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The Economic and Environmental Impact of Marine Engineering on the Development of Offshore Oil and Gas Resources

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Abstract: The development and utilization of marine resources(MR) not only promotes the development and prosperity of coastal society and economy, but also affects the EE of marine engineering(ME). This paper discusses and analyzes the impact of the development of OOAGR on the EE of offshore engineering. This paper analyzes the relationship between the development of marine oil and gas resources(MOAGR) and the Economic Environment(EE) of ME, as well as the contribution of the development of MOAGR to the economy, and probes into the correlation between MR and marine economy(MEC) from a macro perspective; Taking m Province as the research object, this paper analyzes the development of MOAGR and the oil pollutants in marine sediments, and discusses the impact of the development of MOAGR on marine fisheries.

1. Introduction

Due to the externality of MOAGR, the complexity of ecosystem service value assessment and the absence of structural policies for ecological protection, there are obvious government failures and market failures in the development of MOAGR. The ecological compensation mechanism coordinated by the government, the market and society has not yet been established. In order to objectively calculate the resource loss of marine resource development and the impact on marine environment and marine ecology, it is necessary to include social profit and loss, economic net benefit, marine resource loss, marine environment profit and loss into the assessment of comprehensive benefits of marine resource development. In order to maximize the economic net benefit of marine resource development and realize the sustainable utilization of MR, this paper deeply discusses and analyzes the impact of the development of MOAGR on the EE of ME, calculates the contribution rate of resource loss in the development of MR to the development of

MEC, and calculates the proportion of MR in the development of MEC.

Many scholars at home and abroad have studied the impact of the development of OOAGR on the EE of offshore engineering. Sotoodeh K analyzes that offshore oil and gas platforms have very high power requirements, which are usually met locally through the use of gas turbines. For example, these facilities are powered by marine renewable energy. Put forward the value proposition, and studied the feasibility of implementing the combined wave and solar energy system to power the offshore oil and gas platform [1]. Gulas s discusses the carbon footprint of floating production, storage and unloading on a time axis. It is found that floating production, storage and unloading are conceptual products in the design stage, which will not produce carbon emissions, while in the operation stage, a large amount of emissions are released through fuel combustion, accounting for 88.2% of the whole life cycle[2].

This study first screened out the marine industries that directly utilize MR and the types of sea area use and MR involved, constructed the corresponding relationship between MEC, industry, resources and sea use projects, systematically analyzed the correlation between MR and MEC, calculated and analyzed the composition and internal structure proportion value of MR and MEC comprehensive benefits, respectively from the perspective of MEC The relationship between MR and MEC is analyzed from the macro perspective of industrial classification and the micro perspective of MR development projects. The comprehensive benefit evaluation index system of marine resource development and the MEC development evaluation index system are constructed, and the development status of the typical MOAGR in M Province on the ME EE is comprehensively evaluated. Finally, the impact of the development of MOAGR on the ME EE is analyzed [3-4].

2. Impact of Development of OOAGR on EE of Offshore Engineering

2.1. Relationship between Development of OOAGR and EE of Offshore Engineering

The development of MR has become a hot spot at present. While giving play to the advantages of MR, it is very important to enhance the economic development of marine green industries and form the correlation and cooperation effect between MR development and MEC. Therefore, it is of great significance to give full play to the advantages of marine industry, develop MR scientifically and rationally, coordinate with each other, promote the coupling between the comprehensive benefits of MR development and MEC development, and form a new pattern of complementary, interactive and coordinated development between MR development and MEC, to enhance the competitiveness of MEC, make rational use of MR, and promote the construction of Jiangsu Province into a strong marine province [5-6].

By calculating the structural proportion of resource loss, environmental cost and ecological loss in the comprehensive benefits of marine resource development of each sea use project, the relationship between MR and MEC is discussed from a micro perspective, and the contribution value of economic benefits to the comprehensive benefits of marine resource development is obtained. At the same time, the economic benefits corresponding to the loss of MR can be obtained, It indirectly reflects the objective impact of various sea use projects or types of sea use on the green GDP of major marine industries [7-8]. Based on the calculation of the proportion of the added value of each major marine industry in the direct utilization of MR, the correlation between recyclable and renewable MR and MEC can be analyzed in depth, and the impact of MR development on MEC, marine environment and marine ecology can be discussed.

2.2. Contribution of OOAGR Development to Economy

The exploration and development of OOAGR is an industry with strong correlation and great driving force. The development and utilization of rich MOAGR, through the upstream, downstream and lateral links of the industrial chain, strongly supports the development of marine industry, coastal economy and even the economy of the whole province. Mainly in the following aspects;

First, it directly supports the development of the petrochemical industry. In today's oil and gas resources are very scarce, the development of MOAGR plays an obvious supporting role in the development of petrochemical industry; The second is to promote the development of relevant industries and coastal economies through investment. Offshore oil and gas development has increased the demand for steel, shipbuilding and other industries. It plays an important role in promoting the development of steel industry, shipbuilding industry, infrastructure construction in coastal areas, and related industries serving oil and gas development [9-10].

2.3. Exploration and Development Status of OOAGR in Jidong Oilfield

Table 1 summarizes the distribution and exploration of oil and gas resources in the coastal oil and gas area and the beach oil and gas area of the main exploration area of Nanpu Sag in Jidong Oilfield. (unit: x104t)

Table 1. Data sheet of distribution and exploration of OOAGR

Petroliferous zone	Resources	Proved reserves	proved reserves	Controlled reserves	Predicted reserves	Tertiary reserves
Coastal oil and gas area	57000	42800	14600	6900	11300	32800
Beach oil and gas area	43000	25000	1040	5190	21698	27928
total	100000	67800	15640	12090	32998	60728

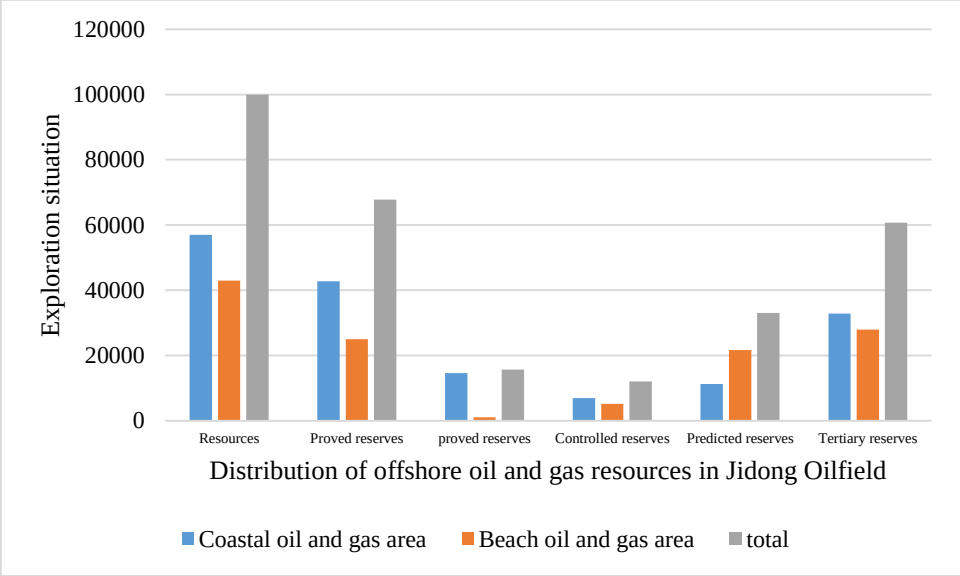

Figure 1. Distribution and exploration of OOAGR in Jidong Oilfield (unit x 104t)

Most of the OOAGR and proven resources of Bohai oilfield and Dagang Oilfield are in the sea area, and the exploration and development prospects of oil and gas resources in the sea area are extremely broad. According to the development planning of each oilfield, there will be a big leap in the output of OOAGR [11]. It has played a huge role in promoting local economic development planning. However, it should also be noted that with the expansion of the oilfield development scale, the negative impact on the marine EE and other marine industries will also increase [12-13].

2.4. Impact of Development of OOAGR on EE of Offshore Engineering

2.4.1. Development of MOAGR and Oil Pollutants in Marine Sediments

There are three main ways for petroleum hydrocarbon pollutants to enter the marine sediments: first, with the volatilization of light components and the dissolution of some petroleum hydrocarbons, when the marine water temperature drops, the oil pollutants in the marine sediments mainly come from the discharge of wastewater from offshore oil exploration, oil extraction and ships, as well as the discharge of sewage and domestic sewage from the petroleum industry and other industries. Take M Province as an example. Regional distribution characteristics of oil pollutants in bottom sediments of M province. There are two high value areas for oil distribution in marine sediments: one is Tanghai Yifeng South China Sea area in the north; The other is the Cangzhou sea area in the south, where the isolines are dense and the oil change gradient is large. According to the change trend and distribution law of isoline. The appearance of these two high-value areas is affected by different pollution sources [14]. In Tanghai Yifeng South China Sea area, the oil isoline shows an increasing trend from nearshore to offshore, the oil content distribution gradient changes obviously, and the isoline density is relatively large. This shows that the oil in the sediments is less affected by land-based pollutants, and the appearance of high oil pollutants is closely related to the exploration and development activities of the oilfield.

In another high-value area, the isoline value shows an increasing trend from southeast to northwest near shore, and the oil content in the sediments decreases from the estuary to the offshore, with the highest content in the sediments of Qikou estuary and Nanpai estuary. The isoline of oil content in sediments has a similar trend to that in seawater [15-16]. From the change law of contour values, the spatial distribution characteristics of oil in local marine sediments are mainly caused by the combined action of onshore oil and gas development and oil and gas development in Dagang beach and Boxi oilfield group.

2.4.2. Impact of Development of MOAGR on Marine Fishery

Effects on fish eggs and larvae. According to the characteristics of Dongyou life habits of fishery resource varieties, fishery resources in M province are divided into two types, local Dongyou fishery resources and offshore Dongyou fishery resources. Because of the breeding habits of fish, estuaries and harbors are the main breeding places for fish. Therefore, generally in the early summer of each year, these two types of fishery resources lay eggs in M coastal cluster one after another, and fish eggs and larvae are mainly distributed in the nearshore.

In M sea area, the number of eggs and larvae in Luanhe estuary and Bohai Bay is larger, and the overall trend is that the nearshore is higher than the far shore. In spring, fish eggs appear in a large range of 5-10 / m3 distribution areas at the Luanhe estuary and the bottom of the Bohai Bay, and more than 10 / m3 concentration areas appear along the Yellow River and the Yellow River. There are 5-10 / m3 distribution areas for larvae in the Luanhe River Estuary and along the Huangjiao River, and there are more than 10 / m3 dense areas in the Luanhe River Estuary. The number of fish eggs and larvae is significantly reduced in summer, and only a small range of high value areas will

appear in the Luanhe River estuary and the North Bank of the Bohai Bay [17].

Most of the MEC fish in the Bohai Sea are floating eggs, and most of the larvae are floating, which further increases their chances of being poisoned by oil pollutants in the oil polluted sea area. The fish eggs are stuck on the floating oil, and the toxic substances contained in the oil can directly kill the fish eggs. If oil spills occur in the spawning season, the oil pollution will drift to the spawning center under the coupling action of wind, coastal currents and tidal currents in Cangzhou sea area, which will greatly affect the sustainable development of fishery resources.

2.4.3. Impact on Marine Aquaculture

Seawater aquaculture is mainly raised by intercepting bays or building dams and gates on coastal depressions, and using the tide of seawater to feed seedlings. M province is located in the north temperate zone, straddling the Bohai Sea and Liaodong Bay. The coastal system is a shelf shallow sea area with a flat terrain. The coastline is 573.05km long (including the island coastline, with a total area of 109487hm2. The coastal bottom is mostly sandy or muddy. There are many rivers entering the sea. The bait organisms are rich and diverse, and the natural conditions for developing marine aquaculture are superior.

Oil pollution will also affect shrimp farming in the form of food chain. The fresh food for shrimp culture in Cangzhou city mainly comes from marine filter feeding Artemia and bivalve blue clam [18]. Shrimp eating Artemia and blue clam contaminated by petroleum hydrocarbons affects their disease resistance, resulting in reduced production and quality of shrimp culture.

3. Benefit Evaluation of OOAGR Development

The comprehensive benefits of green MEC development can be judged by the comprehensive index of MEC development. The comprehensive benefit index is between 0 and 1, and the closer it is to 1, the better the comprehensive benefit.

Based on the comprehensive benefit evaluation function of marine resource development type constructed, the evaluation function of MEC development is deleted, and the comprehensive score of marine resource development type comprehensive benefit in Jiangsu Province and the comprehensive score of green MEC development in Jiangsu Province are taken as examples. The coupling coordination degree and its evolution of the two systems are analyzed by using the coupling coordination model.

Benefit evaluation index of structural offshore oil and gas resource development type:

$$g(x) = \sum_{i=1}^{n} x_i v_i \tag{1}$$

Where g (x) is the evaluation index. The larger the evaluation index is, the better the development degree is; otherwise, the lower it is; Xi is the ith normalized value of original data; VI is the entropy weight of the ith index in the whole index system.

Construct MEC development evaluation index:

$$q(y) = \sum_{j=1}^{n} y_j v_j \tag{2}$$

In the formula, q (y) is an evaluation index. The larger the evaluation index is, the better the development degree is; otherwise, the lower it is; YJ is the jth normalized value of original data; VJ is the entropy weight of the jth index in the whole index system. On the basis of constructing the evaluation functions g (x) and Q (y), the coupling evaluation model is further constructed by using

the evaluation index.

The ratio of the economic net benefit per unit sea area to the comprehensive benefit assessment value per unit sea area is shown in Table 2. From high to low, it is land reclamation, mariculture, sewage dumping, offshore wind power and marine protected areas. The ratio of the ecological profit and loss value of the unit sea area to the comprehensive benefit evaluation value of the unit sea area from high to low is land reclamation, marine protected areas, offshore wind power, sewage dumping and mariculture;

Table 2. Ratio of economic net benefit per unit sea area to comprehensive benefit assessment value per unit sea area

proportion	Marine protected area	Mariculture	Offshore wind power	Sewage dumping	Reclamation
Economic Net Income	60.30%	142.45%	84.14%	95.63%	-105341.57%
MR loss assessment value	-0.94%	-23.83%	-3.04%	-2.99%	62476.19%
Environmental profit and loss value	40.64%	-0.54%	19.55%	8.59%	19874.75%
Loss assessment value	0.00%	-18.09%	-0.65%	-1.23%	23090.63%

The main reason for the lowest comprehensive benefit evaluation value per unit sea area of the marine resource development type of reclamation is that although the economic net benefit per unit sea area is the highest within the sea use period of the reclamation project, the loss evaluation value of MR per unit sea area, the ecological profit and loss value per unit sea area, and the loss evaluation value of ecosystem service function value per unit sea area all show relatively negative values.

4. Experimental Analysis of the Impact of the Development of OOAGR on EE

Exploitation of MOAGR and distribution of heavy metals in marine sediments. In this paper, m province is selected as the experimental research object to analyze the spatial distribution of mercury content in the sediment of M province. According to the change trend of lead content in Qinhuangdao sea area and Tanghai sea area, high-value areas of sediment lead pollution are formed around the oil field, which indicates that the source of lead pollution in the sediment of this sea area is related to the exploitation activities of the oil field. However, high values of 29.8x10-8 and 23.7x10-8 appeared in the stations near Qikou oilfield and Caofeidian oilfield in the far shore, ranking second and fourth among the 11 stations in Cangzhou sea area. Obviously, the content of lead pollution in the sediments of Cangzhou sea area is closely related to the production of onshore oil and gas fields and the oil and gas exploration in the sea area.

Although the content distribution of cadmium and arsenic in marine bottom sediments is not as obvious as that of lead and mercury, they also have similar characteristics, that is, the content of cadmium and arsenic in the bottom sediments near the oil field is slightly higher, but it tends to decrease away from the oil field. On the one hand, it may be related to the chemical properties of Fuhe and arsenic, and on the other hand, it may be related to the low content and large change of

these two heavy metals in crude oil exploitation.

In order to better illustrate the impact of the exploration and development of OOAGR on the marine sedimentary environment, this paper also selects the change of pollutant content at different stations near and far from the oil field in the same sea area, under the same hydrodynamic conditions and the same sedimentary environment. The analysis results are listed in Table 3.

Table 3. Statistical table of content and pollution index of various pollutants in group I and group II

Station	oils		arsenic		Lead		cadmium		mercury	
	Content	PI oil	Content	PI oil	Content	PI oil	Content	PI oil	Content	PI oil
I	8.52	0.02	26.68	1.33	33.05	0.55	0.16	0.32	0.45	0.42
II	2.65	0.005	14.62	0.73	25.4	0.43	0.12	0.26	0.285	1.40
Standard value	500		20		50		0.4		0.3	

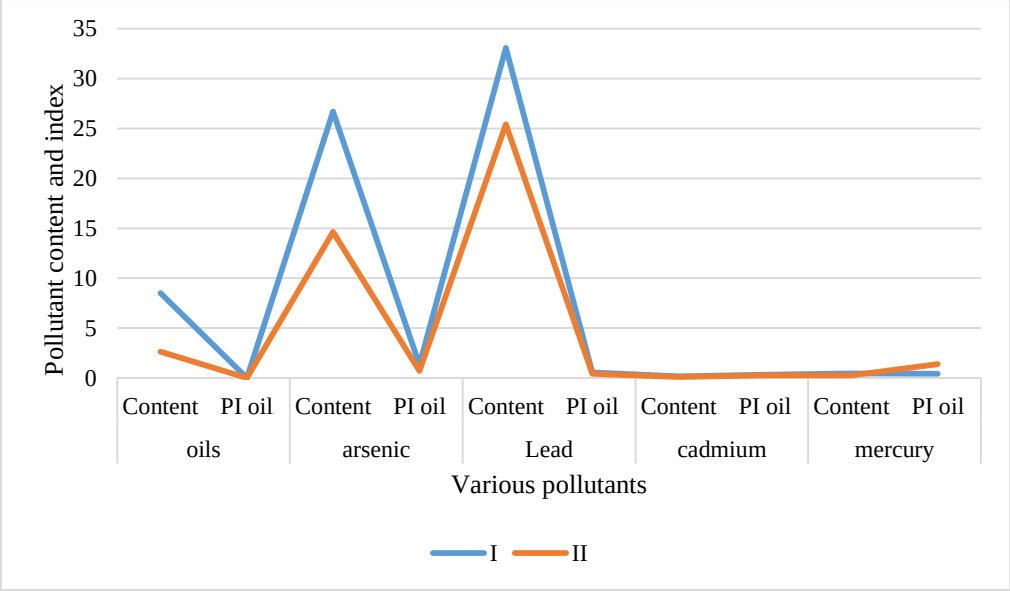

Figure 2. Content and pollution index of various pollutants

Through comparison, the average content of oil and heavy metal arsenic, lead and tin in the marine sediments of the two stations in group I, which are close to the oil field, are significantly higher than the average content of the two stations in group II. Moreover, the average content of heavy metal arsenic in the station in group I has exceeded the standard value of arsenic content in the sedimentary environment, and the pollution index is 1.3; The oil content of the two groups of stations is far lower than the standard value, but the average oil content of group I is 3.2 times that of group II; Only the mercury content of group II stations is higher than that of group I, and the pollution index is 1.41. The specific reasons need to be further studied. Analysis shows that marine oil and gas development has a great impact on marine sedimentary environment.

The evaluation of the current situation of sediment quality in the oil field exploration and development area is mainly concentrated in Cangzhou sea area, which is the concentrated area of oil and gas resources exploration and development in M province. There are various oil fields in the beach area that Dagang oil field mainly develops and the Boxi oil field group of Bohai oil field, which can better reflect the impact of oil field development on sediment quality.

5. Conclusion

The output value of China's MEC has broken through the trillion yuan mark and become an important part of China's national economy. All coastal provinces and cities in China regard building a strong MEC province as their own economic development goal. However, marine environmental pollution and decline of MR have become one of the main problems facing the sustainable development of MEC. This paper studies and analyzes the impact of the development of MOAGR on the EE of ME. Taking m Province as an example, it explores the impact of the development of MOAGR on Marine Fisheries and other economies. The Bohai Sea is now facing many problems that restrict the sustainable development of the MEC, such as the deterioration of the marine ecological environment, the reduction of marine biological species, the serious decline of fishery resources, the increasingly serious pollution of the marine environment, and the continuous occurrence of major oil spill pollution accidents. Therefore, it is necessary to strengthen the construction of the marine EE.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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