



CCICED Special Policy Study Executive Report

**China's Marine Environmental Management Mechanism -
Based on Case of Bohai Oil Spill**

CCICED Annual General Meeting 2012

December 12-14, 2012

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ABSTRACT

The special policy study (SPS) team has, based on shared and available information, assessed the impacts on the ocean environment from marine economic development in the Bohai Sea. Through case studies of the oil spill accident on the Penglai 19-3 oil field in the Bohai Sea of China in 2011, the oil spill accident of US “Deepwater Horizon” drilling rig in the Gulf of Mexico in 2010 and the oil spill accident on the Norwegian “Statfjord” field in the North Sea in 2007, together with analysis of the main problems with China’s marine environmental management, the SPS team have formulated seven policy recommendations to improve China's marine environmental management mechanism:

1. Develop an integrated national marine development and environmental protection plan. This plan should be a national master plan for the development and layout of the main marine industrial sectors: *China’s National Coastal and Marine Spatial Plan*. Such a plan should address and integrate all existing marine development-related strategic plans for coastal and offshore areas in the various provinces.
2. Establish a national marine emergency response plan, “*National Contingency Plan (NCP)*” for marine environmental incidents. The NCP should cover the entire country and include specific *Area Contingency Plans (ACP)* that apply to coastal provinces, large areas of the coast or bays, etc.
3. Harmonize marine-related national environmental laws and marine environmental administrative functions. Among other changes, the “*Three Provisions*” issued by the State Council needs to be modified. To improve inter-ministerial coordination and cooperation, a new department of environmental emergency and environmental protection coordination should be established within MEP.
4. Improve legislation for marine environmental management, including rules for the approval and supervision of all off-shore oil field development planning, the implementation of pollution prevention control and safe production regulations, information disclosure procedures, ecological damage assessments, and improved compensation systems and mechanisms to cover the cost for the emergency responses.
5. Strengthen the enforcement of laws and regulations to protect the marine environment by establishing a unified offshore law enforcement team.
6. Enhance corporate environmental responsibility and improve the environmental risk prevention capacity of enterprises.
7. Strengthen research related to marine environmental management through the support of environmental marine public projects or special national science and technology development programs. International cooperation is a very important way of achieving these goals.

Keywords: Bohai Oil Spill, Marine Economy, Marine Environment, Emergency Management, Normal Management, Organizations System and Mechanism, Laws and Regulations, Overall Plan, Emergency Response Plan, Double-effect Mode (efficient and effective), Inter-ministerial Coordination, Corporate Environmental Responsibility

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China's Marine Environmental Management Mechanism - Based on Case of Bohai Oil Spill

FOREWORD

Although an important part of the marine economy, offshore oil and gas exploitation and transportation also can result in marine oil spill accidents. Tankers and offshore oil production may result in particularly large oil spills.

The subsea oil leakage accident of Penglai 19-3 oilfield in the Bohai Sea of China in 2011 has revealed the inadequacy of the emergency response capacity, an uncoordinated institutional arrangement and the weakness of the support system. In addition the accident has highlighted deep-rooted conflicts between China's marine economic development and the environmental management of the oceans. CCICED approved this Special Policy Study on the Bohai Oil Spill as a Case for China's Marine Environmental Management Mechanism. The study is to: promote sound interaction between marine development and environmental protection, facilitate green transformation of the "blue economy" development mode, and explore the new mode of environmental management, i.e., "environmental protection under development, and development under environmental protection". The need to harmonize marine resources development and marine environmental protection has become an urgent problem for China. In this regard, the Bohai Oil Spill accident has provided a classical case study for improving marine environmental management mechanism and facilitating "green transformation" of integrated land and marine economy.

China's offshore oil development began in the 1960s, and international cooperation began in the early 1980s. Over the past 20 years, China marine oil spill accidents have been characterized as high risk, wide damage range, long lasting and difficult to evaluate. With ever expanding offshore oil development, the Bohai Sea has become the main offshore area for oil production, with 21 offshore oil fields with 178 drilling and production platforms¹ by the end of 2009. In total there have been 1419 production wells completed in this area¹. The annual oil production reached 30 million tonnes in 2010², which makes the Bohai Sea a prolific production area. In addition to the Bohai Sea, oil production in the East China Sea and the South China Sea is also expanding. All these activities lead to increasing risks of oil spill accidents.

In recent years, more than 500 marine oil spill accidents happen every year with a trend of further increase. Moreover, China's offshore oil transportation is only exceeded by that of USA and Japan at present, oil throughput of ports is increasing at a rate of more than 10 million tonnes/year³, shipping intensity is increasing, and the

¹ CCICED, *Ecosystem Issues and Policy Opinions Addressing Sustainable Development of China's Ocean and Coast* (2010), p33.

² Guo Xiaozhe, *World Offshore Petroleum Development history*, Petroleum Industry Press., Beijing, 2012, p337.

³ CCICED, *Ecosystem Issues and Policy Opinions Addressing Sustainable Development of China's Ocean and Coast* (2010), p18.

size of tankers is becoming larger. China's current marine-based economy is increasing at an average annual growth rate of more than 20%, which will surely increase the risk of marine oil spill accidents.

For China's current marine development and environmental protection situation, we can learn from the experiences and lessons from many oil spill accidents in the world, including the emergency response to the explosion and oil spill accident of the US "Deepwater Horizon" drilling rig in the Gulf of Mexico in 2010 and the oil spill accident of Norwegian "Statfjord" field in the North Sea in 2007. Drawing on these experiences will help strengthen and improve China's current marine environmental management.

This study aims at revealing the existing institutional, systematic and legislative problems in both emergency response and normal management of China's marine environment through the case analysis of the "Bohai Oil Spill in 2011" and the comparison of international lessons/experiences of marine environmental disaster emergency response. The study lays out practical policy recommendations on environmental management for a coordinated approach to marine economic development and marine environment protection.

1. MARINE ECONOMY DEVELOPMENT AND THE CHALLENGE OF MARINE ENVIRONMENTAL PROTECTION IN CHINA

1.1 Marine economy development is accelerating while marine development strategy needs to be improved in China

1.1.1 China has a solid foundation for marine and coastal economy development

China is a country with substantial land and sea areas. There are 380,000 km² of territorial sea area, about 3 million km² of the sea under national jurisdiction⁴, a 32,000 km coastline (including 18,000 km mainland coastline) and more than 6,900 islands⁵. China's more than two thousand years of historical experience with economic development shows that coastal development and overseas trade have been important components of the national economic development. Historically, the prosperous periods of country unity and social economic development were all accompanied by opening of coastal economic development and increases in overseas maritime trade. With national economic development and increasing international economic linkages, China's economic activity has shifted gradually from inland to coastal areas.

1.1.2 National marine economy development strategy is being implemented

At the present stage, China is a country at a strategic period of national rejuvenation and stable economic development. Coastal and marine economic development has broad prospects, further boosted by China's constantly strengthened awareness of marine economic development strategies. In 2003, the State Council issued the

⁴ Yang Jinshen, *China's Maritime Strategy Study Collection*, Ocean Press. Beijing, 2006, p271.

⁵ Working Group on Legislative Affairs of the NPC, *People's Republic of China Law of Island Protection Interpretation*, Law Press. Beijing, 2010, p165,182.

Outline of National Plan for Marine Economy Development. The *Eleventh Five-Year Plan (FYP) for National Economic and Social Development* in 2006 further elaborated the strategic directions as “strengthening ocean awareness, safeguarding marine rights and interests, protecting marine ecology, developing marine resources, implementing comprehensive marine management and promoting marine economic development”. In particular, the 5th plenary session of the 17th CPC Central Committee in October 2010 put forward a detailed marine economic development strategy, namely “adhering to integrated land and sea area plan; formulating and implementing marine development strategy; improving marine development, control, and comprehensive management ability. Scientifically planning marine economic development; developing industries such as offshore oil and gas, transportation and fishery, etc.; rationally developing and utilizing marine resources; strengthening construction of fishing ports; and protecting island, coastal zone and marine ecological environment. Guaranteeing safety of sea transportation channels; and safeguarding China’s marine rights and interests.” In Chapter 14 of *Promote Marine Economy Development*, the 12th FYP (2011-2015) provided specific tasks for China’s marine economic development in the future.

1.1.3 The marine economy plays an important role in the national economy

Since the 1990s, the status of the marine economy in the national economy has steadily improved, and has become an important pillar of development of the national economy. According to data from the State Oceanic Administration (SOA), total gross marine production reached 2.1 trillion yuan in 2006, with a year-on-year growth of almost 14%, and accounts for 10% of GDP; this number increased to 4.6 trillion yuan in 2011, with a year-on-year growth of 10.4%, and takes up 9.7% of GDP. According to predictions from the Marine Development Strategy Research Institute of State Oceanic Administration, the proportion of China's marine economy will further increase at least until 2020⁶.

1.1.4 Future marine economic development strategy needs to be adjusted

Compared with marine development strategies and marine economy development measures of other marine powers in areas such as North America, European Union, East Asia and Oceania, there are still some deep-rooted problems for China’s marine economic development.

First, there is a lack of orderly arrangements at the strategic level for marine economic development. The existing coastal economic strategy is derived simply by adding up the various regional strategies. There is a lack of a clear marine economic development strategy, policies that can harmonize development and protection, and policies that integrate the terrestrial and marine economy.

Second, marine development activities in the coastal provinces are carried out simply as an expansion of extensive land-based economic development towards the sea. This has led to overcrowded coastal zones and environmental quality degradation in the

⁶ China Institute for Marine Affairs, *China's Maritime Development Report (2010)*, Ocean Press. Beijing, 2010, p226.

nearshore waters. In contrast, full development of the Exclusive Economic Zone (EEZ) and deep and high seas has yet to be undertaken.

Third, leading enterprises and industrial clusters of traditional marine industries tend to be "marginalized" and are losing out in the global economic competition.

Fourth, China's marine economic development needs to address international relations with surrounding countries in terms of disputes concerning islands and jurisdictional boundaries. These disputes impose unprecedented challenges on further marine development. The competitive development of involved countries brings an ever-increasing uncertainty for marine environmental protection, and risk of environmental disasters.

Historical experiences and realistic outlook of national economic development has demonstrated that marine economy development is a strategic choice for medium and long-term development of China. High economic growth over the past 30 years has laid a solid foundation for future marine economic development. "Top-down" and "bottom-up"⁷ marine economic development strategies have set the stage for marine development as the predominant direction of economic development in coastal areas.

1.2 Marine environmental problems are emerging and getting worse

1.2.1 Significant negative environmental effects of marine industry development

Generally, compared with countries with a developed marine economy, China's marine economy is still in the early stage, and the marine industry structure is still dominated by secondary industry. The added values of the primary, secondary and tertiary marine industries in 2011 accounted for 5.1%, 47.9% and 47.0% respectively among the total marine output value.⁸ The three leading industries, i.e., marine fishery, marine shipping and transportation industry, and coastal tourism, all belong to the labour and capital-intensive traditional industries. The shipbuilding industry, marine engineering industry, marine oil and gas industry and marine petro-chemical industry, as well as second-tier industries, also mostly belong to the capital-intensive industries, where technological innovation abilities are lower than the international advanced level. Marine biological medicine, marine power and mariculture industries have developed rapidly in recent years, but their proportions are relatively low, and it will be difficult for them to become leading marine industries in the near future.

⁷ "Top-down" here refers to the national strategy of strengthening the country by guiding coastal provinces and cities to develop the coastal and marine economy. Meanwhile, "bottom-up" refers to coastal local economy entities spontaneously developing marine economy-related plans and to upgrade the plans within the context of a national marine development strategy.

⁸ SOA of China, *Statistical Bulletin of China's Marine Economy (2011)*.

Table 1. Environmental Effects of China's Marine Industry Development ⁹

Marine Industries	Relative Growth	Environmental Impact	Degree of Environmental Impact
Marine fishery	++	Loss of marine ecological system	++
Marine oil and gas	+++	Oil spill pollution	+++
Marine mining	++++	Seabed (coast) damage, seawater pollution	++
Marine salt industry	+	Coastal land occupation	++
Marine chemical industry	++++	Pollution discharge to ocean	+++
Marine biological medicine	++++	Pollution discharge to ocean	++
Marine power	+++	Coastal (wind power) land occupation	++
Seawater utilization	++++	Possible pollution discharge to ocean	+
Marine shipbuilding	++++	Coastal land occupation	++
Marine engineering construction	+++	Coastal land occupation	++
Marine transportation	++	Emission to ocean and air	+++
Marine tourism	++	Tourism garbage	++

Environmental problems brought about by different marine industries varies due to differences in industrial scale and technical levels. Especially for the large-scale traditional industries and the rapidly developing medium-scale industries¹⁰ their operation can become main sources for marine environmental disasters. For industries such as tourism, fishery and shipbuilding, which are relatively small scale activities, the disaster potential is lower. However, their production and service facilities are generally outdated, and their environmental awareness, responsibility and capacity for handling environmental problems are relatively low. Although marine transportation, offshore oil, and marine chemical industries are relatively large-scale and are in a strong position in the Chinese market, their awareness of marine environmental obligations and emergency prevention/handling capacities can still be improved.

1.2.2 Increasing environmental pressure from spatial layout of the marine economy

Spatially, almost all coastal provinces have become "national-level" marine economic or coastal economic zones. In addition a number of sub-provincial strategic new zones such as Hengqin, Pingtan, and Zhoushan have been appointed. This makes regional marine economy development initiatives increasingly rise to the level of a "national activity", and will surely result in greater tensions between coastal economic development and marine environmental protection.

China's major marine economic activities are located in and around the Bohai Sea Economic Zone, the Yangtze River Delta Economic Zone and the Pearl River Delta

⁹ According to data in *Statistical Bulletin of China's Marine Economy (2011)* issued by SOA of China, some descriptions in *Marine Environment Bulletin of China (2011)*, and other related references.

¹⁰ Large-scale traditional industries refer to marine transportation, marine fishery and marine tourism, which have not developed quickly. Medium-scale industries refer to offshore oil and gas, marine shipbuilding and marine engineering construction.

Economic Zone. Among these three zones, the Bohai Sea Economic Zone is the largest and its growth in recent years is still relatively strong (Table 2). Its marine economic activities are dominated by resource-intensive and labour-intensive traditional industries, which generate relatively large pressure on shoreline space and the marine ecological environment. In addition, some large coastal industrial parks and engineering construction projects are not included in the statistics, e.g., the "coastal new city" in Tianjin. These construction activities occupy and destroy valuable natural coastline and offshore space, and impose long-term threats to the water quality.

Taking into account the cumulative land source pollution over the years due to inland economic development, the Bohai Sea can hardly sustain greater environmental impacts from future coastal and marine economic development. The Bohai Sea therefore warrants "special attention" in terms of a more sustainable marine economy and improved environmental governance. Furthermore, the more vulnerable coastal areas often face greater pressure from land reclamation that will result in loss of coastal wetlands and mud flats, loss of biodiversity, and aggravated regional marine disaster risks.

Table 2. Major Marine Economic Activities Distribution and Environmental Impact

Marine Economic Zone		Around-Bohai Sea Economic Zone	Yangtze River Delta Economic Zone	Pearl River Delta Economic Zone
Proportion of gross marine production in national total (%)	2008 ¹¹	36.1	32.3	19.6
	2009 ¹²	37.6	29.6	20.7
	2010 ¹³	34.5	31.4	21.6
	2011 ⁸	36.1	30.1	21.5
Year-on-year growth (%)	2008	0.1	-1.4	0
	2009	1.5	-2.6	0.5
	2010	-0.1	-0.6	0.9
	2011	1.1	-1.9	0.6
Major marine industry		marine transportation, fishery, coastal tourism, oil and gas	coastal tourism, marine transportation, shipbuilding and fishery	coastal tourism, marine transportation, oil and gas and fishery
Marine environmental impact		Relatively heavy pollution from land-based source; high density of industry activities in shoreline and sea area; and large marine environmental pressure	Medium pollution from land-based sources; relatively high density of industry activities in shoreline and sea area; and relatively large marine environmental pressure	Relatively light land-source pollution; relatively high density of industry activities in shoreline and sea area; and relatively large marine environmental pressure

The existing marine economic development mode is characterised by the traditional land-based economic development and individual industrial sector development mode. This is not compatible with the requirement of modern-day marine economy development, which demands overall coordination, integration and open interaction among stakeholders. The current development mode neglects stakeholder's concerns

¹¹ SOA of China, *Statistical Bulletin of China's Marine Economy (2008)*.

¹² SOA of China, *Statistical Bulletin of China's Marine Economy (2009)*.

¹³ SOA of China, *Statistical Bulletin of China's Marine Economy (2010)*

about the protection of the marine ecological environment. The results are increasing destruction of coastal resources and problems with near-shore pollution.

1.3 Marine pollution in the Bohai Sea is serious and characterized by combined pollution sources

The Bohai Sea drainage basin includes seven major river systems: the Yellow, Haihe, Luanhe, Dalinghe, and Liaohe Rivers, plus the Shandong Peninsula water system and the Liaodong Peninsula water system. The semi-enclosed character of the Bohai Sea limits the exchange of water with the Pacific Ocean. The competition for marine resources, and the fragmented and haphazard development of various marine activities have resulted in environmental degradation over large parts of the area. At present, environmental pollution in the Bohai Sea is very serious with increasingly contaminated near-shore areas. The main pollutants are nutrients and petroleum.

The marine biological quality monitoring results from 37 sampling points in the Bohai Sea during 2010 show that the pesticide hexachloro-cyclohexane (Soprocide), DDT and PCB all comply with the Class I of marine organism quality standard. The percentage of compliance with the Class I standard for total mercury, petroleum hydrocarbon and cadmium are 92%, 73% and 68% respectively. The residual level of hexachloro-cyclohexane and PCB in shellfish in Liaodong Gulf has been decreasing continuously for the past three years¹⁴. The residual level of petroleum hydrocarbon and lead in shellfish from the Bohai Gulf (an alternative name for the Bohai Sea) has, however, been increasing over the last three years, while the residual level of cadmium has continuously dropped over the last three years. Even so, the status of the ecosystem in the Bohai Sea is still unhealthy. In terms of pollution types, it can be seen that environmental pollution in the Bohai Sea has gradually transformed from single industrial pollution featured by oil and heavy metals, towards combined pollution of industrial, domestic and agricultural non-point source pollution.¹⁵

1.4 Marine pollution in the Bohai Sea is dominated by land-based pollution, with an increasing proportion of ocean-based pollution

1.4.1 Total pollution discharge from land-based sources remains high and marine function of some areas is seriously damaged

In 2010 and 2011¹⁶, the compliance rate from pollution sources along the Bohai coast was only 46% of all the sources monitored. According to the monitoring results of total pollutants discharged into the sea from main rivers in 2010, more than 70% of the pollutants are discharged into sensitive marine functional zones, resulting in a water quality compliance rate of 79.8%, 68.5% and 58.8% for nature reserves, tourist areas and fishery areas respectively. The sediment contamination in key areas is severe, especially for mercury, lead, arsenic, copper, petroleum hydrocarbon and DDT. Meanwhile, shrinkage of wetland areas and reduction of fresh water into the sea from

¹⁴ North China Sea Branch of SOA, *Marine Environment Bulletin of North China Sea (2010)*.

¹⁵ CCICED, *Ecosystem Issues and Policy Opinions Addressing Sustainable Development of China's Ocean and Coast (2010)*, p31.

¹⁶ North China Sea Branch of SOA, *Marine Environment Bulletin of North China Sea (2011)*.

river basins has resulted in seawater intrusion in the Bohai region in Liaoning and Shandong Peninsula Coastal Region of up to 1300 km². This represents 90% of the total national seawater intrusion area¹⁴. Furthermore the contribution of large quantities of nutrients from terrestrial sources to the sea is one of main causes of frequent offshore red tide and green tide disasters in China¹⁷.

1.4.2 Sea-based pollution is increasing and the overall pollution is getting worse

Marine ecological environmental disasters are frequent. In 2010, 69 outbreaks of red tide was observed in all Chinese sea areas¹⁸, covering a total area up to 10,892 km², including 7 times in the Bohai Sea with a total area up to 3,560 km² (mainly from *Noctiluca scintillans* and *Cryptomonas* outbreaks). In 2011, outbreaks of red tide occurred 13 times in the Bohai Sea¹⁹, with an area of about 217 km².

Seasonable increase of atmospheric pollution deposition in certain sea areas. The monitoring result of atmospheric pollutant settlement in the Bohai Sea area in 2010 shows that atmospheric dry deposition of pollutants in the Bohai Sea in spring and autumn is higher than that in summer, and atmospheric wet deposition flux is higher in summer than in spring and autumn. Among 11 kinds of pollutants being monitored, ammonium salt and nitrate are relatively high. For heavy metals, zinc is relatively high in the Bohai Strait and eastern sea area of the Liaodong Gulf, zinc and cadmium are relatively high in the Bohai Gulf and the Laizhou Bay sea area¹⁴. In 2011, atmospheric pollutant wet deposition in the Bohai Sea is predominantly by nitrate. The maximum wet deposition of inorganic nitrogen appeared in the Tanggu monitoring station (11.0×10³kg/km²•a), and maximum heavy metal as copper appeared in the Tanggu monitoring station (4.9kg/ km²•a), and maximum lead appeared in Yingkou Xianrendao monitoring station (0.7kg/ km²•a).

The eutrophication situation is getting worse. In the most recent ten years, compared with the last century, the outbreaks of red tides has increased in frequency and total area affected by such blooms have gone up. The main source of such blooms of toxic microorganisms is pollution generated from human activities.

1.5 Intensifying conflicts between economic development and environmental pollution in the Bohai Sea

1.5.1 Frequent oil spill accidents degrade the marine environment

Ocean oil spills can cause serious damage to biological resources, and thus are regarded as the most important pollution threat in the sea. In 2010, there were 195 offshore oil gas platforms in operation in China¹⁸, in which the Bohai Sea is the largest marine oil area. Up to 2009, there were 21 offshore oil and gas fields in the Bohai Sea with total 1,419 production wells and 178 offshore oil production platforms¹. On average, one oil spill accident happened every four days in China's

¹⁷CCICED, *Ecosystem Issues and Policy Opinions Addressing Sustainable Development of China's Ocean and Coast* (2010), p21.

¹⁸SOA of China, *Marine Environment Bulletin of China* (2010).

¹⁹SOA of China, *Marine Environment Bulletin of China* (2011).

coastal areas. From 1998 to 2008, 733 ship oil spill accidents occurred in the sea areas under China jurisdiction²⁰. On 16 July 2010, an oil pipeline of PetroChina Dalian Newport Oil Reserve had an accident involving an explosion and subsequent oil leakage. In June 2011, what was perceived to be a major oil spill accident happened in the Penglai 19-3 oil field on Bohai Bay. In addition, small oil spill accidents also happened in Bozhong 28-2 south oil field, Chengdaoxi A platform, Suizhong 36-1 oil field and Jinzhou 9-3 oil field¹⁹. In recent years, oil spill and oil leakage accidents due to oil and gas development activities have taken place frequently, leading to a large number of crude oil spills into the sea and causing serious impacts on the surrounding marine environment.

1.5.2 Increasing discharge of pollutants from marine oil and gas drilling areas continuously affect water quality

The main source of pollutant discharge from offshore oil and gas regions comes from production wastewater, drilling fluid, drillings and domestic sewage. In 2010, discharge amounts of production wastewater, drilling fluid, drillings, and domestic sewage from offshore oil and gas fields in the Bohai were $623.19 \times 10^4 \text{ m}^3$, $1.04 \times 10^4 \text{ m}^3$, $3.04 \times 10^4 \text{ m}^3$ and $12.05 \times 10^4 \text{ m}^3$, respectively. In 2010, seawater environment monitoring in the Bohai Sea (from 17 offshore oil and gas fields) showed that petroleum hydrocarbon concentrations in Jinzhou 21-1 oilfield area in the spring exceeded the Class I of sea water quality standard¹⁴. Although the petroleum concentration in other oil and gas fields has complied with the standard, which indicating obvious improvement compared with 2009, the overall water environment quality is not adequate. In 2011, monitoring results in 22 marine oil and gas regions (clusters) and in Bohai Sea show that the "Penglai 19-3 oilfield oil spill accident" had a serious influence on environmental conditions. The impacts of the "7.16 Dalian oil pollution accident" on the marine environment so far have not been fully eliminated; obvious petroleum pollution still exists in the marine environment, and its effects on Boshiwan beach and intertidal zone organisms still exists¹⁶.

1.5.3 Increasing instances of dumping of solid waste seriously affects the marine environment

Monitoring results in 2010 of the water and sediment quality, and in benthic communities, in five relatively large marine dumping areas in the Bohai Sea show that temporary dumping is not in compliance with the Class I seawater quality standards; and the dumping activities impacted water depth and submarine topography. For instance, water depth south of C1 temporary dumping area of Huanghua port has decreased to less than 60% of the original water depth¹⁴. In addition, wastes such as plastic bags and fishing nets are found in large volumes. In 2010, monitoring results of Gaolin Wanjia sea area near Huludao City show that the average density of submarine garbage (rubber pieces, plastic bottles, paint buckets, etc.,) is about 313.8 kg/km^2 . The approved garbage dumping into the Bohai Sea in 2011 is 22.68 million m^3 , a 31.3% increase over 2010.¹⁶

²⁰ <http://news.sohu.com/20110707/n312681416.shtml>.

1.5.4 Increasing pollution from aquacultures in the Bohai Sea increase the problems with eutrophication

Since 1990, China's aquaculture production has remained the largest in the world, and China is the only country in the world with aquaculture production higher than fishing production. At present there is a total of 226 seawater aquaculture areas in the Bohai Sea, taking up 16.8% of the offshore area. Intertidal mudflat aquaculture has the largest share, 4,240 km², accounting for 71.7% of the total area of aquaculture. Raft culture has the second largest culture area, 559 km², accounting for 9.5% of the total area¹⁴. The rapid development of aquaculture brings serious pollution to the sea. Research shows that 20% of the food input for cage culture is not eaten, thus becoming waste. Although the pollution discharge arising from marine culture operations only accounts for about 5 % of gross pollutant discharge into the sea, a large portion of the pollutants are nutrient substances, such as residual food and excrement that cause eutrophication of the surrounding water. This makes offshore aquaculture an important contributor to the occurrence of red tides.

1.5.5 Pollution from intensive ship and port operations seriously affects offshore aquaculture environment

In 2008, China had more than 240,000 ships with a total DWT of more than 70 million tonnes, ranking second largest in the world. China has 1,430 ports and 34,000 berths²¹. There are 79 ports around the Bohai Sea shoreline, at an average port interval of 65 km, of which there are 9 major ports with individual capacity of more than 200 million tonnes.²² Ports and ships are an important source of marine pollution. Ships docking at ports and various operations at ports will directly pollute the surrounding water environment. In addition, oil spills caused by ship collision/sinking, and wastes from ship dismantlement (residual oil, waste oil, oil sludge, oil-contaminated sewage, heavy metals, etc.) pose a serious threat to marine and coastal environments. According to available statistics, 35% of marine environment pollution comes from ship oil spills²³. These pollution sources are a serious threat for development of near-shore and offshore aquaculture.

2. EXPERIENCES, LESSONS AND IMPLICATIONS FROM TYPICAL CASES OF MARINE OIL SPILL RESPONSES

2.1 Ineffective marine oil spill management and insufficient emergency response capacity in China

On June 4 and June 17, 2011, two oil spills occurred in the *Penglai 19-3 oilfield in the Bohai Bay*. It has been said that they caused seawater pollution around the oilfield and northwest sea, covering an area of several thousand square kilometres (non-compliance with Class I seawater quality standard) and a large area of sediment

²¹ Dinesh C. Sharma, *Pollution in Harbors are Attracting More Attention*, Environmental Health Perspectives in USA (Chinese Version), March, 2007, Vol. 115, No. 1c, p5-6.

²² http://www.idoican.com.cn/ido/paper/briefArticle.do?article=nw.D210200xsb_20110311_4-03.

²³ http://www.simic.net.cn/news_show.php?id=113965

pollution. Exact figures are not quoted since there are various views about the extent.. However it has been suggested that some 870 km² of the sea area was severely polluted (the content of petroleum-based pollutants apparently exceeding Class IV seawater quality standard), which caused significant impact on marine ecology and fishery production. The accident investigation report from the State Oceanic Administration pointed out that the operator, ConocoPhillips China Inc. (COPC), violated the overall plan of oilfield development during its operation. There were defects and negligence in the safety of the operations, and preventive measures were not in place. This finally resulted in the Penglai 19-3 oil spills. In accordance with the Chinese-foreign cooperation contracts signed, COPC was the operator of this oilfield and therefore must take full responsibility for this oil spill accident^{24, 25}

2.1.1 Inadequate and late information disclosure

It took as long as one month for the information about the oil spill to be disclosed by relevant parties under media and public pressure. Furthermore, the State Oceanic Administration (SOA) only announced causes of the accident and did not publish any results for other investigations in time. On July 27, 2011, the North China Sea Branch of SOA started to publish updated information on the oil spill on its website.²⁶ So far, the basis of damage evaluation for marine ecology compensation and fishery losses and the content of the agreements reached between the relevant parties have still not been published. Due to the absence of systematic measures related to the handling of oil spill accidents in China, there is a lack of corporate social and environmental responsibilities at the part of the enterprises. This puts the public in an unfavourable situation with respect to information disclosure. In the Penglai 19-3 case, the relevant parties didn't disclose information related to the accident timely, actively and adequately according to relevant regulations in "*Regulation on the Disclosure of Government Information*". This has caused widespread public criticism and undermined the credibility of the government. It also hindered the mobilization of all parties to timely respond to the accidents. In particular, it failed to enable fishery operators to timely control and minimize losses and collect evidences to be able to put forward damage claims.

2.1.2 Ineffective regulation and missing responsibilities

According to the SOA Joint Investigation Group there was a lack of self-regulation and environmental responsibility on the part of the COPC. Its petroleum production operation and reinjection of debris violated the overall development plan, and caused the spill as a result of a well kick (blowout). Furthermore, when signs of the accident appeared, operations were not stopped in a timely manner in order to investigate the cause of the pollution. This aggravated the extent of the pollution. In addition, the depth of the surface casing of this well was too shallow. This violated the

²⁴SOA, *the Joint Investigation Group of PL 19-3 Oil Spill Accident Announced the Findings and Cause*, November 11, 2011.<http://www.soa.gov.cn/soa/news/importantnews/webinfo/2011/11/1320551791757083.htm>.

²⁵SOA, *Report on the Accident Investigation Process by the Joint Investigation Group of PL 19-3 Oil Spill*, June 21, 2012.<http://www.soa.gov.cn/soa/news/importantnews/webinfo/2012/06/1339980559103721.htm>.

²⁶<http://www.ncsb.gov.cn/oilspill/index.asp?pageno=8&pagesize=1>.

requirements in the environmental impact assessment and undermined the emergency handling capacity, so additional leakage occurred²⁴.

There have been various comments about why information was not released in a timely fashion, and much finger pointing among the key players. In the Joint Investigation it was suggested that the COPC did not recognize the seriousness of the accident, and hid the truth through reporting false information and covering up mistakes. This caused continued oil spill and widespread pollution and aggravated damage. On June 4, 2012, another oil spill accident occurred in the Penglai 19-3 oilfield during the process of transferring crude oil and a small amount of oil was spilled²⁷. This indicated severe problems in the internal management of COPC.

China National Offshore Oil Corporation (CNOOC), as one of the central-level SOE and a main investor and partner of COPC in China, failed in performing the responsibility of direct supervision on its partner's operation as required in accordance with "*Regulations on the Exploitation of Offshore Petroleum Resources in Cooperation with Foreign Enterprises*". As the department in charge of the administration of environmental protection in the exploration and development of offshore petroleum stipulated in "*Regulations on the Administration of Environmental Protection in the Exploitation and Development of Offshore Petroleum*", the SOA and its North China Sea Branch were unable to locate the oil spill in time in order to start the clean-up in the early phase of the accident. The Ministry of Environmental Protection (MEP) did not play an overall supervision and coordination role as specified in the "*Environmental Protection Law*", and only participated in the joint investigation group. It has been suggested that the Ministry of Transportation (MOT) had responsibility for coordination.

Furthermore, the investigation group was led by SOA, a sub-ministerial body, which according to the regulations should coordinate other ministries. This misalignment of levels would certainly affect the effectiveness of the coordination. Up to now, SOA has not fully explained the issues of causality and coordination that increased the difficulty of handling the Bohai Bay oil spill accident. This also implies that the subject of liability related to the affected fishermen became more complicated. The scope and depth of the joint investigation led by SOA (with participation of seven administrative bodies and ministries) were insufficient. It lacked participation from the judicial department, People's Congress, and the securities and state-owned assets management authorities. In addition, the relevant coastal provinces and departments did not actively engage in the accident handling (e.g., investigation, response and rights claim).

The main reasons for these failures are:

- ***the interests of regulator and the enterprises are not separated but mingled;***
- ***excessive bureaucracy prevented effective action;***
- ***technology was out-dated;***
- ***the number of agencies involved prevented effective regulation of the operation;***
- ***weak regulations not clearly expressing the responsibility of the operator.***

²⁷ <http://www.ncsb.gov.cn/oilspill/file.asp?idnum=149>.

Currently, the administrative supervision and management system neither clarify the liability of the responsible party nor foster an appropriate quality assurance system through imposing strong obligations.

2.1.3 Insufficient emergency response and slow reaction

a). Emergency response capacity was insufficient. The SOA does not have the ability of emergency response for marine environmental accidents; the remediation was mainly conducted by CNOOC and by renting vessels from industrial enterprises, while the Ministry of Transport, which has the oil clean-up capacity, was not directly involved. Since the authority in charge has no ability to mobilize emergency response, while the department with this ability did not participate, the time of oil removal and recovery lasted from June to September. Meanwhile, the accident also revealed the weakness of some marine oil exploitation and drilling technologies in China.

b). Relevant parties did not act according to the corresponding emergency plans. According to regulations in the “*Execution Procedures of Oil Spill Emergency Response to Marine Oil Exploitation and Development*”, both the volume and area of spilled oil in this accident were classified as belonging to the Level I response standard, i.e., a significant environmental pollution incident. However, SOA did not start the Level I response procedures stipulated in *Emergency Plan of Oil Spill Accident of Marine Petroleum Exploitation and Development*, and the North China Sea Branch started only a Level III emergency response procedures. Moreover, losses in this accident exceeded RMB10 million yuan, which is classified as an extraordinarily significant environment incident. However, MEP did not start Level I responses according to the *National Emergency Response Plan for Abrupt Environmental Accidents* issued by the State Council. The State Administration of Work Safety (SAWS) did not start the *Emergency Plan of Accidents and Disasters of Marine Petroleum and Natural Gas Operation*.

c). Warning levels of emergency plans in different government levels and departments were inconsistent. Although there are corresponding emergency plans at all levels from national government to local governments and even to ports in China, they are not unified and coordinated. For instance, the warning level of oil spill from ships is inconsistent with that for oil spills originating from an oil platform; therefore, the final response efficiency is low.

d). There is a lack of a national emergency plan. The *Emergency Plan of Oil Spill Accident of Marine Petroleum Exploitation and Development* of the SOA is only a sectoral plan from a single department under the State Council. With the increasing expansion of marine oil exploitation and increasing impact on coastal fishery, tourism and economy by marine oil spill accidents, it is necessary to upgrade this emergency plan to a national level plan, or to formulate a national emergency plan for significant marine environmental accidents (including oil spill), so as to unify warning standards and classes, establish various levels of emergency response organizations, establish a smooth inter-departmental coordination mechanism, construct an emergency response infrastructure, and allocate emergency resources in a unified way.

2.1.4 Light punishment and low compensation

a). Penalties for violating laws and regulations to protect the environment too low. The SOA could impose only a RMB 200,000 yuan penalty on COPC in accordance with relevant provisions of the *Marine Environmental Protection Law*²⁵. In addition, there is no judicial intervention, and thus no criminal prosecution for significant environmental pollution crimes as stipulated in the *Criminal Law*. Considering the economic turn-over in the offshore oil industry a penalty of 200,000 yuan does not play a significant role either as punishment or deterrent in general.

b). Claims and compensation for environmental damages must be coordinated and payment made without delay. SOA claimed 1.683 billion yuan for marine ecology compensation and the Ministry of Agriculture (MOA) claimed 1.35 billion yuan of damages for fishery resources compensation. COPC paid 2.303 billion yuan of the total claim by SOA and MOA, while the remaining amount was paid by CNOCC. Furthermore, CNOCC has promised to pay substantial money for ecological compensation including research funding. However, civil claims have not yet been started. The civil claims from Shandong, Hebei and Liaoning have far exceeded claims by the central government.²¹

The current Maritime Environmental Protection Law is basically a single law for preventing marine pollution, with the main purpose of serving economic development. It lacks content needed for adequately protecting and improving marine ecological environment through compliance measures such as high fines and other claims²⁸.

2.1.5 Ineffective law enforcement and incomplete laws and regulations

It seems from the Bohai Sea oil spill that there is, in the normal management of marine resources, a lack of specifications of how to compile, review, approve, implement and supervise the operations in marine oilfields. The Environmental Impact Assessment (EIA) and environmental review system is not fully implemented during the process of developing an oil and gas field, and the environmental safety supervision and regulation on operating entities is deficient. From the discovery of the 19-3 oil field in 1999 to the accident in 2011, i.e. over more than 10 years, the company and relevant authorities have not tracked and evaluated the implementation of the overall oil field development plan. Proactive reporting from enterprises and disclosure of government information fell behind. The legislation on environmental information disclosure in China is incomplete and weak in actual operability. The supporting system of supervision, liability mechanism and remedy system for protecting the public's right to know is also incomplete.

The existing legal basis related to assessment of marine oil pollution damage and claims for marine ecological environment in China is insufficient and there is no unified system for litigation procedures. There is also a lack of operability, resulting in confusion and difficulties in enforcement²⁹. Although the Marine Environmental

²⁸ Wang Shuguang, *Marine Management in China*, Ocean Press, Beijing, 2004, p56-57.

²⁹ China Institute for Marine Affairs, *China's Maritime Development Report (2012)*, Ocean Press, Beijing, 2012, p233.

Protection Law has identified the compensation system for ecological damages in principle, responsibilities for compensations for damages from marine oil spills have not been clearly defined, and the contents, procedures and standards of compensation as well as the rights and obligations between parties receiving compensation and parties paying compensation, are not specified. Besides, lower-level regulations on marine ecology damage compensation³⁰ have not been detailed, so the compensation for marine ecology damage is difficult to implement.

In 2007, SOA issued the ocean sector industrial standard *Technical Guidelines for Ecological Damages Assessment on Marine Oil Spills*, but it is not a regulation designed as an administrative penalty. Therefore, the standard could only be a reference for court decisions instead of the basis for litigation. In 2008, MOA took the lead in formulating the national standard of *Calculating Methods on the Economic Loss of Fishery Pollution Accidents*. In June of 2010, Shandong Province was the first to issue regulations related to marine ecology damages and compensation in China. Although the above regulations and acts identified the subjects to be compensated, the compensation standard was not explicitly defined (e.g., specific standards and fixed number of years of compensation, etc.) so the operability still remains to be seen.

2.2 Effective marine oil spill management system and rapid emergency response in the United States

On April 20, 2010, *Deepwater Horizon*, a drilling platform in the Gulf of Mexico, under the control of the BP Company suffered from an explosion and sank due to a burst of methane gas from the well. The accident killed 11 workers and injured 17 others, and more than 200,000 million gallons (about 750,000 m³) of oil spewed out of the well, contaminating a sea area of 1500 km². The oil leakage continued for 85 days. The full evaluation of the damages to the Gulf environment caused by this oil spill may take decades to carry out. It is clear, however, that the oil spill severely impacted the economic development of residents around the Gulf.

The main reasons for this accident involve three aspects: **(a) Weak self-supervision by the industry and lack of sufficiently robust technological safety mechanisms and procedures.** There were inadequate communications between the management systems of the various parties involved in drilling operation of the oil well, and inadequate risk awareness in decision-making. The drilling technology adopted was not the most advanced, with serious technical faults. At the critical moment operational safety procedures were not followed and serious mistakes were made. **(b) Weak government regulations failed to control the risk of explosion.** Minerals Management Service of the U.S. Department of the Interior was the supervisory organization for offshore crude oil development, and was accused of negligence in their management. The staff in the Minerals Management Service had no experiences of supervising deepwater drilling and did not receive relevant training, and in addition

³⁰ Lower-level law and upper-level law are the two basic categories used to differentiate the legal levels established in *Legislation Law of China*. The former is the derived law according to the principle and procedures, i.e., regulated by the latter. And the former needs to be subordinate to the latter, as clause 87 stipulates in *Legislation Law of China*. For *Marine Environmental Protection Law*, the laws related to marine ecology damage compensation belong to the lower-level ones.

failed to follow the rules and regulations. The Service's risk assessment failed to keep up with deepwater drilling development. Besides, when the Obama administration announced that the "ban" on offshore oil exploitation in the Gulf of Mexico was lifted, no strict measures for supporting supervision were taken. No proper environmental assessment was performed when the offshore oil and natural gas drilling permit was issued. (3) ***An imbalanced national energy policy has encouraged overdependence on oil and gas.*** The US government over the past 30 years or more failed to make decisions on offshore oil exploitation and other domestic actions for energy security, leading to the situation where the current generation of Americans has become heavily dependent on external oil resources to an extent that threatens a way of life³³. There were thus great pressure to produce this well at a high flow as quickly as possible.

2.2.1 Quick and effective emergency responses

a). Emergency response is quick. When an oil spill accident occurs, the US government initiates national, regional and local emergency command systems to unify and coordinate all departments in the effort to stop leaks, undertake treatment and recovery from an offshore oil spill. On the day of the explosion at the *Deepwater Horizon*, the US government started the national marine oil spill emergency response system and established a local emergency command centre with the US Coast Guard (USCG) as the core body. The next day, the regional emergency group started to coordinate the federal Coast Guard, Department of Homeland Security, Department of Commerce and Department of the Interior, and to offer technical suggestions and assemble goods and materials from subordinate bodies and emergency response reserve station for taking preventive/remedial measures and performing search and rescue. On the third day, the national oil spill emergency response group was tasked with the responsibility of coordinating emergency preparations and handling pollution of oil and harmful substances, and a decision was made that the BP Company should be in charge of stopping leakage and oil clean up operations. Meanwhile, US Environmental Protection Administration (USEPA) experts provided guidance on oil clean up. The National Oceanic and Atmospheric Administration (NOAA) provided forecasts on the oil drift trajectory to help the clean up group adjust remedial measures according to weather changes.

b). Multiple technologies were used to remove and prevent oil leakage. At first, the BP Company assigned underwater robots to repair the safety valves and assigned ships to remove leaked oil, and drilled two new wells to relieve the pressure and reduce the rate of oil leakage. Although remedial technologies adopted are mainly conventional techniques during the remedial process, the final remediation effects were obviously due to the support of national marine oil spill emergency response system, adequate reserve of goods and materials, rational deployment and proper treatment.

c). Active participation of volunteers was encouraged. About 2,000 volunteers helped with oil clean up. BP Company set up a website for receiving suggestions from

³³ National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, *Deepwater Report to President, January, 2011*, pp. 87-307.

the public over the world. Tens of thousands of suggestions were received; some of them were classified as adoptable suggestions. The government recruited volunteers to clean up oil contaminations on birds and wild marine animals.

d). System reforms and remedial measures were actively promoted. President Obama established an independent committee to investigate this accident. Granting of new deep-water exploration permit was suspended for half a year, and those permits already issued were subject to re-evaluation to prevent similar accidents. The Department of Interior announced the separation of the National Mineral Management Service into three independent agencies, the Bureau of Ocean Energy Management, Bureau of Safety and Environmental Enforcement and the Office of Natural Resources Revenue. It is also planned to revise the \$75 million upper limit of an oil company's damage compensation stipulated in the *Oil Pollution Act of 1990*, either to increase the upper limit, or not to have an upper limit. Moreover, the government actively intervened in the claim for compensation, and especially, the Department of Justice initiated civil and criminal investigations to force the BP Company to set up a \$20 billion compensation fund³³.

2.2.2 Complete emergency management system for marine oil spill

Problems in the oil spill emergency response³³.

The emergency preparedness was insufficient to actively respond to a large-scale deep-water oil spill. When the oil well exploded, the federal government was unable to monitor the containment of deep-water oil well, underestimated the amount of oil leakage which in turn resulted in poor implementation of measures, plans and analyses of oil well containment. In the absence of effective techniques to stop the blow-out, the BP Company used unproven measures to try to control the spill. A key technical problem was the blowout preventers which did not function properly.

In addition the massive use of oil dispersants might cause secondary pollution although it probably prevented shoreline contamination. About 7,000 tons of dispersants were used to treat the spilled oil. Some of those dispersants contained petroleum products with significant toxicity (Crystal Clear Oil Dispersant and kerosene). However, despite these problems, the emergency management system for marine oil spills in the US is effective.

The *Oil Pollution Act of 1990* provides a fundamental base for the establishment of an emergency response system for offshore oil spills. An emergency command and response systems for all levels (including national, regional and local levels) has been established. The US Coast Guard (USCG) has the role to make the final decisions on behalf of the government, to coordinate and with a responsibility to combine the administrative areas and districts. The USCG can initiate national emergency response plans and authorize coordination whenever necessary to facilitate communication among relevant national and regional authorities and the stakeholders involved. It plays a decisive and important role in carrying the national emergency response strategies forward.

A system of oil spill clean up funds has been established. The federal government has established a \$1 billion oil spill clean up fund, and could demand accountability of the oil spill polluters. Meanwhile, a \$100 million oil spill clean up fund was established through legislations of various states. The main sources of the federal oil spill fund come from: 25 cents per barrel levied on domestic and imported crude oil; bank interest on the oil spill fund; damages paid by polluters for oil spills; penalties paid by polluters for oil spills; and money from other funds in an emergency situation. The oil spill fund is managed by the National Oil Pollution Trust Fund Centre.

The drilling and production operators are members of oil spill clean up associations. Such associations have been set up for mutual benefit to any operator in case of an accident. They maintain the stocks of equipment and has trained personnel on stand-by and will start operating immediately in connection with an accident. The specialized spilled oil clean up associations are non-profit organizations, and their main expenses and equipment cost are covered through membership fees paid by members including oil refineries and oil companies.³⁴

2.3 Effective marine oil spill management system and emergency response in Norway

On December 12, 2007, an oil spill accident happened when one platform on the Statfjord oil field in the North Sea in Norway pumped oil to the tanker Navion Britannia via pipelines. About 3,220 tonnes (24,150 barrels) of crude oil was spilled into the North Sea. This oil spill accident is the country's second largest ever³⁵. However, the emergency response was active and effective to a large extent due to the sound overall marine oil spill management system.

2.3.1 Effective marine oil and gas exploitation management system

Integrated marine oil and natural gas exploitation management system is implemented. In Norway, there are a number of Ministries involved in management of marine oil exploitation activities. The Ministry of Petroleum and Energy has the overall responsibility for exploration and exploitation activities; the Ministry of Finance is in charge of finance, including taxes; the Petroleum Safety Authority of the Ministry of Labour is responsible for operation safety; the Climate and Pollution Agency of the Ministry of the Environment is in charge of pollution discharge permit (including pollution prevention and response requirements); the Ministry of Health and Care Service is responsible for workers' health; and the Coastal Administration of the Ministry of Fisheries and Coastal Affairs is in charge of the Governments' response system to oil spill accidents, including oil remediation. Although different agencies have specific division of responsibilities, the effective integrated management is carried out during the management of oil and gas development activities. In case of oil spill accident, the Petroleum Safety Authority will be notified by the Operator and report it further to the other Ministries.³⁶

³⁴ Peter K. Velez, *Summary of the United States Offshore Oil Pollution Prevention and Response Regulatory Scheme*, August, 2012.

³⁵ <http://www.coes.org.cn/shownews.asp?id=101>.

³⁶ Per W. Schive, *Oil spill preparedness and response – Norwegian legislation and administrative*

Pollutant discharging permit system for oil production is carried out. The oil company that has obtained the rights to conduct exploration and exploitation in a certain area of the continental shelf is required to apply for a pollutant discharge permit before starting its drilling operation. The pollutant discharge permit is issued by the Climate and Pollution Agency. It covers every activity of the company that may have an impact on the environment, including oil spill emergency plans and response requirements as well as all requirements to address environmental risks. The company has a constant obligation to review and revise its emergency response plan to accommodate actual conditions. The relevant departments (such as environment protection authorities) will conduct regular inspections of the operation of the company to ensure that its daily operations comply with relevant rules and regulations and special requirements in permits. This system emphasizes trust, communication and transparency between governmental departments and petroleum industries, and has been implemented for more than 30 years.³⁶

It is specified that the production company is responsible for accident prevention and emergency response. Pollution Control Act of 1981 is the legal basis of preventing and responding to oil spill accidents. It explicitly stipulates that those responsible for oil and gas exploitation activities bear the obligations for oil spill prevention and emergency response. It also requires that the developers whose activities might possibly cause contamination shall have necessary oil spill prevention and response plans to prevent, detect, stop, eliminate and limit impacts caused by pollution. The oil spill prevention and response plans shall be drawn up according to probability of pollution and extent of damage. A risk-oriented approach is adopted, which requires that all operators must have a prevention and response plan that always matches with the dynamic business risks.³⁶

2.3.2 The national marine oil spill management system must be improved

Emergency plans fully ensure the sharing of emergency response resources.

The petroleum industry, the municipalities and the Government all have prepared emergency plans based on environmental risks and oil spill emergency evaluation. The main principle is that the operators must have a well prepared and implementable oil spill emergency plan and all the necessary response resources to handle any oil spill situation caused by the offshore operations. Generally, they should have their own resources (trained personnel, oil booms, skimmers, vessels and other equipment) which could be used according to the emergency plans to handle the spill. They shall also be responsible for having guaranteed availability of any additional reserves of equipment resources and that these can be mobilized without delay in a worst-case situation. This may include resources owned by others or owned mutually, and available through agreements in the case of a major accident. If necessary, as the supervisory organization of oil spill incidents, the Coastal Administration could take over action management by laws and mobilize all available resources obtained from private and public departments as national prevention and response reserves. In

arrangements regarding preparedness and response for accidental oil spill from offshore oil and gas activities, July 2012.

addition, an advisory group consisting of representatives from government and public consulting entities may be established.³⁶

National oil spill prevention and emergency plan system functions well. The point of departure according to the Norwegian Pollution Control is that in the case of oil spill accidents caused by offshore oil and gas exploitation activities, the remediation of these accidents would be entirely under the responsibility of relevant enterprises. By law, these enterprises/operators must always have effective emergency plans in place. The municipal government shall have necessary oil spill prevention and response plans to cope with minor accidents that cause pollution. In addition, the Coastal Administration has the responsibility to provide for the necessary oil spill prevention and response plan at the national level to handle major pollution accidents (e.g., oil spills from ships) that are beyond the prevention and response range of municipal government or private companies. For fulfilling this responsibility the Coastal Administration needs to ensure that private sector, municipal and national oil spill prevention and response plans are compatible and coordinated.

Professional organizations for oil spill prevention and response has been founded. Relevant administrative authorities could require enterprises to found an independent professional oil spill prevention and response organization based on agreements. If there is no agreement, the pollution control authority could make a decision on the cooperative organization for oil spill prevention and responses, and allocate the cost sharing among participants. As a result, the petroleum industrial enterprises have established the Norway Marine Cleaning Allied Company, responsible for managing the oil spill emergency plans. In addition, if the company's resources were insufficient, the oil companies can mobilize resources from this organization.

Furthermore, ***public participation*** is an integral part of effective implementation and enforcement of environmental laws and regulations. The public has the rights to know the results of work, inspections and audit reports of relevant departments.

2.4 Pay great attention to offshore oil spill management systems and accelerate the construction of an efficient and effective emergency response model

2.4.1 Oil spill emergency response management system is clearly specified in relevant laws in foreign countries^{37,38, 39}

The legal contents are relatively complete. The laws cover the following issues: organizations and their responsibilities; funding sources; required prevention equipment and recovery system for oil spill; procedures and standards for oil spill disposal; penalty system; and regulations on use of dispersants. For example, the US *Oil Pollution Act of 1990* and Norway's *Pollution Control Law* mainly focus on the protection of natural resources. In contrast, in China's *Marine Environmental*

³⁷ Wang Zhugang, Dong Hua. *The Emergency Response, Disposal Measures and Revelations of Mexico Gulf Oil Spill in US*. The International Petroleum Economics. June, 2010, p1- 4.

³⁸ Yang Yufeng, Miao Ren, An Qi, etc., *The Causes Analysis of Mexico Gulf Oil Spill and It's Enlightenment and Suggestion*. Energy In China. August, 2010, Vol. 32 No. 8, p13-17.

³⁹ Wang Guanghui, Chen An. *Study on Mechanism for Handling Offshore Oil Spill Events*. Journal of Natural Disasters, December, 2011, Vol. 20 Suppl., p35-42.

Protection Law, relevant provisions are not clear or absent. The main purpose of the law is to promote offshore economic development.

Legislation is general and covers all types of incidents. In the aspect of legislative technique, advantages of Norwegian laws are features of statute law in the continental legal system of Germany. Norway's *Pollution Control Law* can be applicable to all kinds of pollution. Compared with the situation in China, where there are many complex and interrelated administration structures that result in confusion in practice, the Norwegian law only use one "pollution control authority". Therefore, any change of institutional arrangements will not impact the integrity and authority of the law. Norwegian regulations on oil management put environmental protection, health and safety into one framework, and achieve these three social goals by supervising industrial activities. To a great extent, prevention of oil spill in oil development is achieved by ensuring production safety, equipment safety and worker operations.

Rules and guidelines covers details to ensure its applicability. The legislative advantage of the US is the level of detail that is addressed. US laws and regulations, such as *Oil Pollution Act*, *Federal Water Pollution Control Act* and *National Oil and Dangerous Article Emergency Response Plan*, have detailed provisions and a rigorous logical structure. Their applicability is ensured through auxiliary provisions such as guidelines and rules.

China must improve its laws and regulations and their enforcement. At present, the industrial technical standards used as the basis of claims are weak, while associated clauses in *Marine Environment Protection Law* are too general. Therefore, China should take the oil spills in Bohai as a turning point to establish a more demanding and strict legal system. The US *Oil Pollution Act of 1990* can be used as a reference to establish a law for oil spill emergency response by the state and relevant departments. The upper penalty limit in *Marine Environmental Protection Law* should be increased or abolished, clauses relevant to determination of damage compensation should be added, and law-enforcing departments should be authorized to take the mandatory measures when needed. Clauses should be detailed to differentiate slight and severe damage behaviour, differentiate categories of pollutants, define and specify the land and sea area zoning department responsibilities so as to enhance the law enforcement operability. Because environment and resources have many values, environmental legal relationships have both public right and private right aspects; therefore, the environmental protection law should be advanced from administrative regulation law towards social law. A public participation mechanism needs to be set up, and corporate information disclosure obligations should be strengthened.

2.4.2 One responsible authority should be in charge of offshore oil spill emergency management with coordination and cooperation from other relevant departments in foreign countries^{37, 38}

In the USA, the USCG is in charge of supervising and responding to offshore oil spills. In Norway, the Climate and Pollution Agency of the Ministry of Environment is in charge of supervising environment pollution caused by offshore oil, and the Fishery and Coastal Administration is in charge of responses to accidents.

In China, the SOA is in charge of supervising and responding to offshore oil spill from oil production platforms, and the MOT is in charge of supervising and responding to oil spills of ships. In China, offshore oil spill emergency response responsibility is divided by sectors, with the same function duplicated in various agencies. Such a situation is counterproductive to marine environmental protection.

By contrast in the foreign countries surveyed, authorities have good coordination for offshore oil and gas development and accident emergency management, and prevention and supervision of pollution is conducted by the responsible sectoral authority. In Norway, the Petroleum Safety Authority plays an important role in prevention and supervision of oil pollution. In the USA, the prevention of oil pollution is mainly supervised by the Environment and Safety Executive Agency. This arrangement shows the emphasis on industrial sector supervision and makes full use of industrial technologies, and tries to ensure industry's awareness of self-regulation. In Norway, the normal management authority for marine oil development is the environment protection authority, which exercises a "professional management" function, such as issuance of pollutant discharging permits for offshore oil development and approval of the use of oil dispersant. Such an arrangement is good for the uniformity of environment protection and reflects the "cross-sector" characteristics of environment protection. Certainly, this professional management is built upon a foundation of scientific monitoring data such as total amount of pollutants and chemical and biological characters of pollutants.

China must improve its emergency response mechanism. By establishing an integrated land and marine planning and coordination mechanism between ministries, cooperation and joint management can be developed and consolidated, so that enforcement of policies and laws can be better assured. A national level joint-action mechanism should be established with participation of many ministries. Stakeholders should share information through joint meetings in order to avoid overlap, ensure simultaneous implementation of rapid spill clean-up; efficient investigation of accident causes, acceptance of public claim litigation, remedial plans, information disclosure etc. A special risk fund should be considered with main contributions from oil enterprises. For serious environmental accidents such as offshore oil spills, an inverted burden of proof can be considered, and civil litigation and punitive compensation mechanism can be introduced. Proactive information disclosure and accountability mechanism of responsible parties need to be established so that the enterprise and relevant functional departments actively will disclose any relevant information, and engage in the damage mitigation process. A third party supervision and monitoring mechanism should be established to clarify environment protection responsibility of enterprises. An ecological compensation negotiation mechanism should be established to internalize the ecosystem damage activities, i.e., assess the value of marine ecological damages and let the liable party compensate the full cost of ecological damages. This effort will adjust relationships between environmental and economic interests, and will encourage environmental protection.

2.4.3 Foreign emergency response emphasizes efficiency and effectiveness^{37, 38}

Emergency management should be both efficient and effective. An efficient response should be implemented without delay. It should be built on a comprehensive

emergency handling system under the leadership of an emergency response agency. Effectiveness refers to operations that minimize the impacts of accidents. The emergency response should be built on sufficient contingency resources in the form of containment and clean up techniques and well-trained support personnel. Relevant laws in foreign countries specify the emergency response mechanism, organizations, responsibilities and authority of emergency management. An effective and efficient authority that has centralized power, reliable capital guarantees, and unified leadership, should have the capability of organizing, coordinating and commanding. There are multi-level management mechanisms from national to local levels with command institutions and rescue powers at different levels. Factors such as type of accident, scale of accident, probability of occurrence and potential social and environmental impacts, should determine the hierarchical disaster management system. When an accident occurs, a response is triggered depending on the size and type of the accident and the potential threats to environmental and economic resources. The collaboration of non-government organizations and volunteers in response to a clean-up effort should be carefully managed in order to be meaningful and safe⁴⁰. Then the high efficiency of emergency response and the high benefits will be ensured.

China must develop an emergency response arrangement that will be able to respond immediately in the case of an accident. Currently, several governmental departments are involved in cases of oil spills offshore. An authority with overall responsibility for the situation must be appointed; emergency resources from the various departments should be integrated, and unified arrangements be made with clear distribution of responsibilities. The emergency disposal of minor offshore oil spills should be managed by the local and relevant departments according to different sectors. Drawing on US experiences, a national oil spill emergency response command system needs to be established in China, and cooperation among departments with overlapping functions should be strengthened to increase the response speed.

2.5 Improve China's offshore oil spill management system and improve the emergency disposal capability in a comprehensive way

2.5.1 Oil spill emergency management in several other countries is more efficient and effective

The national emergency plan usually takes the lead, and there are national and regional multi-level emergency command institutions whose responsibilities are identified according to the scale and range of the accident^{28, 29}. In general, foreign emergency response organizations can be divided into a management layer and an operational layer. The management layer is mainly responsible for commanding and coordinating the oil spill response, and the operational layer is mainly responsible for pollution clearing on site. Meanwhile, the national emergency response systems will have a standing body such as a 24 hour spill alarm institution and emergency response command centre with supreme decision-making power.

⁴⁰ Gao Zhenhui, Yang Jianqiang, Wang Peigang, etc., *Theory, Method and Case Study of Ecological Damage Assessment of Offshore Oil Spill*, Ocean Press. Beijing, 2007, p389.

At present, China has established ship oil spill emergency response centres at various levels with the Rescue Centre of Maritime Authority of MOT as the main body, with a set of emergency measures of its own. The other key departments, such as the China Meteorological Administration (CMA) and MOA, are not incorporated into the overall emergency system, while SOA, CNOOC, PetroChina and Sinopec also set up their own offshore oil spill emergency centres. In some countries, the oil spill clean-up is conducted by professional clean-up companies, or by special institutions of the government, or by both. Oil spill clean-up is implemented in the form of contracts in US and in the form of prior contracts in Norway, and the operator uses their own equipment or rented equipment or contracts professional oil clean-up companies. Both USA and Norway have national emergency plans, while China only has ministerial emergency plans.

China should prepare a national special emergency plan for serious offshore oil spill accidents, and form a well-coordinated emergency response system operative at national, regional and local levels. The different regional emergency plans should be prepared according to the needs and local conditions of the different sea regions. Based on the multi-level preparedness principle, an emergency response capacity compatible with local, regional, national or international level oil spill accidents should be formed at the various levels. Training and drill exercises must be carried out in an effective way so that personnel are well acquainted with the equipment and how to use it.

2.5.2 Foreign oil spill emergency management mechanisms are built on mutual agreements and cooperation

Both in Norway and the USA emergency response is based on the condition that the operator is responsible for both preparedness and response and that the company shall enter into prior agreements with pollution clean-up companies to guarantee that adequate pollution response is always available. Only when the accident is considered very serious, should the government get involved in the emergency response. The costs of pollution clean-up and environmental recovery can only be compensated by clearly identifying the responsibilities for compensation for such costs. The operator is responsible for emergency plan preparations, setting up of oil spill emergency teams and emergency response actions including training, equipment test, periodical drilling and emergency equipment inventory. This mode follows the “polluter pays” principle, and as a result, the person liable shall carry all emergency costs. This stimulates the enterprise to improve its prevention capacity, promote the development of an emergency response industry, and facilitate environment protection under a market framework. However in China, the government is mainly in charge of mobilization and organization, and the establishment of response-level principles and mechanisms. The enterprise is the person liable after an oil spill accident occurs, and the government supervises the oil spill emergency response.

The operator is required to immediately report the occurrence of oil spill accidents and the application of oil dispersant to the authority³⁴. If violating the obligation of reporting, the operator will have to carry the administrative, civil and criminal responsibilities. The relevant authority is required to make relevant information available to the public. There also exist regulations in China that require government

to disclose environmental information to the public. However, the scope of information disclosure is not specified. For instance, the public has no right to know the results of inspections and supervisions by the marine environment authority. This is different from practices in many other countries.

*The ecological damage compensation system and oil clean-up fund system are well developed in US, which guarantee the resources needed for ecosystem restoration*³⁴. In the US, the natural resource damage compensation system, (similar to the ecological damage compensation in China) was set up by the *Oil Pollution Act of 1990* and relevant laws, and an Oil Spill Responsibility Trust Fund was established according to *Internal Revenue Code of 1986*. In Norway, the *Pollution Control Law* stipulates the pollution damage compensation system, and *Oil Activity Law* stipulates the marine ecological damages due to offshore oil and gas exploitation in detail. In China, the national ecological damage compensation system (including management and utilization of ecological damage compensation fund) has yet to be set up. The only reference is the *Management Regulations of Collection and Use of the Ships Pollution Damage Compensation Fund* issued by the MOT in May 11, 2012⁴¹.

In the foreign countries studied, besides emergency response by professional clean-up companies, great attention is paid to civil and social participation in supervision and actual pollution cleanup, which fully ensures the public's right to know and right to participate. The public participation is good for promoting the nationwide environment protection awareness, as well as motivating the practice of environment protection. However, the safety of such volunteers must always be a priority.

*With respect to research and technological innovation related to oil spill preparedness and clean up, Norway mainly takes advantage of continuous investment from oil and gas enterprises and entrusts the research institutions and universities to carries out relevant research*⁴². As a result the offshore oil spill emergency management system is highly risk averse, and its emergency system is effective and efficient.

3. MARINE ENVIRONMENTAL MANAGEMENT ISSUES AND SOME ROOT-CAUSES IN CHINA

3.1 Marine environmental management in China is outdated and must be improved

*3.1.1 Many departments are involved in marine environment management, without strategic planning and overall coordination mechanism, and the overall efficiency is low.*⁴³

⁴¹ http://www.gov.cn/zwqk/2012-05/28/content_2147033.htm.

⁴² Guo Xiaozhe, *World Offshore Petroleum Development history*, Petroleum Industry Press., Beijing, 2012, p175-176

⁴³ Xu Xiangmin, Li Bingqiang, et all. *Study on System Issues of Bohai Management Law*, People's

The *Marine Environmental Protection Law* stipulates that governmental agencies with sectoral responsibilities related to the oceans should protect the marine environment as a priority in their daily operations. According to this provision, MEP is in charge of providing guidance, coordination and supervision on issues related to marine environmental protection. SOA is responsible for investigations, monitoring and assessments. MOT is in charge of pollution management and prevention as it relates to ships and ports. MOA is responsible for offshore fishery resources and environmental conditions in waters of importance to fisheries. Environmental protection agencies at the provincial, municipal and county-levels along the coast are responsible for providing guidance, coordination and supervision of local marine environmental protection. However, the present situation means that there are a number of barriers between higher and lower administrative levels and between different departments and regions. This has led to a situation where important aspects are not managed by any agency while there are overlaps in other areas.

The monitoring of seawater quality may be taken as an example: SOA, MOA and MSA all have their individual monitoring systems and data gathering arrangements. For some other concerns, no agency carries out any implementation of the regulations due to the lack of an inter-ministerial coordination agency and regional and a cross-sectoral joint-efforts mechanism. Multi-department management itself does not inevitably result in administrative inefficiencies. However, the lack of an overall strategy, oversight, and effective coordination between departments creates administrative inefficiencies. At present China's marine environmental management displays many such weaknesses.

Currently, there are two main forums for inter-ministerial joint coordination to achieve environmental protection in China. ***These are the Inter-ministerial Joint Meeting of National Environmental Protection led by MEP***⁴⁴ and ***the Inter-ministerial Joint Meeting of the Bohai Sea Environmental Protection led by NDRC***⁴⁵. The former is a temporary authority coordinated by the General Office of MEP and supported by other related departments within MEP. It focuses on water pollution prevention in coordination with the Ministry of Water Resources (MWR) and the coastal provinces, but not on marine environmental protection. The latter is to promote the coordination required for strengthening the environmental protection in the Bohai Sea and for implementing the *Overall Plan of the Bohai Sea Environmental Protection*. However, with the present management set-up, MEP has not been able to implement its statutory management function for integrated supervision of China's marine environment in the above two forums.

In March 2012, MEP and SOA signed a framework agreement on the *Communication and Cooperation Mechanisms in Establishing Marine Environmental Protection* and decided to strengthen cooperation in marine pollution control and marine ecological protection of marine areas in order to promote coastal and marine economic

Publishing House. Beijing, 2011, p1-26.

⁴⁴ http://www.110.com/fagui/law_146722.html.

⁴⁵ http://www.sdpc.gov.cn/gzdt/t20110727_425564.htm.

development in harmony with the marine environment.⁴⁶ However, at present, there are no effective marine ecological regulation and control policies to promote the coordination of the marine economy and at the same time ensure environmental protection. As a result a number of acute marine environmental issues remain unsolved due to the lack of practical administrative regulations and departmental rules, and without corresponding technical standards at a level sufficient for effective protection of the marine eco-environment.

China lacks an overall strategic plan for national marine development and marine environment.⁴⁷ Marine environmental protection must become a priority in China and no economic development in offshore areas or in coastal regions or important drainage areas should be allowed if it impacts the marine environment. The government must develop operational strategies based on scientific information, that both achieve marine development in coastal and offshore areas and at the same time protect the marine environment. The productivity and biodiversity of China's marine environment can only be preserved for coming generations if laws and regulations set up to protect the environment are followed. Since the start of the 12th FYP period (2011-2015), the State Council and related ministries have issued many measures, such as *The 12th FYP for National Economic and Social Development of the People's Republic of China*, *The 12th FYP Environmental Protection Program*, *The 12th FYP for National Marine Science and Technology Development*, and *The 12th FYP for National Marine Environment Monitoring and Estimation System*. However, none of these can be considered as the overall strategic plan of China's marine development and marine environment.

The marine-related environment laws are not fully consistent with the "Three Provisions" (State Council Regulation on Government Organization and Functions) about marine environment management and the functional division of responsibilities issued by the State Council. China has two laws related to marine environment, *Environmental Protection Law* and *Marine Environmental Protection Law*. The former is the fundamental law for China's environment management, while the latter is a specialized law for marine environment. The relation between the two laws is the same as that between other fundamental laws and special laws. The two laws establish a management system that is built on a unified supervision of the marine environment in combination with individual responsibilities in different departments.

Based on these two laws, the State Council stipulates "***Three Provisions***" for departments involved in marine environment management. However, the overall and unified supervision and management duties are not clearly defined for specific work and responsibility (Table 3). The result is a lack of overall coordination related to marine environment management. The barriers at different levels and between regions have not been resolved and marine environment problems increase. The normal practices in national marine environment management have been very sector-specific and unable to solve inter-departmental and cross-regional marine environment

⁴⁶ http://www.lrn.cn/media/seanews/201003/t20100315_471876.htm.

⁴⁷ Tang Baiping, *Study on the Legislative System of Marine Resources Protection*, Law Press. Beijing, 2008, p218-221.

problems. As a result the statutory unified supervision and management department of marine environment in MEP was able to do little to react to the serious marine environment accident. The total pollution control from offshore activities and land-based sources has not been effective.

There may be three options for solving the problem. The first option, ideally, is to assign marine environment management to MEP, as well as other management functions related to the aquatic environment, rural environment, and water and soil conservation. However, this option might have to include adjustments of national authorities and ministerial obligations. It can only be considered when political system is reformed fundamentally. The second option is to revise or adjust the current provisions related to marine environment management in *Environmental Protection Law* and *Marine Environmental Protection Law*. However, this will take time, because legislation and law amendments will have to go through a relatively long procedure as determined by the National People's Congress (NPC). **The third option is to revise or adjust the current “Three Provisions” of the State Council, which is considered the easiest one to be implemented.**

Table 3. Provisions in Statutory Laws in comparison with Responsibilities in “Three Provisions” of the State Council

Supervision and Management Function	Basis in Statutory Laws		Functional Division in “Three Provisions”	
	<i>Environmental Protection Law</i> and other laws	<i>Marine Environmental Protection Law</i>	MEP	SOA
1. Control of total amount of pollution discharged into key sea area		Clause 3		Yes
2. Marine functional division	Clause 12	Clause 7		Yes
3. Nationwide marine environmental protection plan	Clause 12	Clause 7		Yes
4. Regional marine environmental protection plan in key sea area	Clause 12	Clause 7	Yes (jointly with other organization concerned)	Yes
5. Inter-department coordination for serious marine environment incident		Item 2 in Clause 8	Yes	
6. Pollutant discharge standard into ocean and mechanism of total pollution control	Clause 10	Clause 9		Yes
7. Environment monitoring standard	Clause 11	Clause 14		Yes
8. Pollution discharge fee	Clause 12 in Management Regulation on Pollution Discharge and Management	Clause 11		Yes
9. Offshore joint law enforcement		Clause 19		Yes
10. Approval of report of environmental impact assessment on marine engineering project	Environmental Impact Assessment Law	Clause 47	Yes (Accreditation)	Yes (approved)
11. Supervision of environmental impact assessment on marine engineering	Environmental Impact Assessment Law	Clause 47	Yes	

3.1.2 The emergency management mechanism to deal with accidents is ineffective and inefficient.

Although the oil spill in from the Penglai 19-3 oil field was identified as a serious environment incident, Level 3 of emergency response was applied by SOA. MEP did not trigger a Level 1 response to this serious environment incident, either. The main reason is that ***China has not set up a national special emergency response plan and emergency management institution for serious marine environment incidents. The National Environment Emergency Response Plan*** only outlines the mechanism for responding to environment accidents, but does not include the basic principles and specific measures for emergency response for offshore pollution (such as an offshore oil spill). **In addition, there is no specific inter-ministry and inter-provincial coordination and management authority to deal with such environmental emergencies.**

The *National Environment Emergency Response Plan* identifies the inter-ministerial joint-meeting of MEP as the comprehensive coordinating institution in charge of the response to a national environment accidents. However, this plan has not yet been developed. Furthermore, the “***Three Provisions***” of the State Council has not defined the organizer of the inter-ministerial joint-meeting, who the members are, and the corresponding administrative body in the State Council. At present, **ministerial emergency response plans** for marine environmental accidents mainly includes the *Emergency Plan for Oil Spill in Offshore Oil Exploration and Exploitation* issued by SOA and the *Emergency Plan for Disaster in Offshore Oil and Gas Operation* issued by SAWS. However, it is difficult to handle inter-departmental and cross-regional cooperation and coordination in cases of serious marine environment emergencies based on those plans. Therefore, the corresponding response is likely to be late and lack overall coordination and technical and scientific rigour.

3.1.3 The marine environment management system is incomplete, and law enforcement is ineffective.

MEP is unable to implement its statutory “unified supervision and management” role and the punishment for the responsible party for the marine environment accident is insufficient. The information sharing mechanism among ministries does not function. The information disclosure system is not effective⁴⁷. There is no unified supervision and law enforcement team in offshore areas⁴³. The preparation, approval, revision, implementation and supervision of offshore economic development plans are not effective. Related laws need to be progressively revised and updated. Offshore rescue mechanisms and loss compensation mechanisms need to be improved.

3.2 Until now the main emphasis has been on short-term economic exploitation of offshore resources while less attention has been given to marine environmental protection

3.2.1 China places emphasis on marine economy development and not on effective regulation of the environmental performance of the offshore industry

The environmental performance of the offshore industry has not been effectively supervised by the central government and relevant authorities. There is a lack of strict enforcement of environmental protection standards in offshore oil and gas production activities. Too little attention has been given to marine environmental impacts during the change or revision of development and production plans. There has been a relative lack of investments in marine environmental protection, inadequate emergency response planning and emergency disposal capacity, and the adoption of preferential policies with low environmental protection standards in order to attract foreign investments. Overall, marine pollution is mainly caused by land-based pollution sources. However, sea-based pollution is becoming more important, accompanying the increase in marine economic activities. In particular, most marine environment emergencies can be attributed to either production accidents or negligence of environmental management on the part of enterprises.

Although the *Environmental Protection Law* stipulates that all enterprises are obliged to protect the environment, and that whoever pollutes the environment shall take the responsibility of remediation, some enterprises seek to maximize profits at minimum cost by sacrificing environment and resource use efficiency, and by not voluntarily fulfilling their commitments on environmental protection. As long as the supervision and enforcement of laws and regulations are insufficient, some enterprises will continue to try to escape from their environmental protection responsibilities. This will result in new environment problems that will jeopardize future generations' possibilities to utilize the full potential of China's ocean areas.

The main reasons why corporate environmental responsibility cannot be implemented seriously at the present time are as follows: lack of environmental ethics and voluntary awareness of social responsibilities; unclear environmental liability, complicated relationships between causes and results of environment pollution—where results may not occur immediately and could be attributed to many sources; lack of governmental environment protection responsibility, supervision and enforcement; and lack of strict governmental requirements for large enterprise's environment protection responsibility. With high demand for capital, technology, equipment, material and personnel, marine industries are monopolized by large enterprises, such as large state-owned enterprises and joint-venture companies. These enterprises have strong connections and public relations capabilities. Some state-owned enterprises have a superior administrative level by comparison to the marine environment management authority. Once environmental issues appear, relevant governmental departments may be unable to punish adequately these large enterprises for the damage they have done.

The 2011 Bohai oil spill incident clearly showed that the government did not exert its full role as a regulator. The responsible governmental agencies should have demanded at a much earlier stage that the enterprises involved should perform based on high environmental protection standards. How to solve the problems of an enterprise's environmental protection performance? On one hand, the government needs to improve the system for the prevention of pollution and of other public nuisances from the marine industry by clarifying the pollution prevention and accident response responsibility of the enterprise. On the other hand, the enterprise should be much more active in both internal and external awareness building and education in order to

meet their environmental protection responsibilities, exert much better internal supervision, and strengthen the internal control carried out by the managers and personnel of the companies.

3.2.2 China pays inadequate attention to marine environmental protection planning and management practices, and the supporting capacity of science and technology is insufficient

Marine environmental management mainly includes management of marine environmental planning, marine environmental quality and marine environmental technology. The marine environmental planning focuses on resolving the policies and planning issues associated with the coastal areas, including: development and construction, population expansion, various pollution controls, water quality control and emergency response reserves. Marine environmental quality management focuses on the formulation of marine environmental standards, marine environmental monitoring, and marine ecosystem restoration. Marine environmental technology management focuses on handling of pollution prevention technology, forecasting and early-warning technology, developing information platform technology, emergency disposal technology and other technologies associated with the planning and quality management.

Currently, the national marine environment monitoring capacity and technology system need to be enhanced. The marine environmental early-warning system is incomplete. The marine environmental emergency information system and the information command platforms urgently need to be established. The formation process of disaster chains caused by marine emergency and emergency technology system need further research. The theory and method for evaluating the marine environmental loss need to be further studied.

In general, the investment in science and technology supporting capacity is insufficient. Although, from the 9th FYP to the 12th FYP, the national investments in scientific research in the marine environmental field has been rising. But, in comparison with fields like marine energy, marine exploration and marine resource utilization, neither the amount of funds nor the number of projects are enough. The investments in scientific research on marine environment from relevant departments of the government are mainly provided to the quality control field, such as surveys, and exploration and monitoring of marine environments. Fewer investments are directed to research into the fields of planning management and technology management. This has led to the problem that many actual demands cannot be matched by existing capacity. For example, in the clean up of the spill in Bohai Bay in 2011, the oil dispersant used might result in additional damages to the marine ecosystem over the longer term. With sufficient technology preparedness, this issue might have been avoided. Therefore, it is necessary to sort and classify relevant issues, and resolve them by systematic scientific research.

4. POLICY RECOMMENDATIONS

The analysis of the recent oil spills in China and the experiences from oil spills abroad makes it possible to draw a number of conclusions. These are:

- *The government must develop proactive regulations and effective supervision of high-risk activities such as offshore oil and gas exploration and production.*
- *At the government level there must be an integrated inter-agency coordination mechanism and a national emergency response plan that is kept updated in order to respond immediately and effectively in the case of an oil spill.*
- *The responsibility of the operator of offshore oil and gas exploration and production to protect the environment must be clearly spelled out in the regulations applicable to such activities.*
- *The operator of offshore oil and gas activities must be able to provide or guarantee the immediate activation of the oil spill response plan with deployment of equipment and personnel to respond in the case of an accident.*
- *In order to enhance the emergency response capacity, regional and local cooperation and resources sharing are necessary for effective emergency response.*

4.1 Speed up the formulation of an integrated national marine development and environmental protection strategy and plan

NDRC should take a leading role, with the participation of MEP, MLR, SOA, MOT (Maritime Safety Administration), MOA (Fishery Administration) and coastal provincial governments, to develop a national master plan for marine development and environmental protection. This plan should be based on national development strategies, existing land and marine zoning plans, and the development plans of coastal governments. The plan should cover all coastal and marine areas of China including the Exclusive Economic Zone and islands. The plan will identify fundamental policies and strategies for balancing economic development and the need for marine environment protection. Such a plan will need to provide requirements for the management of the marine and coastal environment and should provide a positive interaction mechanism between marine economic development and environmental protection while at the same time balancing the interests among various industries, stakeholders and coastal regions.

4.1.1 Further integrate marine development-related strategic plans for coastal and offshore areas in the various provinces.

In order to establish a sustainable marine economy in combination with effective marine environmental protection in the Yellow Sea, Bohai Sea, East China Sea and South China Sea, planning for the development of offshore areas should be integrated with plans for near-shore waters areas and coastal plans for coastal provinces.

4.1.2 Develop a national master plan for the development and layout of the main marine industrial sectors

The Master Plan (*National Coastal and Marine Spatial Plan of China*) should be drawn up based on existing sectoral plans for different maritime industries and the development plans for the different regions and local governments. The Master Plan should take into account the need for environmental protection and the importance of securing the full protection of sufficiently large key habitats and ecosystems to enable true long-term sustainable use of the resources such as fisheries and aquaculture. The plan must include renewable resource activities such as fisheries and aquaculture, tourism, offshore oil and gas, coastal nuclear power, ports, wharfs, ports and shipping lanes, coastal real estate, heavy industries such as chemical and petrochemical plants, and metal smelters. The master plan should incorporate any sub-sector plans into the overall coastal and marine spatial plans taking into account individual sub-sector needs for adequate environmental and ecosystem protection and enhancement of ecological services. NDRC needs to be responsible for the coordination, implementation, and maintenance of such a plan, including linkages to Five-Year Plans.

The planners should promote the maintenance and the strengthening of the national maritime rights and interests, through orderly investments in marine development and protection and the management of marine industries. In order to enhance the quality of the marine ecosystems, issues related to environmental protection should be given priority in international negotiations related to the development of marine resources, including for disputed sea areas.

4.2 Establish a national marine emergency response plan for environmental incidents including the system for managing such a plan

A National Emergency Marine Response Plan for Major Environmental Incidents should be established. Such a plan should be based on existing, relatively uncoordinated laws including:

The National Environmental Protection Law, the Marine Environmental Protection Law, the Safe Production Law, the Overall Emergency Response Plan for National Public Incidents and the Emergency Response Plan for National Sudden Environmental Incidents, and through consolidation of the existing Emergency Response Plan for Oil Spill in Offshore Oil Exploration and Development and the Emergency Response Plan for Accidents and Disasters in Offshore Oil and Natural Gas Activities, as well as the relevant regulations in the different coastal provinces.

The plan system should be made up of a *National Contingency Plan (NCP)* that applies to the entire country and different *Area Contingency Plans (ACP)* that applies to coastal provinces, large areas of the coast or bays, etc.

Led by MEP, together with administrative units such as SOA, SAWS, the Maritime Safety Administration of MOT and the Fishery Administration of MOA, a NCP (*National Marine Emergency Response Plan for Major Environmental Incidents*) should be jointly compiled, and then used as the *Special National Contingency Plan*. Existing plans from relevant departments should comply with this plan or be

integrated with this plan. The Master Plan should provide the regulatory framework and guidelines for handling major marine environmental accidents, which affect more than one sector, region or country. The marine departments and coastal provinces/districts need to take their responsibilities in compiling emergency response plans for marine environmental events, respectively. Those plans shall be the *emergency response plans of departments under the State Council* and the *local or regional emergency response plans*, which may equal the ACP to some degree.

4.2.1 The Master Plan should include special emergency response plans and on-site emergency handling plans

The system should formulate special emergency response plans and on-site emergency handling plans for various tiers and types of potential marine environmental accidents. The responsibilities of relevant departments and companies for various types and at different stages of accidents (before, at the beginning of, during, and after accidents) should be defined. The tiers of response refer to the severity of marine environmental accident, and might include four levels: extraordinarily severe, severe, relatively severe and moderate. These types refer to risk sources posing significant environmental threats including oil spills, leakage of dangerous chemicals and radioactive contamination, or the risk of such events.

4.2.2 The Master Plan should define specific institutional responsibilities of organizations

The Master Plan should identify the responsibilities of the leading agency, the coordinating/commanding authority, and the roles and responsibilities of supporting agencies. It should be made operational through the “*Three Provisions*” of the State Council and be part of the integrated national, local and sectoral emergency response network through coordination between the State Council (lead agency), the Emergency Management Office of the State Council (administrative body), relevant departments of ministries (operating bodies) and relevant departments of provinces and cities (regional bodies). The establishment of a proper emergency response equipment reserve and the conducting of regular drill exercises will improve overall national emergency response capacity.

4.2.3 The Master Plan should pay special attention to the efficiency of emergency response and effectiveness of emergency handling

China’s marine environmental management must be both effective and efficient, and its response and preparedness must be built into every step of the operations of potentially harmful activities such as oil and gas operations offshore. Disaster chain characteristics of major environmental accidents should be taken into consideration during the construction of the system. Marine environmental accidents can be caused by natural disasters such as typhoons, or accidents in offshore exploration and production units, or a combination of events. Although an oil spill may originate in offshore areas, it can affect coastal zones and result in severe damage for example to aquaculture and tourism. Such coastal impacts make it necessary to involve both sectoral agencies and provincial authorities. The system also must consider clean up in coastal areas and along shorelines. Therefore, the system must be both inclusive,

covering the activities of all potentially important sectors, and considered operational and effective by all concerned parties.

4.3 Harmonize marine-related national environmental laws and marine environmental administrative functions

4.3.1 Modify the State Council's government organization and responsibility regulations

Provisions such as “establish and enhance the enforcement and supervisory system for marine environmental protection” should be added to the “*Three Provisions*” in order to harmonize the responsibilities of relevant departments with the *Environmental Protection Law* and *Marine Environmental Protection Law*. Since marine environment protection is the overriding goal for all marine environmental management authorities, the provisions should clearly specify the function of the “unified supervision and management of marine environment protection”. The recommendations on specific function adjustments are noted in Table 4.

4.3.2 Set up a new Department of Environmental Emergency and Environmental Protection Coordination within MEP

A new Department of Environmental Emergency and Environmental Protection Coordination within MEP should be set up. The new department should be assigned the responsibility of managing national environmental emergency accidents, and the coordination of MEP with other governmental agencies. As the national emergency management department for environmental accidents, it can carry out its coordination and command functions in the case of serious marine environment accidents. It can also act as the operating office for the *Inter-Ministerial Meeting of National Environmental Protection* of MEP and of the *Provincial and Inter-Ministerial Meeting of Bohai Environmental Protection* of NDRC, and carry out its coordination function and administration of the marine environment. Three offices might be considered under the new department:

- "Emergency Management Office", responsible for the emergency management of severe and extraordinarily severe environment accidents;
- “Environmental Coordination Office”, responsible for the daily tasks of the “Inter-Ministerial Meeting of National Environmental Protection” and “Provincial and Inter-Ministerial Meeting of Bohai Environmental Protection”, and for coordinating MEP, the other ministries of the State Council and provinces in the environmental protection;
- “Program Planning Office”, responsible for compiling the annual environmental protection emergency programs and program coordination, and the corresponding budgets.

Table 4. Recommendations on function adjustments of key institutions

Basic system of unified supervision and management	Legal Basis		Recommendations on Division of Functions	
	<i>Environmental Protection Law</i> or other environmental protection laws	<i>Marine Environmental Protection Law</i>	MEP	SOA
1. total quantity control for pollutants discharged to important sea areas		Clause 3	Development of plans and allocation of total quantity	Implementation, supervision and monitoring
2. Marine functional zoning plan	Clause 12	Clause 7	Developed together with Environmental Functional Zoning Plan and Main Functional Zoning Plan	Implementation, supervision and monitoring
3. National Marine Environmental Protection Plan	Clause 12	Clause 7	Compiling jointly	Participant in compiling
4. Regional marine environmental protection plan for important sea areas	Clause 12	Clause 7	Compiling jointly	Participant in compiling
5. Inter-departmental coordination for serious marine environmental accidents		Item 2 in Clause 8	Key responsibility	
6. Proposing the sewage discharge standard and the total quantity control system	Clause 10	Clause 9	Organize the proposal development	Implementation, supervision and monitoring
7. Proposing the environmental monitoring specification	Clause 11	Clause 15	Organize the proposal development	Implementation, supervision and monitoring
8. Pollution fee	Clause 12 in the <i>Regulations on the Administration of Collection and Use of Pollution Fees</i>	Clause 11	System establishment	Implementation, supervision and monitoring
9. Approval of EIAs for marine projects	<i>Environmental Impact Assessment Law</i>	Clause 47: recommend revision of the legal provisions	Change “for record” to “for approval”, in order to be consistent with <i>Environmental Protection Law</i> and <i>Environmental Impact Assessment Law</i>	Approval
10. Supervision on EIAs for marine projects	<i>Environmental Impact Assessment Law</i>	Clause 47	Marine environmental supervision	Supervision and monitoring
11. Joint law enforcement on ocean matters		Clause 19	Marine environmental supervision	Marine environmental supervision

4.3.3 Establish an effective inter-departmental coordination mechanism for marine environmental management by enhancing the responsibilities of relevant departments with duties related to marine environment protection following the principle of prevention

Drawing on experiences from Norway and USA, it is necessary to emphasize the roles and responsibilities of the energy authority, the safety regulatory agency, the maritime administrative agency and the environmental protection agency in the prevention of oil spills and the immediate emergency response. The Maritime Safety Administration of MOT has extensive experiences in managing marine oil spills from shipping and has cooperated with many oil spill clean-up companies over a long period. It is thus rational that the Central Staffing Office in China has assigned a coordinating role to MOT in cases of serious marine oil spill accidents. The SOA

specializes in monitoring, water quality analysis, supervision and ecological damage assessments. It is recommended that SOA continue to exert this important role in marine oil spills emergency responses in the future. Simultaneously, it needs to strengthen the capacity in oil spill emergency response support system. Under the centralized leadership of the Emergency Office of the State Council, the new department proposed will be responsible for coordinating the response work for the severe, and extraordinarily severe categories of marine environmental accidents. This office should ensure that all relevant agencies carry out their individual duties in handling environmental accidents in their professional fields, and ensure various supporting agencies to adequately support this work according to their respective duties.

4.4 Improve legislation for marine environmental management

4.4.1 Improve the institutional and regulatory system for the approval and supervision of overall off-shore oil field development planning

The improved system should consider the rules and regulations for environmental assessment as articulated in the *Environmental Impact Assessment Law and Regulation on Environmental Impact Assessment of Planning*. The overall oil fields development plan for offshore oil fields, which is a special sector plan, must follow strict environmental protection review procedures. The environmental authority's responsibilities and review procedures of the plans for oil field development must be followed. The Energy Administrative Authority and Environmental Protection Authority should jointly formulate sector rules and regulations associated with planning, approval, revision, implementation and supervision of the overall development program for oil fields.

4.4.2 Strengthen the implementation of pollution prevention control and safe production regulation in oil development

The safety regulations of offshore oil production to prevent environmental damage by accidents should be strictly enforced. The key role and full responsibility of the operator for all damages must always be emphasized. Technical requirements and specifications of equipment and measures related to oil exploration and production should be incorporated into legal provisions. For example, the National Energy Administration should formulate technical requirements of equipment and facilities for safe oil production. Well-organized inspections of industrial enterprises should be routinely arranged to check that environmental safety procedures are followed, and that the facilities to be used in an emergency are in order and ready to be used. The regulations should also explicitly stipulate that they have the obligation to identify problems, eliminate hidden troubles and disclose violations, and that penalties can be imposed immediately when problems related to environmental risks have been identified.

4.4.3 Improve the information disclosure procedures

As an initial priority, a unified mechanism of receiving and publishing the information should be established. Legislation such as the *Marine Environmental*

Protection Law should provide clear and specific provisions on information collection and publishing, in accordance with the unified information publishing mechanism provisions stipulated in the *Law of Dealing with Emergence Incidents*. As the second priority, the enforcement of *Regulations on Open Government Information* should be strengthened to ensure the public's right to know. Furthermore supporting regulations on procedures for complaints and litigation to make the information disclosure regulations operational should be formulated. An approved information disclosure system will enable accident victims to receive information on time and to get ready for emergency preparation and for making pollution damage claims. In addition, the improvement of the information disclosure system is beneficial for the establishment of public participation mechanisms and for the enhancement of the implementation and compliance of environmental laws.

4.4.4 Improve the ecological damage assessment and compensation system

Specific regulations and provisions for ecological damage assessment and compensation need to be formulated, e.g., in the *Ordinance on Claim for Compensation of Marine Ecological Damage*. The regulations and provisions shall provide specific rules for case identification, compensation scope, liability exemption conditions, claiming subject of ecological damages and rights and liabilities, claim procedures and remedy methods. The existing *Technical Guidelines on Marine Ecological Damage Assessment* shall be improved and their applicability in legal practices strengthened. That means clarification of the criteria for ecological damages and for the obligations of the operator of oil and gas facilities to, as a routine, carry out monitoring of key environmental parameters of relevance to the legal provisions.

Furthermore an Ecological Compensation Fund funded from the economic transactions of the offshore oil developers should be established. It is important that the money accumulated in such a Fund be used strictly to compensate for damages that cannot be traced to any individual operator's failure to meet the regulations. An Ecological Damage Compensation Fund was developed in connection with the Bohai Sea Oil Spill accident. This Fund should be made functional and any economic transactions from such ecological compensation funds should be made available to the public to promote transparency of operation.

4.4.5. Establish and improve the mechanisms to recover the cost for maintaining emergency response

On the one hand, the damage compensation system should clearly and explicitly identify that the party responsible for the accident should bear the full cost of emergency response. The environmental damage compensation system needs to be articulated in laws such as the *Environmental Protection Law* and *Tort Liability Law*, or through the special *Oil Pollution Damage Compensation Law*. The regulations should clearly indicate the cost-bearing responsibility of the operator. In addition, the emergency response obligations and cost-bearing responsibilities of the operator need to be strengthened by the means of compulsory insurance, corporate environmental reserve fund and industrial funds. The insurance or other financial mechanisms provided by the operator shall fully cover all potential damages that the

operation may cause. Large corporations may be able to self-insure the cost of any damage.

On the other hand, the emergency response equipment and management industry shall be encouraged to establish a market mechanism for the operation of an emergency response service to be provided to the industry. Based on existing international experience it is clear that the private sector can be an important component of the national emergency response capacity. Therefore, it is necessary to establish a sound market environment (including improving the pollution damage compensation system and establishing the emergency service system) to make emergency pollution cleanup a market activity. Specific measures include the strengthening of the qualification and capacity of emergency response service entities, ensuring that compulsory pollution cleanup agreements are signed by enterprises, and that the financial guarantee system for emergency pollution cleanup expenses is in place. The clean-up organizations will need responders' immunity from liability as they are responsible for doing the cleanup and not for the accident.

4.5 Strengthen law enforcement of marine environmental management

Through legislation and State Council authorization, strengthen the enforcement and supervision capacity in the marine environmental protection of the national oceanic administrative authority and establish a system for the administrative supervision in the marine environmental protection and law enforcement of the national environmental protection administrative authority.

4.5.1 Establish a unified offshore law enforcement team

In order to strengthen the supervision and enforcement capacity of the marine environment administrative authority, an offshore law enforcement team should be established. Such a team will ensure that law enforcement is the key supervision function of the marine environment administrative authority.

4.5.2 Establish China's marine environment administrative supervision and law enforcement system

In order to enable better supervision and guidance to other marine environment administrative agencies, the national environmental protection administrative authority should be strengthened. That will enable the identification of cross-regional and inter-departmental marine environment issues that need to be coordinated through daily administrative supervision.

4.5.3 Strengthen the supervision of the environment impact assessment system for marine energy development activities

China's marine environment administrative authority and the supervision agency should enhance their supervision and inspection capabilities by carrying out assessments of environmental impacts and damage evaluations. Provisions for such evaluations, their frequency and report contents should be specified in the legislation. The exercise of responsibilities by the relevant authorities in charge of environmental

impact follow-up and post-evaluation, as well as of violations needs to be well supervised.

4.6 Enhance corporate environmental responsibility and improve environmental risk prevention capacity

4.6.1 Express the responsibility of operators for developing and complying with the emergency response plan and revising the emergency response plan as necessary

Oil and gas companies exploring and operating in offshore areas must be required to have adequate emergency response plans. Relevant laws should be revised drawing on experiences from Norway and the USA to clearly specify that the operator (the oil/gas companies) shall have the full responsibility to meet any need for immediate emergency response. The governmental authority role is to check that the companies fulfil all such obligations. By law in Norway and the USA, the operator, before entering into any activity that may cause harm to the environment, has to either guarantee that the company/operator itself is able to provide full emergency response capability or, as an alternative, has signed an agreement with a capable emergency response company/organization as a prerequisite condition for approval of oil development activities.

4.6.2 Develop a complete set of applicable specifications of appropriate disaster response, exploration/production and engagement permission for the operators

It is recommended that the national environment administrative authority (MEP) should take the lead and work with industry associations and leading enterprises to prepare the specifications by consulting the relevant international standard of the same industries, such as offshore oil/gas.

4.6.3 Strengthen corporate environmental awareness and responsibilities

The information departments of various marine administrative authorities should contribute to the building of environmental awareness among the public and inform the private sector of their responsibilities in protecting the environment. Corporate environmental protection capacity will be considered an essential condition for approval of the enterprises' involvement in any activity related to marine development and resource exploitation. Local maritime courts and procuratorates should clearly address enterprises' legal responsibilities for pollution and damages of marine environment due to their operation. Such actions will discourage operators from risking environmental damage in order to save costs. The authorities for the industrial sector shall require the preparation of response plans, insurance and compensation guarantee systems to spread the risks for enterprises through industrial sector associations, enterprise alliances and insurance companies.

4.6.4. Enhance the prevention of environmental risk from marine-related enterprises

Legislation departments in the National People's Congress (NPC), NDRC and MEP must consider the environmental responsibility of foreign and national companies in cooperative offshore development projects. Relevant laws and regulations should clearly define the responsibility of the government and the operators respectively in cooperation and joint development projects, in order to mitigate or decrease the risks of marine accidents leading to environmental damage.

4.7 Strengthen capacity building of science and technology in marine environmental management

4.7.1 Strengthen research, technology development and monitoring related to marine environmental management

Environmental or marine public projects or special national science and technology development programs, should emphasize the need for theoretical and technological research. Research and development is particularly needed in areas such as the overall strategic spatial planning of ocean and coastal, coastal and marine emergency response, marine environmental management laws and regulations, marine environmental monitoring and early-warning systems, methods for networking and information dissemination, marine pollution control technologies and standards, marine ecological loss evaluation and remediation methods, and marine disasters risk assessment and prevention tools. One very important way of stimulating research and development is through stimulating international cooperation.

4.7.2 Strengthen special studies on oil spill emergency management technologies

Priority areas for research are environment impact assessment methods for offshore oil and gas development projects and procedures for ecological risk assessments caused by disasters, guidelines for oil spill damage evaluation and compensation, oil spill emergency monitoring and pollution control and clean-up technology, as well as research on the environmental state and capacity of the Bohai Sea and other Chinese seas. Other priority research areas include decision-making support systems for emission reduction, oil spill source tracing technologies, oil spill risk monitoring and assessment technology, national oil spill emergency response systems, risk identification for offshore oil spills, risk prevention and comprehensive management technologies, research related to marine industrial policies and restructuring, national energy policies and structure adjustment. Oil and gas developers should be obliged to invest in such research and to establish regional marine environmental research funds.

ACKNOWLEDGEMENTS

Thanks to China Council for International Cooperation on Environment and Development (CCICED) for providing the basis platform for the Special Policy Study (SPS) on Bohai Oil Spill. Financial support for the implementation of this SPS was provided by CCICED, Shell China and the US Energy Foundation.

As an important part of the research activities, the SPS team held 7 working meetings, including 3 joint working meetings of Chinese and international members and 4 Chinese member working meetings. In addition, the team has organized 3 workshops in Qingdao and Beijing. Thanks to the experts present on the special policy study meetings from Academy of Sciences of the Ministry of Transportation, North China Sea Branch of SOA, National Marine Environmental Monitoring Center, Pollution Control Division of MEP, and Yellow Sea Fisheries Research Institute of MOA, etc., for their valuable information, experience sharing and recommendations. Also thanks to Mr. Knut Alfsen, the member of Chief Advisers' Support Team and the former director of CICERO - the Center for International Climate and Environmental Research in Norway (Oslo), for his guidance and recommendations in the joint working meetings and in compiling relevant reports.

This report was submitted by the Special Policy Study on the Bohai Oil Spill as a Case for China's Marine Environmental Management Mechanism.