

Article

Evolution of Marine Environmental Governance Policy in China

Jinkai Yu *  and Wenjing Bi 

College of Economics, Ocean University of China, Qingdao 266100, China; biwenjing321@163.com

* Correspondence: yujinkai8@126.com

Received: 13 July 2019; Accepted: 11 September 2019; Published: 17 September 2019



Abstract: This paper aims to unearth the ways in which the Chinese government applies policies to govern the marine environment effectively. Co-word analysis, word frequency analysis and multi-dimensional scaling (MDS) were chosen to analyze the evolution of marine environmental policy. This paper focuses on the marine environmental governance policy of China since 1982, takes the five-year plan for marine economic development as the node, divides these policies into five stages: The germination period, the 10th Five-Year Plan period, the 11th Five-Year Plan period, the 12th Five-Year Plan period and the 13th Five-Year Plan period. The evolution characteristics of China's marine environmental governance policy are analyzed accordingly and include the diversification of participants, changes from ex-post control to ex-ante control, diversification of policy tools, and expansion of governance scope. Finally, we elucidate the challenges regarding the formulation and implementation of China's marine environmental governance policies in the future.

Keywords: evolution; marine environmental governance; policy

1. Introduction

The marine environment has been deteriorating for many years, and restricting the development of the marine economy. Marine pollution has become a major and common problem across the world [1], attracting the efforts of international organization and economies.

The UN is advancing the process of marine environmental governance actively. In 1982, the “United Nations Convention on the Law of the Sea” stipulated the rights and obligations of states to protect the marine environment and take measures to prevent, reduce and control pollution of the oceans. In 1992, “Agenda 21” was devoted to the marine conservation and rational utilization and exploitation of marine resources. In 2016, the United Nations General Assembly adopted “The 2030 Agenda for Sustainable Development”, which specialized setting sustainable development goals in the marine sector, thereby indicating the ways for sustainable development of the marine economy.

Under the framework of the “United Nations Convention on the Law of the Sea” and other international treaties, major maritime economies have explored ways to govern the marine environment actively. Japan's marine environmental governance has gone through a process from passive response to active governance and further improvement. From the Second World War to the 1960s, the government of Japan promulgated laws on marine environmental protection passively driven by the environmental movement, promulgated the “Basic Law of Pollution Countermeasures” and established the marine environmental governance policy system initially. Since the 1970s, a complete marine environmental governance policy system has been formed. Japan has taken the initiative to govern the marine environment and promulgated marine environmental governance policies covering education, economy, international cooperation and other fields. Since the 21st century, Japan has implemented the strategy of “Ocean State”, attached importance to the construction of marine environmental governance systems and improved the marine environmental governance policy system actively. The EU has

gone through a process from single management to comprehensive management [2]. In the 1970s and 1980s, the EU began to formulate marine environmental policies in a certain field, such as the “Aquatic Shellfish Water Quality Directive”. Since the 1990s, the EU has tried to use integrated management to deal with regional marine environmental problems and promulgated a series of policies for integrated management of marine environment, such as the “Water Framework Directive”. The marine environmental governance policy system in the United States has gone through a process from sector-oriented management to comprehensive management. From the 1960s to the beginning of the 21st century, marine environmental governance policies were formulated with sectoral orientation, such as the “Marine Resources and Engineering Development Act” “Marine Protection, Research, and Sanctuaries Act” and “Shore Protection Act”. Since the 21st century, marine environmental governance has been developing in a comprehensive way, such as “An Ocean Blueprint for the 21st Century” and “Stewardship of the Ocean, Our Coasts, and the Great Lakes”.

China is a large maritime country that includes the Bohai Sea, the Yellow Sea, the East China Sea and the South China Sea within its maritime border. The sea area spans temperate zones, subtropics and tropics, with a wide variety of marine resources and a great potential for development. The exploitation of marine resources has brought great economic benefits to China, and the marine economy plays an important role in the national economic system. In 2017, the gross ocean product (GOP) was 7.7611 trillion yuan, an increase of 6.9% over 2016. The total marine economy continued to grow, doubling from 3.8439 trillion yuan in 2010. GOP accounts for 9.4% of GDP, and has accounted for more than 9% of GDP for eight consecutive years. The development of the marine economy further promotes the exploitation and utilization of marine resources, the excessive dependence and predatory exploitation of marine resources hinders the sustainable development of the marine economy. A series of problems such as pollution in coastal waters, a reduction of marine biodiversity and a decline in the bearing capacity of the sea area are caused by this exploitation [3,4].

Different from Japan, the EU, the US and other major marine economies, marine environmental governance of China started in the 1980s, much later than them, and faces a more serious situation. China has signed the international MARPOL convention actively. With reference to the contents of the conventions, combining national conditions, China has formed a marine environmental governance system. In this system, most of the contents of the international MARPOL convention are internalized into domestic laws, and some of the contents, such as anticipated environmental remediation costs caused by oil pollution, need to be further converted into domestic laws and applications due to the incompatibility between China’s domestic legal system and the international legal system. In the situation concerning foreign relations, the international MARPOL conventions are applied in priority.

The marine environment of China has been greatly improved in a short time through the establishment of the marine environment governance policy system. Taking the quality of sea water as an example, the sea area in China’s jurisdiction, which is inferior to the first-class water quality standard, exceeded 200,000 square kilometers at the end of the 20th century, but in 2018, it was reduced to 110,000 square kilometers; the quality of sea water has been greatly improved. China has accumulated much experience and received many lessons on marine environmental governance; how to use policy to govern the marine environment effectively in such a short time is worth studying. However, there are few studies on the evolution of China’s marine environmental governance policy, and the studies are mostly limited to theoretical discussions, lacking of macroscopic discussion on the policy system. Moreover, in previous research on policy evolution, qualitative methods are usually adopted to describe the dynamic changes in policy documents, which are highly subjective and lack objective and scientific evaluation of policies.

In this paper, we use the co-word analysis, combined with word frequency analysis and multi-dimensional scale analysis methods and focus on the marine environmental governance policy of China since 1982; we take the five-year plan for marine economic development as the node and divide these policies into five stages: The germination period, the 10th Five-Year Plan period, the 11th Five-Year Plan period, the 12th Five-Year Plan period and the 13th Five-Year Plan period. We elaborate

and interpret China's marine environmental governance policy system comprehensively and aim to unearth the ways in which the Chinese government applies policies to govern the marine environment effectively. The evolution characteristics of China's marine environmental governance policy are analyzed accordingly, providing a perspective and method for the quantitative analysis of China's marine environmental governance policy.

2. Materials and Methods

2.1. Data Collection and Pre-Processing

With the exploitation and utilization of marine resources, problems in the marine environment continue to appear, thereby hindering the sustainable development of the marine economy. To rationally exploit marine resources, China has promulgated a series of marine environmental governance policies. The change in marine environmental governance policy reflects the change of the marine environment problem and marine development goals. This paper studies the policy documents directly related to marine environmental governance, such as laws, administrative regulations, departmental rules, normative documents, planning outlines and notices issued at the national level since the promulgation of the "Marine Environment Protection Law of the People's Republic of China" in 1982. We collected policy documents about marine environmental governance through the Peking University Legal Information Website, and official government websites such as The Ministry of Natural Resources.

A total of 80 policy documents were selected and collected, based on principles that directly related to the management of the marine environment. ROSTCM6 automatically extracted keywords and calculated their word frequency in the 80 policy files. Then certain keywords were preselected and the five meaningless common keywords "marine", "environment", "Chinese", "People's Republic of China" and "China" were deleted. The final word frequency was determined.

2.2. Methods

2.2.1. Word Frequency Analysis

Word frequency analysis is a bibliometric method to determine research hotspots and develop trends according to the frequency of keywords or subject words appearing in a certain research field [5]. The higher the frequency is, the more it can represent the core content of related fields. We use co-word analysis software ROSTCM6 to conduct keyword frequency statistics for the collected and collated policy texts, and analyze the core contents and key points of the policy texts according to the order of word frequency.

2.2.2. Co-Word Analysis

Co-word analysis is a content analysis method that emerged in the late 1970s [6]. This method is now widely used in metrology, management, information retrieval and other fields [7]. Research shows that co-word analysis can identify the relationships between subjects in the research field [4,8] and then trace their development trends [9,10]. It is generally believed that the more times two keywords appear simultaneously, the more closely related the two keywords are. Using co-word analysis to count the frequency of keyword co-occurrence, and obtaining the co-occurrence matrix, provides reliable data sources for subsequent statistical analysis of data. During the development of co-word analysis, new methods and tools such as social network analysis [5] and cluster analysis [11] were produced. We choose the top 30 high-frequency words, and use ROSTCM6 to establish the co-word matrix at each stage, which was the key input of multi-dimensional scaling analysis.

2.2.3. Multi-Dimensional Scaling Analysis (MDS)

MDS is a kind of cluster analysis and uses appropriate dimensionality reduction methods to locate multiple variables in low-dimensional space through coordinates, and the Euclidean distance between

variables can reflect their differences and similarities [12]. In the graph of MDS, the distance between different keywords in the space shows the level of similarity, the highly similar keywords are clustered together [13]. In general, the more clustered categories tend to be in the center of the graph, the higher the attention the category gets. We use SPSS20 to conduct MDS of the co-word matrix in each stage and present it as a multi-dimensional scale graph.

3. Results

To achieve sustainable development of the marine economy, the government of China formulated a five-year plan for marine economic development. The five-year plan makes plans for the layout of marine economy, development of marine industry and marine ecological civilization and sets goals and directions for long-term marine development. During the same planning period, the development goals and directions of the marine environmental governance policies are similar; these policies can be integrated. We focus on the marine environmental governance policy since 1982 of China, take the five-year plan for the development of marine economic as the node and divide these policies into five stages: The germination period, the 10th Five-Year Plan period, the 11th Five-Year Plan period, the 12th Five-Year Plan period and the 13th Five-Year Plan period. As China's marine environmental governance policy was in its infancy and the number was small before 2000, it was merged into the germination period.

3.1. The Germination Period (1982–2000)

The adoption of the “Marine Environment Protection Law of the People's Republic of China” in 1982 marked the emergence of the Chinese marine environmental governance policy system. There are 16 marine environmental governance policies at this stage. We extracted the top 30 high-frequency keywords in each stage and compared them with the previous stages. The new emerging keywords and word frequency in each stage are arranged as Table 1. Figure 1 is the multi-dimensional scale analysis diagram in this period.

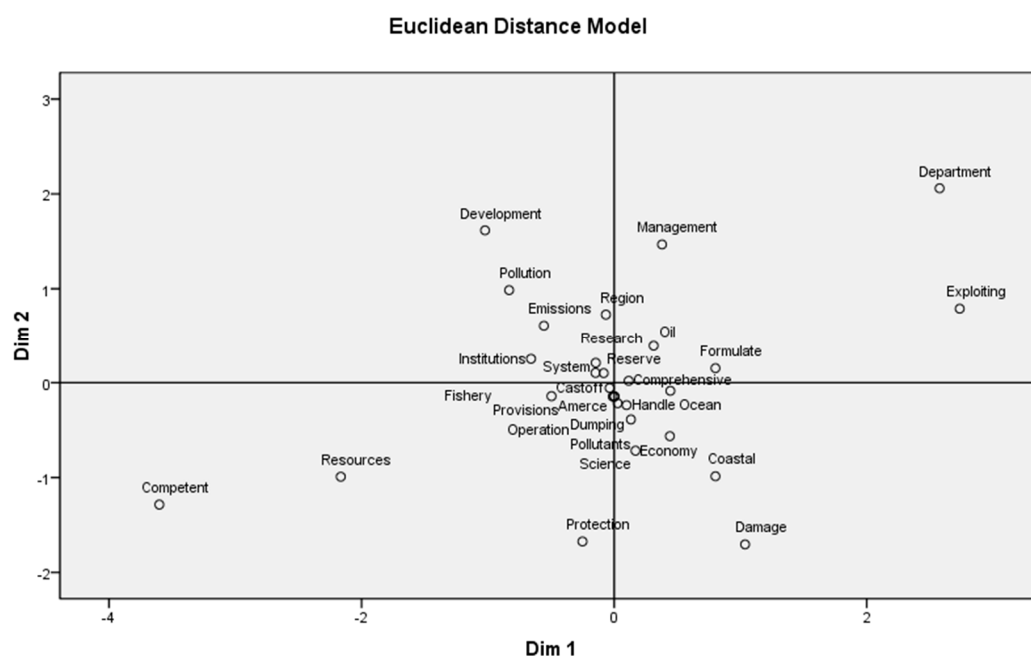


Figure 1. Marine environmental governance policy multidimensional scale graph of 1982–2000.

Table 1. New emerging keyword frequency statistics of marine environmental governance policy in each stage.

Stage	New Emerging Keywords Frequency
The Germination Period (1982–2000)	Exploiting (555), Resources (534), Protection (516), Department (422), Management (415), Development (368), Pollution (332), Ocean (297), Competent (280), Project (256), Handle (235), Economy (230), Research (209), Provisions (189), Region (172), Institutions (171), Reserve (168), Oil (161), Emissions (153), System (151), Damage (149), Dumping (140), Science (137), Fishery (136), Pollutants (130), Formulate (129), Comprehensive (129), Amerce (125), Operation (124), Castoff (118)
The 10th Five-Year Plan Period (2001–2005)	Control (239), Monitoring (233), Plan (199), Focus (180), Engineering (174), Harbor (168), Sector (158), Sewage (153), Aquaculture (124), Action (114), Coastal (111), Ship (107)
The 11th Five-Year Plan Period (2006–2010)	Island (447), Department (405), MPA (375), Function (357), Supervisor (291), Organization (198), Capacity (186), Zonation (182), Law (177), Approve (150)
The 12th Five-Year Plan Period (2011–2015)	Evaluation(253), Waters (240), Facilities (185), Red Line (147), Emergency (139), Prevention (134), Compensation (131), Mechanism (114)
The 13th Five-Year Plan Period (2016–2020)	Ecology (817), Launch (257), Promote (203), Repair (168), Nature (151), Residents (147), Pasture (139), Coastline (137), Regime (124), Participate (124)

(1) Emphasizing rational exploitation and utilization of marine resources. In Table 1, “exploiting”, “development”, “resources”, “protection” and “management” are high-frequency words in this stage, all of which are in the top six of word frequency. In the early stage of reform and opening, with the rapid development of the economy and the scarcity of land resources, China has a strong dependence on marine resources. During the process of development, the unreasonable exploitation and utilization of resources limit the sustainable development of the marine economy. To solve this problem, the government has promulgated policies to clearly regulate the exploitation and utilization of marine resources, such as the “Administrative Regulation on the Prevention and Control of Pollution Damages to the Marine Environment by Coastal Engineering Construction Projects” and “Concerning Environmental Protection in Offshore Oil Exploration and Exploitation”.

(2) The marine environmental governance system has formed initially. In Figure 1, keywords such as “oil”, “dumping”, “pollutants”, “emissions” and “castoff” are concentrated in the central area, most of them are major marine pollution problems. This indicates that the marine environment governance policy focused on pollution governance during this period. The government has promulgated policies to make clear provisions on the treatment of marine pollution issues such as oil pollution, marine dumping pollution, ship damage pollution and land pollution, to detail the contents of the “Marine Environment Protection Law”, and make the law more operational. China has gradually formed a marine environmental governance system supported by various policy laws and regulations, with the “Marine Environment Protection Law of the People’s Republic of China” as its core.

(3) The characteristics of “ex-post control” are obvious. Ex-post control refers to taking measures to solve the existing problems. At this stage, the keywords of the policy mainly are the pollution problems of the marine environment. The main goal of policy is to solve the existing pollution problems, which have obvious ex-post control characteristics. Meanwhile, “management” appears with a high frequency of 415 in this stage, indicating that marine environmental governance is dominated by administrative means. The marine environmental governance is still in its infancy and there are still many urgent marine environmental problems to be solved. Taking administrative measures led by the government is conducive to focusing on solving problems in a short time and improving the efficiency of marine environmental governance.

3.2. The 10th Five-Year Plan Period (2001–2005)

From 2001 to 2005, the “10th Five-Year Plan” period was implemented for marine economic development; this stage of marine environmental governance strictly implemented the marine functional zoning system, the rational development and protection of marine resources and the prevention of marine pollution and ecological damage and promoted the sustainable development of the marine economy. There are 13 marine environmental governance policies at this stage. The statistics on new emerging keywords in this stage are shown in Table 1. Figure 2 is the multi-dimensional scale analysis diagram in this period.

(1) From ex-post control to ex-ante control gradually. Ex-post control refers to taking measures to solve existing problems. Ex-ante control is a preventive measure, which means that certain measures have been taken to avoid conflicts before problems occur. According to word frequency analysis, “Monitoring” occurs 233 times in this stage. Different from the last stage, the government began to pay more attention to marine environment dynamic monitoring rather than the governance of pollution. The marine environment monitoring system has been established to monitor the changes of resources and the environment in the jurisdictional sea areas and the coastal zones to obtain comprehensive and timely information on marine resources and environment and prevent the occurrence of marine environmental problems. Marine environmental governance has gradually shifted to a combination of prevention and treatment, with prominent “forward-looking” features.

(2) Attention was paid to the development of marine science and technology. In the central area of Figure 2, two short-distance hotspot keywords, “technology” and “research”, appear, which indicates that the government has begun to attach importance to the role of science and technology in marine environmental governance, and they issued a series of policies to promote the development of marine technology. The trend of marine environmental science and technology in this stage is to deepen the investigation and research of marine environment and resources. For example, the government has built sewage and solid waste treatment facilities in coastal cities and established a precise monitoring system for the marine ecological environment. Marine environment science and technology is an important support to maintain marine ecological environment protection and sustainable development of the marine economy.

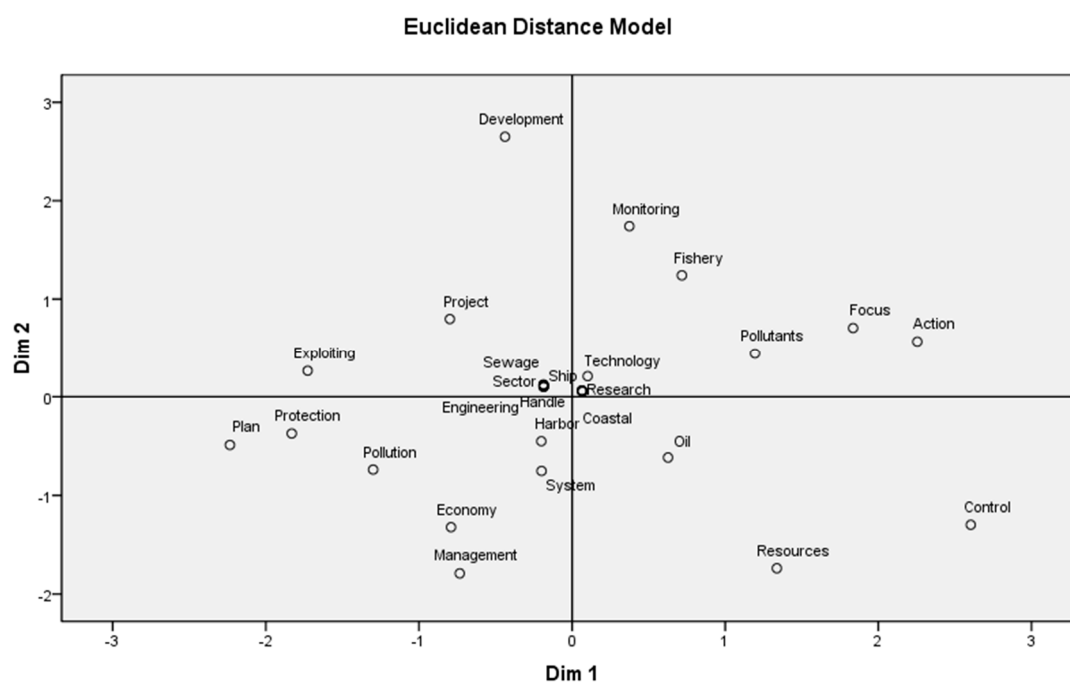


Figure 2. Marine environmental governance policy multidimensional scale graph in 2001–2005.

3.3. The 11th Five-Year Plan Period (2006–2010)

From 2006 to 2010, the “11th Five-Year Plan” period was implemented for national marine economic development; the marine environmental governance of this stage adheres to the principles of river and ocean balance. The total amount control system based on marine environmental capacity was implemented in key sea areas. Strict marine environmental supervision increased marine pollution control and governance efforts. China strengthened the investigation and evaluation of marine ecology to promote the natural restoration of marine ecology. There are 18 marine environmental governance policies at this stage. Compared with the previous stages, the statistics of new emerging keywords in this stage are shown in Table 1. Figure 3 is the multi-dimensional scale analysis diagram in this period.

(1) The scope of environmental governance has been expanded. “Island” emerges 447 times at this stage, and hot keywords such as “harbor” and “fishery” appear in the central area of Figure 3. This indicates that the government has begun to pay attention to the protection of typical ecosystems such as islands and important fishery waters, and the scope of environmental governance has been expanding. Policies such as the “Island Protection Law” were issued to protect the ecosystems of islands and surrounding sea areas, strengthen the protection of port shoreline resources and protect inshore fishery resources.

(2) Attach importance to marine protected areas. “MPA” appeared at the high frequency of 375 during this period, and is closer to the word “management” in Figure 3, which indicates that the policy system paid more attention to marine protection areas (MPA) during this period. According to the 11th five-year plan, the total area of MPA should reach 5% of the area under the jurisdiction by 2020. Meanwhile, the species of MPA has increased. China has proposed to set up special island protected areas and Antarctic MPA to improve the network of MPA.

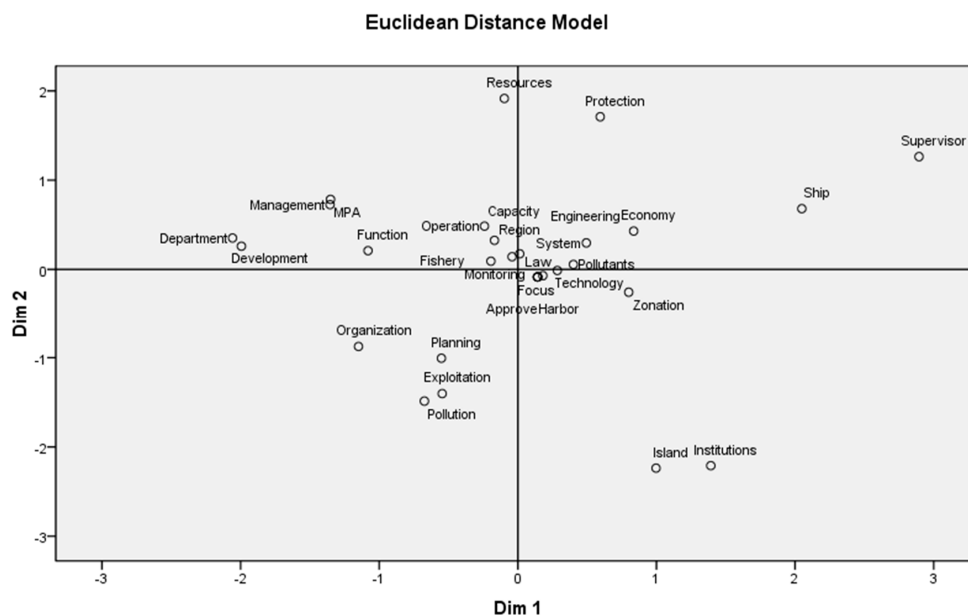


Figure 3. Marine environmental governance word multidimensional scale graph of 2006–2010.

3.4. The 12th Five-Year Plan Period (2011–2015)

From 2011 to 2015, the “12th Five-Year Plan” period was implemented for national marine economic development. The objective of marine environmental governance in this stage was to scientifically exploit marine resources, actively develop a circular economy, vigorously promote energy conservation and emission reductions in the marine industry, strengthen the prevention and control of land-based sources of pollution, protect the marine ecological environment effectively, enhance the abilities of disaster prevention and mitigation effectively and promote green developments. There are

17 marine environmental governance policies at this stage. The statistics of new emerging keywords in this period are shown in Table 1. Figure 4 is the multi-dimensional scale analysis diagram in this period.

(1) Marine environmental governance was strengthened. The “redline” is in the central region of Figure 4 and appears at the high frequency of 147. Marine ecological red line (MERL) refers to the identification of important marine ecological functional areas, ecologically sensitive areas and ecologically fragile areas as key control areas and the implementation of strict institutional control. MERL represents the maximum development that an ecosystem can sustain. Once a red line is established, it should not be adjusted theoretically [14]. In 2012, the Bohai Sea first established the marine ecological red line system, which proposed that the proportion of the marine ecological red line area in the area under the jurisdiction should not be less than 40%, the natural shoreline preservation rate should not be lower than 40% and four other targets. It explicitly prohibits or restricts the entry of industries and activities in the MERL by coercive targets and means. Compared with previous stages, marine governance has been greatly strengthened.

(2) The characteristic of “prevention” is obvious. Hot keywords such as “emergency” and “planning” appeared in Figure 4, and “prevention” appeared at the high frequency of 134. This indicates that China has formulated many policies on “emergency” and “plan”, which are more forward-looking and predictive. During this period, the government formulated emergency plans concerning ships pollution and oil spills to improve emergency construction capacity. China has developed a high sensitivity to environmental crisis events, and has shifted from the treatment of existing marine environmental pollution problems to the prediction and control of marine environmental risks, making effective predictions of possible problems, and drawing up plans for marine environmental risks and crisis events in advance. Meanwhile, China has formulated several marine environmental plans, including the “National Island Protection Plan”, “marine main functional area planning” and the “action plan for water pollution control” to provide long-term goals and directions for improving the marine environment.

(3) Policy tools are diversified. Compared with previous stages, “compensation” has become a new high frequency keyword. At this stage, China stipulated the management methods of the ship oil pollution compensation fund and the methods of claiming for marine ecological damage. China has begun to explore new management methods based on the previous compulsory administrative means such as fines and penalties, established a marine ecological compensation system and developed from single administrative means to multiple policy tools such as administration, economy and law.

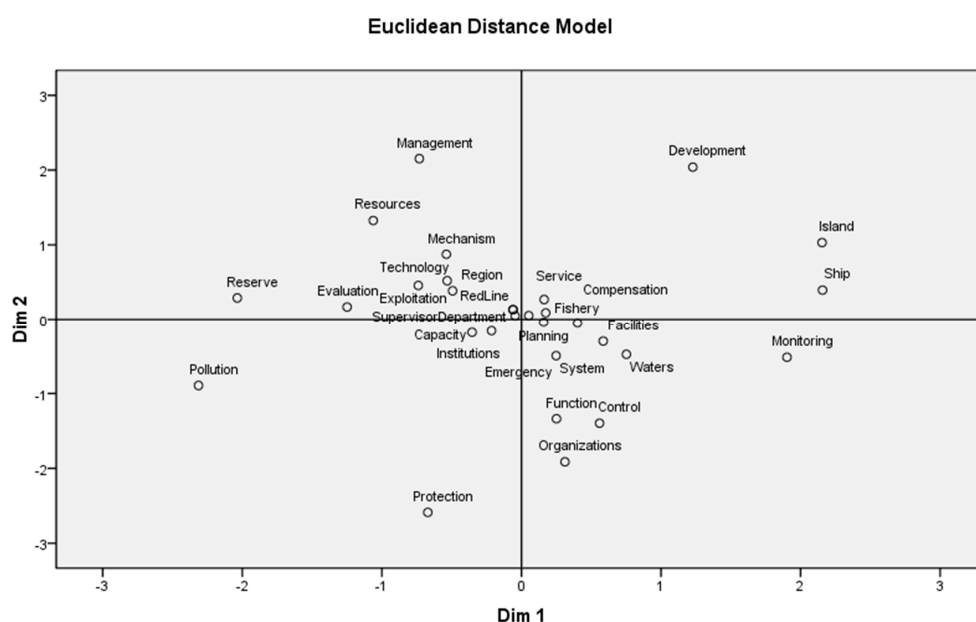


Figure 4. Marine environmental governance policy multidimensional scale graph in 2011–2015.

3.5. The 13th Five-Year Plan Period (2016–2020)

From 2016 to 2020, the “13th Five-Year Plan” period was implemented for national marine economic development. According to the marine environment and the national marine development goals, the state promulgated a new series of policies for marine environmental governance. There are 16 marine environmental governance policies at this stage. The statistics of new emerging keywords in this stage are shown in Table 1. Figure 5 is the multi-dimensional scale analysis diagram in this period.

(1) Pay attention to environmental governance model innovation. “Pasture” appears for the first time in this stage at the high frequency of 137. Many policy documents on “pasture” were added, which is a new idea of marine environmental governance at the present stage. Marine pasture refers to the establishment of artificial fish farms in specific sea areas, the planned cultivation and management of fishery resources, the proliferation and release of artificial reefs and marine ecological restoration. China plans to build 178 national marine pasture demonstration areas by 2025 to maintain the stability of the marine ecosystem and maximize comprehensive benefits.

(2) Coordinated land and marine development. “Coastline” appears for the first time with a frequency of 137, indicating that the coastline was included in the scope of marine environmental governance. The scope of environmental governance was further expanded. Based on the original seaports, islands, harbors and so on, the scope of governance was extended to the coastline. Through establishing a clear coastline management mechanism, the State Oceanic Administration is responsible for directing, coordinating and supervising the governance and use of the national coastline; the relevant departments of the State Council manage the protection and use of coastlines; the local government of the coastal province is responsible for supervising and managing the coastline of the administrative region. At this stage, the formulation of policy is more focused on land and sea integration, optimizing the allocation of coastline resources and constantly extending the scope of marine environmental governance.

(3) Diversity of participants. “Resident” appears in the central area of Figure 5 and received a higher level of attention during this period. At the same time, “residents” and “participate” appeared at frequencies of 138 and 135, respectively, indicating that the government was no longer the single subject of marine environment governance, other stakeholders appear in the governance process, the participants developed from single to diversified. The development of marine environmental governance policies at this stage is more open; new media and other platforms provided more channels for the public to obtain marine environment information and participate in marine environment governance.

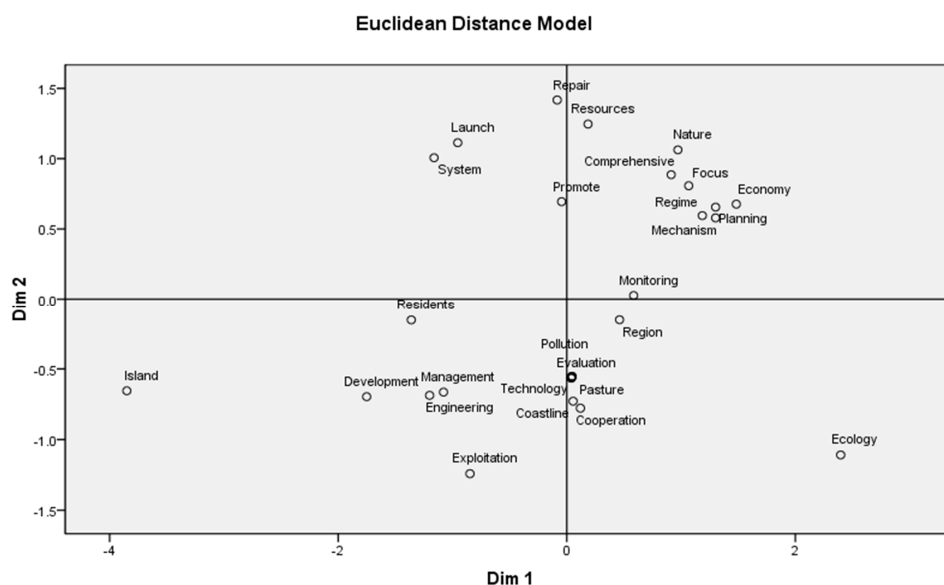


Figure 5. Marine environmental governance policy multidimensional scale graph of 2016–2020.

In summary, China's marine environmental governance policies show different characteristics in five stages. The specific characteristics of marine environment governance policies and relevant new emerging keywords at each stage are summarized in Table 2.

Table 2. Evolution characteristics of marine environmental governance policy.

Stage	Characteristics	Relevant New Emerging Keywords
The Germination Period (1982–2000)	(1) Ex-post control. (pollution control)	Pollution (332), Oil (161), Dumping (140), Castoff (118)
	(2) Single policy tool. (administrative means)	Management (415)
The 10th Five-Year Plan Period (2001–2005)	(1) Shifted to ex-ante control. (dynamic monitoring)	Monitoring (233)
	(2) Increased policy tools. (economy means)	Sewage (153)
The 11th Five-Year Plan Period (2006–2010)	(1) Expanded governance scope.	Island (447), MPA (375)
	(2) Increased policy tools. (legal means)	Law (177)
The 12th Five-Year Plan Period (2011–2015)	(1) Ex-ante control. (risk prevention and control)	Red Line (147), Emergency (139), Prevention (134)
	(2) Diversity of policy tools.	Compensation (131)
The 13th Five-Year Plan Period (2016–2020)	(1) Coordinated land and marine.	Coastline (137)
	(2) Diversity of participants.	Residents (147), Participate (124)

4. Evolutionary Characteristics of China Marine Environmental Governance Policy

4.1. Diversification of Participants

In the early stage of the formation of China's marine environmental governance system, economic development was still the emphasis of national development, and the governance of the marine environment had to be forced and effective. The government was the main participant and unified management of the marine area. With the deepening of marine development, land pollution, oil pollution, coastal engineering pollution and other issues gradually appeared. Relying solely on government forces cannot guarantee sustainable marine utilization, so enterprises, the public and other stakeholders began to participate in marine environmental governance.

During the process of policy formulation, various industry departments coordinated and cooperated [15]; the participation of various stakeholders for the formulation of marine environmental governance policy provides a common vision that is conducive to the final implementation of the policy [16]. In the "13th five-year plan" period, "participate", "residents" and other hot high-frequency keywords appeared. The government has taken various measures to increase the participation of all stakeholders. For example, the Natural Resources Ministry established a marine information disclosure system to publicize marine environmental information, strengthen the publicity of marine environment-related knowledge and incorporate the popularization of marine knowledge into the national education system, expanding channels for public participation, holding seminars on marine environmental governance and providing media platforms for public comment.

4.2. From Ex-Post Control to Ex-Ante Control

In the early stages of marine environmental governance policy, the Chinese government lacked experience in marine environmental governance. In facing increasingly serious marine environment problems, ex-post control was in line with China's national conditions and was conducive to the rectification of marine environmental problems in a short period of time. However, with the continuous

improvement of the marine environmental governance policy system, the simple problem-oriented framework could not meet the requirements of marine environmental governance. The prevention feature of policy making is obvious, and gradually shifted to ex-ante control.

In the empirical analysis of policy texts, government “management” is the main method, which shows obvious characteristics of control after the event in the germination period. “Monitoring” appeared at high frequency in the “10th five-year plan” period, China set up a marine environmental monitoring system to monitor marine environmental risks, and the policy began to show forward-looking characteristics. Emergency plans for ship pollution and oil spills were formulated during the “12th five-year plan” period, which shifted from the control of marine environmental pollution to the prediction and control of marine environmental risks. At the same time, China established the Marine Ecological Red Line System (MERL) to prevent and control marine environmental pollution; MERL is a protective and preventive system focusing on strict zoning control [14]. China’s marine environment has shifted from pollution control to ecological protection, and from treatment to prevention, gradually shifting from ex-post control to ex-ante control.

4.3. Diversification of Policy Tools

China’s marine environment governance has evolved from a single policy tool to a multipolicy tool, and gradually formed a policy tool system dominated by executive orders and supplemented by economic and legal means.

In the “embryonic stage”, there were many marine environmental problems in China that needed to be solved, and administrative means such as “management” were the main policy tools in the germination period. Then economic, legal and other policy tools began to appear. Marine engineering sewage fees were collected in the “10th five-year plan” period. The emergence of sewage fees as an economic means prompted enterprises to balance the relationship between pollution costs and benefits and to force the improvement of corporate environmental governance systems. The management of the fund for compensation of oil pollution from ships and the claims for marine ecological damage during the “12th five-year plan” period was regulated and a more realistic marine ecological compensation system was established. The diversification of policy tools is conducive to the formation of a low-cost and high-efficiency environmental governance system.

4.4. Expansion of Governance Scope

The scope of governance of the marine environment shifted from a single environmental governance system to ecosystem governance. China’s government focused on the governance of typical ecosystems such as islands, important fishery waters and MPA, issued the “Island Protection Law” and other policies to protect the ecosystems of islands and surrounding sea areas, strengthened the protection of port shoreline resources and protected inshore fishery resources.

Based on the original harbors, islands and other scopes of governance, the governance of the coastline increased; this shift indicated the attention on land and sea integration, optimizing the allocation of coastline resources and constantly extending the scope of marine environmental governance.

5. Ways Forward

5.1. Increasing the Participating Subjects

The central government, local governments, enterprises and the public are the main stakeholders of marine environmental governance. In the process of formulating marine environmental governance policy, the government should make greater efforts to make full use of the knowledge of various stakeholders to fill gaps in information and knowledge management [15].

In the process of policy formulation for marine environmental governance, various stakeholders are involved and play different roles. First, the central government participates in the formulation of environmental governance policy guidance and environmental supervision, establishes a normal

and effective supervision mechanism and exerts environmental supervision. The knowledge and recommendations of various stakeholders on marine environmental governance are implemented to ultimately obtain an effective governance plan [15]. Second, marine environmental governance should integrate into the scope of assessment to enhance the local government's enthusiasm for marine environmental governance. As the direct subject of marine environmental governance, local governments often consider local economic development in the context of environmental governance, consider the selective implementations of environmental policies, support the local governance [16] and increase the environmental performance of local governments. Third, the incentive mechanism for enterprises is increased, which encourages enterprises to independently carry out environmental protection technology innovations and upgrades to achieve the effect of controlling the marine environment pollution at the source. Finally, as one of the stakeholders of marine environmental governance, the public has been less involved in China in recent years. Enhancing national awareness of the ocean and strengthening the fundamentals of marine environmental protection will help to ensure that the public has the basic knowledge needed to participate in the governance of the marine environment. When the public is more aware of the marine ecosystem, it will participate more meaningfully in marine environmental governance [17,18].

5.2. Promoting Diversification of Policy Tools

The application of policy tools promotes the formulation of marine environmental governance policies more rationally and effectively. China's marine environmental governance policy tools should range from command and control tools to economic incentive tools and persuasion tools to adapt to different stages of China's marine environment development and achieve environmental impact governance.

In the current stage of marine environment development, the environmental problems faced by the state are constantly complex, and these problems cannot be solved by adopting a single policy tool alone [19]. First, different policy tools should be selected according to different environmental problems, so that the policy effect is optimal. Second, in face of complex scenarios of many problems, different types of policy tools should be properly matched to promote the tools' diversification. Finally, governance should make full use of technological developments and promote escalating policy tools.

5.3. Improving the Policy Evaluation Mechanisms

Policy evaluation is an essential part of scientific decision-making. Through policy assessments, we can inform decision makers of the potential impact of policy options [20]. Policy evaluations should run through the whole process of policy formulation. China's marine environmental governance policy assessment mechanism has played an important role in the formulation and adjustment of marine environmental governance policies. However, compared with Canada, Japan and other countries, China's marine environmental governance policy assessment mechanism can still be improved [21].

To improve the marine environmental governance policy assessment mechanism, first, the possible impacts and consequences of policy promulgation should be analyzed through specific methods and procedures when formulating policies to reduce their cost implementation. Second, policy implementation progress and effectiveness should be assessed, and assessment frameworks and reporting procedures should be strengthened to ensure methodological integration and support practical approaches to reduce and adapt to risks [22]. Finally, the outputs, outcomes and impacts of the policy should be assessed. Once the assessment results are published, there should be extensive public discussion, such as ways to explore alternative policies [23].

6. Conclusions

This paper summarizes 80 policy documents related to marine environmental governance directly since 1982 and takes the five-year plan for marine economic development as the node; these policies can be divided into five stages: The germination period, the 10th Five-Year Plan period, the 11th

Five-Year Plan period, the 12th Five-Year Plan period, and the 13th Five-Year Plan period. We used co-word analysis, word frequency analysis and multi-dimensional scaling (MDS) methods to analyze the features of environmental governance policies of each stage. Then we summarized four evolution characteristics of marine environmental governance policy. Firstly, diversification of participants and the participation of enterprises, the public and other stakeholders has gradually increased; secondly, from ex-post control to ex-ante control, the focus of marine environmental governance has shifted from pollution control to risk prediction and control; thirdly, diversification of policy tools, a system of policy tools dominated by executive orders and supplemented by economic and legal means was gradually formed; lastly, expansion of governance scope, the scope has developed from single environment to ecosystem governance, paying more attention to protecting typical ecological systems such as islands and MPA and coordinating land and sea.

Under the guidance of China's marine environmental governance policy, the country's marine environment is developing effectively, but there are still many aspects to be improved. Firstly, increasing the participation of all stakeholders in marine environmental governance to achieve effective governance. Secondly, promoting the diversification of policy tools to obtain a reasonable combination and achieve optimal policy results. Finally, the marine environmental governance policy assessment mechanism should be improved and policy evaluation should be carried out over the entire process of policy formulation.

Author Contributions: Design of the research: J.-K.Y.; Data collection and analysis: W.-J.B.; Critical revision of the article: J.-K.Y.; Final manuscript preparation: J.-K.Y. and W.-J.B.; and All authors have read and approved the final manuscript.

Funding: This research was funded by the National Natural Science Foundation of China, grant number 71673259, Fundamental Research Funds for the Central Universities, grant number 201862004.

Conflicts of Interest: The authors declare that they have no competing interests.

References

1. Khim, J.S.; Hong, S. A comparative review and analysis of tentative ecological quality objectives (EcoQOs) for protection of marine environments in Korea and China. *Environ. Pollut.* **2018**, *242*, 2027–2039. [[CrossRef](#)] [[PubMed](#)]
2. Bigagli, E. The EU legal framework for the management of marine complex social—Ecological systems. *Mar. Policy* **2014**, *54*, 44–51. [[CrossRef](#)]
3. Chen, J.D.; Wang, Y. Analyzing the decoupling relationship between marine economic growth and marine pollution in China. *Ocean Eng.* **2017**, *137*, 1–12. [[CrossRef](#)]
4. Wang, Z.Y.; Li, G.; Li, C.Y. Research on the semantic-based co-word analysis. *Scientometrics* **2012**, *90*, 855–875. [[CrossRef](#)]
5. Han, S.F.; Zhu, R.F.; Zhao, J. A study of clinical psychological nursing research hotspots in China and variation trends based on word frequency analysis and visualization analysis. *Chin. Nurs. Res.* **2017**, *4*, 186–191. [[CrossRef](#)]
6. Callon, M.; Law, J.; Rip, A. *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World*, 3rd ed.; The Macmillan Press: London, UK, 1986; pp. 1–242.
7. Ding, Y.; Chowdhury, G.G.; Foo, S. Bibliometric cartography of information retrieval research by using co-word analysis. *Inf. Process. Manag.* **2001**, *37*, 817–842. [[CrossRef](#)]
8. Tang, Y.H.; Ma, Y.L.; Christina, W.Y.W.; Miao, X. Evolution of Government Policies on Guiding Corporate Social Responsibility in China. *Sustainability* **2018**, *10*, 741. [[CrossRef](#)]
9. Coulter, N.; Monarch, I.; Konda, S. Software engineering as seen through its research literature: A study in co-word analysis. *J. Am. Soc. Inf. Sci.* **1998**, *49*, 1206–1223. [[CrossRef](#)]
10. Lee, B.; Jeong, Y. Mapping Korea's national R&D domain of robot technology by using the co-word analysis. *Scientometrics* **2008**, *77*, 3–19.
11. Leydesdorff, L.; Welbers, K. The semantic mapping of words and co-words in contexts. *J. Informetr.* **2011**, *5*, 469–475. [[CrossRef](#)]

12. He, J.Y.; Shang, P.J. Multidimensional scaling analysis of financial stocks based on Kronecker-delta dissimilarity. *Commun. Nonlinear Sci. Numer. Simul.* **2018**, *63*, 186–201. [[CrossRef](#)]
13. Torgerson, W.S. Multidimensional scaling: I. theory and method. *Psychometrika* **1952**, *17*, 401–419. [[CrossRef](#)]
14. Lu, W.H.; Liu, J. A comparison of marine spatial planning approaches in China: Marine functional zoning and the marine ecological red line. *Mar. Policy* **2015**, *62*, 94–101. [[CrossRef](#)]
15. Tuokuu, F.X.D.; Gruber, J.S.; Idemudia, U.; Kayira, J. Challenges and opportunities of environmental policy implementation: Empirical evidence from Ghana's gold mining sector. *Res. Policy* **2018**, *59*, 435–445. [[CrossRef](#)]
16. Lester, S.E.; Ruff, E.O.; Mayall, K.; McHenry, J. Exploring stakeholder perceptions of marine management in Bermuda. *Mar. Policy* **2017**, *84*, 235–243. [[CrossRef](#)]
17. Satumanatpan, S.; Moore, P.; Lentisco, A.; Kirkman, H. An assessment of governance of marine and coastal resources on Koh Tao, Thailand. *Ocean Coast. Mang.* **2017**, *148*, 143–157. [[CrossRef](#)]
18. Olsen, S.B. Educating for the governance of coastal ecosystems: the dimension of the challenge. *Ocean Coast. Manag.* **2000**, *43*, 331–341. [[CrossRef](#)]
19. Mirzaei, A.; Knierim, A. Assessment of policy instruments towards improving the water reservoirs' governance in Northern Iran. *Agric. Water Manag.* **2019**, *211*, 48–58. [[CrossRef](#)]
20. Feyaerts, G.; Deguerri, M. Analysis of the decision-support function of policy assessment in real-world policy making in the field of poverty and social inequalities. Case study on migrant integration policies in the Brussels-Capital Region. *Environ. Impact Asses. Rev.* **2017**, *67*, 40–48. [[CrossRef](#)]
21. Su, M.; Yang, Y. Evolution of district marine policies in China: The case of Shandong Province. *Mar. Policy* **2018**, *89*, 124–131. [[CrossRef](#)]
22. Evans, K.; Bax, N.J.; Smith, D.C. Enhancing the robustness of a national assessment of the marine environment. *Mar. Policy* **2018**, *98*, 133–145. [[CrossRef](#)]
23. Edenhofer, O.; Kowarsch, M. Cartography of pathways: A new model for environmental policy assessments. *Environ. Sci. Policy* **2015**, *51*, 56–64. [[CrossRef](#)]



© 2019 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).