery production in Zhuanghe City in 2017.

2. Appropriate Measure for the Outcome: Regarding the fishery output of Zhuanghe City, it can be obtained through the results published in the annual government work report of the Zhuanghe City Government.

3. Base Year: Since the latest data that can be found is the data disclosed by the Zhuanghe Municipal Government in 2017, I choose 2017 as the base year.

4. The Region: Zhuanghe City, the government entity is Zhuanghe Municipal Government

5. The Time Horizon: The next ten years, 2021-2030.

Step 1:

The first step is to find out the output of the aquaculture industry in Zhuanghe City in the benchmark year. According to the report released by the Zhuanghe Municipal Government, the output of aquatic products in Zhuanghe City in 2017 was 584,000 tons. The annual growth rate of aquatic product output in Zhuanghe City is about 1.5%. Therefore, the output of aquatic products in Zhuanghe City in the next ten years can be inferred, as shown in the following table:

Base Year	# Aquatic product output (Unit: 10,000 tons)
2017 (baseline)	58.4
2021	62.0
2022	62.9
2023	63.9

2024	64.8
2025	65.8
2026	66.8
2027	67.8
2028	68.8
2029	69.8
2030	70.9

Step 2:

Alternative 1: Continuously improve the level of marine environmental monitoring

Although it is difficult to quantify, according to the relevant governance experience in other regions, improving the monitoring level will slow down the discharge of pollutants into the ocean by individuals and enterprises to a certain extent, so it can improve the water quality of the ocean in a short period of time, which in turn will increase the water quality of the ocean. output of the product. I predict this will increase the production of the aquaculture level by 0.3% per year. Therefore, in the next ten years, the output of aquatic products in Zhuanghe City is expected to be as follows:

Base Year	# Aquatic product output (Unit: 10,000 tons)
2017 (baseline)	58.4
2021	62.7
2022	63.8
2023	65.0
2024	66.2
2025	67.4

2026	68.6
2027	69.8
2028	71.1
2029	72.3
2030	73.6

Alternative 2: Realize the advanced structure of marine industry

Upgrading the current marine industry structure can fundamentally change the current extensive development mode of aquaculture in Zhuanghe City, and it is a sustainable development strategy. In the long run, this method can greatly solve a series of marine environmental pollution problems caused by the excessive use of chemical fertilizers in Zhuanghe City. According to the experience of other countries and regions in controlling marine environmental pollution, this step is the only way to go and has been proven to be effective. The implementation of this strategy is expected to increase Zhuanghe's annual aquatic product output by 0.7%. The specific forecast is as follows:

Base Year	# Aquatic product output (Unit: 10,000 tons)
2017 (baseline)	58.4
2021	63.7
2022	65.1
2023	66.5
2024	68.0
2025	69.5
2026	71.0
2027	72.6
2028	74.2

2029	75.8
2030	77.5

Alternative 3: Promote the industrialization of marine environmental protection technology

Promoting the industrialization of environmental protection technology will help improve the efficiency of the government, and it can also promote the process of environmental pollution control with the help of the scale effect of the industry. Compared with the previous solution, this solution also fundamentally changes the development model and seeks a green and healthy economic development. Therefore, it will be more effective than simply investing money and increasing government supervision. I predict that this approach can increase seafood production by 0.5% per year. The specific figures are as follows:

Base Year	# Aquatic product output (Unit: 10,000 tons)
2017 (baseline)	58.4
2021	62.0
2022	62.9
2023	63.9
2024	64.8
2025	65.8
2026	66.8
2027	67.8
2028	68.8
2029	69.8
2030	70.9

Alternative 4: Strengthen the construction and management of marine pollution control experimental areas and environmental protection areas

Similar to Option 1, this is also a short-term solution that can improve ocean water quality. By increasing government monitoring efforts, environmental pollution problems at the source can be eliminated. In the short term, it will be effective quickly, but in the long run, the effect is not as good as the second and third options. Likewise, similar to Option 1, I predict that this solution can increase seafood production in Zhuanghe City by 0.3% per year. The specific numbers are as follows:

Base Year	# Aquatic product output (Unit: 10,000 tons)
2017 (baseline)	58.4
2021	62.0
2022	62.9
2023	63.9
2024	64.8
2025	65.8
2026	66.8
2027	67.8
2028	68.8
2029	69.8
2030	70.9

Step 3:

According to the data, Zhuanghe City completed a total fishery economic output value of $35.5 billion in 2017. Then, the value of seafood is 0.61billion per 10,000 tons.

Step 4:

Assuming that the price of seafood is stable every year, the total fishery economic output value of Zhuanghe City in the next ten years can be obtained. As shown in the table below:

Base Year	# Gross economic output value of fishery (billion)
2017 (baseline)	35.5
2021	37.8
2022	38.4
2023	39.0
2024	39.5
2025	40.1
2026	40.7
2027	41.4
2028	42.0
2029	42.6
2030	43.2

Step 5:

Alternative 1: Continuously improve the level of marine environmental monitoring

Base Year	# Gross economic output value of fishery (billion)
2017 (baseline)	58.4
2021	38.2

2022	38.9
2023	39.7
2024	40.4
2025	41.1
2026	41.8
2027	42.6
2028	43.4
2029	44.1
2030	44.9

Alternative 2: Realize the advanced structure of marine industry

Base Year	# Gross economic output value of fishery (billion)
2017 (baseline)	58.4
2021	38.9
2022	39.7
2023	40.6
2024	41.5
2025	42.4
2026	43.3
2027	44.3
2028	45.3

2029	46.2
2030	47.3

Alternative 3: Promote the industrialization of marine environmental protection technology

Base Year	# Gross economic output value of fishery (billion)
2017 (baseline)	58.4
2021	37.8
2022	38.4
2023	39.0
2024	39.5
2025	40.1
2026	40.7
2027	41.4
2028	42.0
2029	42.6
2030	43.2

Alternative 4: Strengthen the construction and management of marine pollution control experimental areas and environmental protection areas

Base Year	# Gross economic output value of fishery (billion)
2017 (baseline)	58.4

2021	38.2
2022	38.9
2023	39.7
2024	40.4
2025	41.1
2026	41.8
2027	42.6
2028	43.4
2029	44.1
2030	44.9

Step 6:

Net present value for the baseline: $35.5 billion;
Net present value for Alternative 1: $44.9 billion;
Net present value for Alternative 2: $47.3 billion;
Net present value for alternative 3: $43.2 billion;
Net present value for Alternative 4: $44.9 billion.

Step 7:

The total cost of water pollution in Zhuanghe City is approximately US$67 million.
Estimates for the base case: $35 billion
Alternative 1: $44 billion
Alternative 2: $47 billion
Alternative 3: $43 billion
Alternative 4: $44 billion

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