

Marine environmental quality, pollution monitoring and environmental management *

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Abstract—Chinese government has adopted a series of management measures to prevent and manage marine pollution and to protect ocean bio-resources and ecosystem. The key points of Chinese marine environmental quality status, pollution monitoring and environmental management since 1980' were discussed in this paper. Those included the investigations of Chinese coast environmental quality, monitoring techniques and standards, as well as the marine environmental management measures. Recent status of marine environmental pollution and the monitoring network in China were also introduced.

Keywords: Chinese coast; marine environmental quality; marine pollution monitoring; marine environmental management.

1 Introduction

China has a long coastal line. Since 1980', economy in coastal areas has been developing fast, along with the increasing population. Large amounts of industrial and domestic wastes were discharged into sea, resulting in marine pollution in some areas. In order to control marine pollution, protect ocean bio-resources and ecosystem, and ensure human health, Chinese government has adopted a series of management measures. The key points of Chinese marine environmental quality status, pollution monitoring and environmental management in these years are reviewed bellow.

2 Investigation and monitoring of coast environmental quality

2.1 General survey for national marine environmental quality

Over the period 1980—1986, State Oceanic Administration (SOA), State Agriculture Department and other three units had jointed forces in integrated investigation on resources of coast and tidal flat, taking environmental quality as one of the major issues. The involved areas covered 10 provinces, cities and autonomous regions, ranging from 10 km off the coast on land to the 15 meter isobath in the sea along almost the whole coastline in China. The results showed that coastal environmental quality was fundamentally sound when viewed at the national level, however, some main pollution problems were identified, namely, (1) significant organic pollution and increasing red tide frequencies; (2) generally existed petroleum pollution and (3) heavy metals and organochlorinated pesticides (NCZO, 1989).

* Supported jointly by the United Nations Development Program UNDP and Global Environmental Foundation (GEF)

Following the above survey, integrated investigations on environment and resource of national islands were organized by SOA and other units. A series of investigation reports, like that of Xiamen (Leading Office, 1997), had been presented.

Integrated investigation on environment and resource of highlighted bays and estuaries was launched by the SOA at the end of 1980's. A series of books on general information had been published (Compiling, 1993; 1994).

Mussel watch and ecological monitoring (Zhang, 1986) are given increasing attention. The first national wide mussel watch program (Xu, 1996) had been performed during 1990—1991. Under the charge of National Marine Monitoring Center and Third Institute of Oceanography of SOA, an investigating plan on remaining toxin in economical shellfish had been executed.

2.2 General monitoring program for marine water quality and pollution (Monitoring, 1994)

Since 1984, SOA has organized working units concerned to execute national monitoring program for marine pollution. Until recently, there are more than 500 marine monitoring stations established in China. Among them, there are 182, 53, 25 and 6 monitoring stations for seawater quality, sediment, residential toxin and atmospheric environment, respectively, and another 257 stations for estuaries, ports and effluent sites. The routine monitoring parameters involved are 57 altogether. Information accumulated shows the 2 million km² of off-shore areas suffer pollution, in general, whereas the pollution of inorganic nitrogen, petroleum and inorganic phosphorus is significant. Land-based emissions are pointed as the major pollution sources (Wei, 1996).

In addition, special monitoring issues are being carried out every year, such as: (1) Monitoring on waste dumping areas. The amount of dredged waste is increasing year by year. There were more than 80 million tons dredged waste in 1989. Periodic monitoring has been carrying out on 38 dumping areas. (2) Monitoring and investigation of red tide (Monitoring, 1994; Zhu, 1995). Since 1989, SOA and relevant units have been performing key monitoring on areas of frequent red tide, and announcing the possibility and information of red tides. Third Institute of Oceanography of SOA, Institute of Oceanography Academy in Tsingdao, Ji'nan University in Guangzhou, and SOA South China Branch carry out the research on red tides, including the investigations on happening conditions, organisms, mathematics models and other activities.

2.3 Some regional marine monitoring programs

Monitoring projects concerning regional problems were performed with different forms and scales.

Taking investigation on hepatitis virus pollution for example, comprehensive investigation shows that the prevalence of epidemic hepatitis in east China in spring of 1988 was related to a shellfish polluted by hepatitis virus. The area was then under intensive monitoring and research (Monitoring, 1994).

In a case to assess the impact of nuclear power station on ecosystem, the program of ecological base-line investigation of Daya Bay had been carried out from 1986 to 1988 (Third, 1989; 1990), benthonic ecology and water chemistry were involved.

As for marine enclosed ecological experiment (MEEE), a jointed program by China and Canada from 1983 to 1987 in Xiamen was practiced to mimic marine pollution ecosystem and establish MEEE system (Wong, 1987). Two MEEE systems and 1 clean lab were set up for studying effects and fates of trace heavy metals, port sediments and petroleum.

As atmospheric transportation is the main input channel of ocean pollutants, especially vaporizable materials, the relevant monitoring is necessary. The Third Institute of Oceanography

of SOA charges in monitoring of atmospheric pollutants in Routine Monitoring Program of Marine Pollutants.

3 Recent status of marine environmental pollution in China

With the development of regional economy, estuaries and gulfs, such as Yangtze Estuary and Pearl Estuary, are suffering relatively heavier pollution than less exploited region like Beibu Bay. Due to the intensive development of industry, as well as the unfavorable hydrodynamic condition, marine environment of Bohai Bay, especially Dalian Gulf, stays steadily polluted.

3.1 Sources of pollutants (NCZO, 1989)

The main input channels are the followings: river input, direct discharging from land, sea oil field discharging, ship discharging and atmospheric transportation. According to statistical data, total amount of industrial and domestic wastewater discharged into sea in China is about 850000 tons per year. 87.2% of it is come from river, especially from Yangtze River and Pearl River (about half of the total). Among the pollutants, 78% are from industrial waste water; 20% from domestic wastewater. Organic pollutants make 97.5% of the total pollutants discharged while petroleum makes 0.91%.

3.2 Status of marine pollution (NCZO, 1989; Monitoring, 1994)

Generally speaking, environmental quality of the major coastal zone in China is good, except for some estuaries and harbors.

Problems caused mainly by organic pollution (considering COD) come first. The annual average concentration of phosphates in near-shore seawater is $0.59 \mu\text{mol/L}$; of nitrates, $7.5 \mu\text{mol/L}$. The increasing organic pollution has already brought about more frequent red tide cases in some estuaries and harbors, leading to several hundred million Yuans losing every year. For instance, 41 cases of red tide were recorded in 1990, while there were altogether 43 cases throughout 1980's. It is indicated that eutrophication caused by aquaculture is concerned seriously by the government as an important problem of organic pollution.

Petroleum pollution was predicted keeping increasing. The amount of the petroleum discharged into sea was increasing steadily since 1970's. The amount of petroleum discharging into east China sea in 1984 was 4 times of that in 1979. The main polluted areas gather in places such as Dalian Gulf, Jiaozhou Bay, Yangtze River estuary and Pearl River estuary. The concentration of petroleum pollutants has not yet increased to the range of acute toxicity to ocean livings, but probably accumulating in their bodies.

The average concentration of organochlorinated pesticides in coastal seawater of Guangdong is about $1.0 \mu\text{g/L}$, much higher than that in other sea areas. China has prohibited the producing and using of BHC and DDT. This will help to decrease the concentration of those pollutants in seawater and sediment.

Trace metals, mainly including Hg, Cu, Pb, Zn and Cd, are not the major pollutants in China sea compared to organic materials. However, concentration of sedimental Pb of coastal region around Bohai Bay and south to Yangtze Estuary had exceeded the standard. Trace metal pollution also gathers in the major estuaries and bays.

Colon bacillus in some sea areas had exceeded the standard of water quality due to the discharge of domestic wastewater. The deteriorating water quality of beaches nowadays, and the prevalence of hepatitis in 1988, are related to microorganism pollution.

4 Monitoring network of marine environment

4.1 National monitoring network of marine environment (Monitoring, 1994)

As part of national environmental monitoring network, national monitoring network of marine environment was organized by SOA in 1984. The main tasks of the network are to monitor environmental quality and pollution sources for long term, to predict the pollution status and trends, and to serve marine environmental management and economic development. The related units of provinces, cities and autonomous zones on the coast take part in the work. At present, more than a hundred units join in the network. Bo Sea, Yellow Sea, East Sea, and South Sea all have respective regional monitoring networks for marine environment, as the secondary level of the national network.

4.2 Professional monitoring network of marine environment

Founded in 1985, national monitoring network of fishery environment is supported by a 3-level monitoring organization. The main tasks of the network are to monitor marine fishery areas, important marine aquaculture zones, ecosystem of some defined marine fishery resources, red tide in some important fishery areas, remaining toxin in fish, and events of marine pollution.

There are some other professional monitoring networks such as networks of transportation department, marine petroleum corporation, and the Navy. They are working on marine environmental monitoring for their special needs.

5 Techniques, standards and inter-lab calibration (Zhang, 1991)

5.1 Standards for marine monitoring (MSD of SOB, China, 1994)

"Standards for Marine Monitoring" was compiled and published, which consisted of 10 chapters: (1) general principles; (2) data processing and analytical quality control; (3) sample collection, prevention and transportation; (4) water quality analysis; (5) sediment analysis; (6) organism analysis; (7) atmospheric analysis; (8) nuclide determination; (9) near-shore pollution ecology and biological monitoring; and (10) investigation on flux of pollutants discharged into the sea.

5.2 Producing of standard and reference materials (Monitoring, 1994)

A set of standard and reference materials have been developed and produced, they are: (1) nitrates, nitrites, ammonium, silicates, phosphates, iodinate, and HCl; (2) Cu, Pb, Zn, Cd, Cr, Hg; (3) mussel standard with standard values for 17 elements, reference values for 4 elements, information values for 16 elements; (4) standards of near-shore sediment with standard values for 34 elements, such as Hg, Cu, Pb, Cd, Zn and As.

5.3 Inter-lab calibration

Inter-lab analytical calibration is held at least once a year by national monitoring network of marine environment. Besides that, SOA and National Marine Monitoring Center joined 5 international inter-lab calibration activities held by IOC. International training courses of marine sediment monitoring and marine benthon monitoring were also opened in China entrusted by IOC.

6 Marine environmental management (MSD of SOB, China, 1994; Seawater Quality Standards, GB 3097-82, 1982)

6.1 Laws, regulations and standards for marine environment protection

The followings are the related rules and regulations executed in China since 1980's: (1)

National marine environment protection law of China; (2) Regulations of environmental protection and management on marine petroleum exploration; (3) Management regulations of preventing ships from polluting seawater; (4) Management regulations of dumping waste on sea; (5) Management regulations of preventing land-source pollutants from destroying marine environment; (6) Management regulations of preventing coastal constructional projects from destroying marine environment.

And marine environmental quality standards include: (1) Sea water quality standards of People's Republic of China; (2) Standards of marine pollutant discharging; (3) Quality standards of marine environmental organisms (under formulating); (4) Quality standards of marine environmental sediment (under formulation).

6.2 Ways of marine environmental management

Marine environmental quality standards supply different quality levels for sea areas with different function, and thus supply practical standards for environmental management.

Establishing and managing marine reservation zones plays an important role in environmental and ecological protection. Fifty seven natural marine reservation zones and reservation zones for rare animal in imminent danger, were established successively. Direct discharging of wastes in these areas is prohibited. Other activities, such as exploiting natural resources, even traveling and scientific researching, are forbidden.

At present, 38 delimited dumping areas on sea are under rigid management and monitoring. A major step for better control of marine pollution is the transformation for control of the total discharging quantity, which is now beginning to be practiced in some areas such as Xiamen.

Marine environmental quality, pollution monitoring, and environmental management in China have been briefly discussed above. More works on these subjects are still carried on.

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