

## Water pollution and its control in China

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**Abstract**—Based on comprehensive analysis of the status, major characteristics and regulation of regional differentiation of water pollution in China, the following counter measures for control water pollution were suggested: Overall planning and rational allocation; Comprehensive utilization and technical reform; Strengthening environmental management and the legal system.

**Keywords:** water pollution; regional differentiation; rational allocation; comprehensive utilization.

Among many environmental problems facing Chinese environmental scientists today, two require urgent attention: environmental pollution and ecological damage. The focus of this paper will be put on the status of water pollution and its control counter measures in China.

### MAJOR ACHIEVEMENTS IN WATER POLLUTION CONTROL

During the past 10 years, the Chinese government has taken environmental protection as a basic national policy, and established a guiding principle of synchronous development in the economy and in the environmental protection. Correspondingly, the government has also taken a number of measures to strengthen environment management. The achievements in controlling water pollution and treating industrial wastes are mainly reflected in the following aspects.

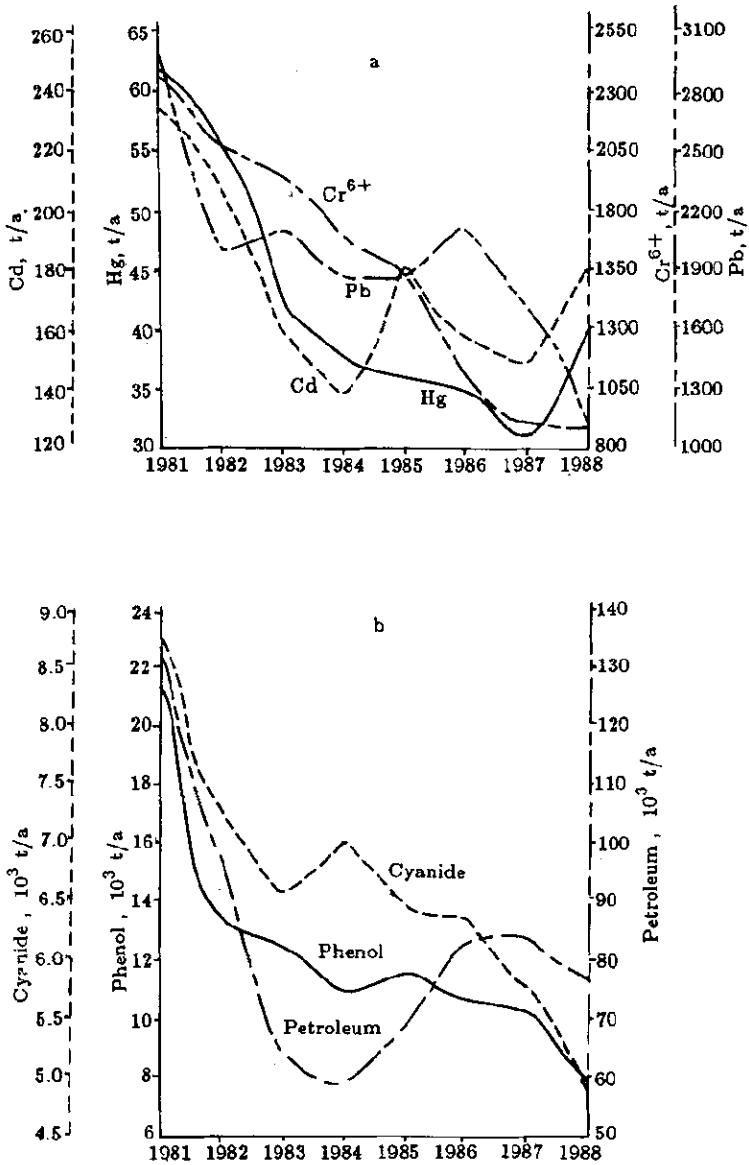
More than 120000 projects throughout the country were instituted for pollution treatment facilities between 1981 and 1988. The ability to process industrial wastewater has increased by more than 4 billion tons (Table 1. Chinese EPA, 1988).

Table 1 Ability to process industrial wastewater from 1981 to 1988\*

Items	1981	1985	1988
Rate of meeting the requirements set for industrial wastewater, %	26	41	46
Annual amount of processed industrial wastewater, 10 <sup>6</sup> t	3.1	5.7	7.2
Rate of processed industrial wastewater, %	13	23	27

\*after Chinese EPA, variation of major environ. index in China, 1988.

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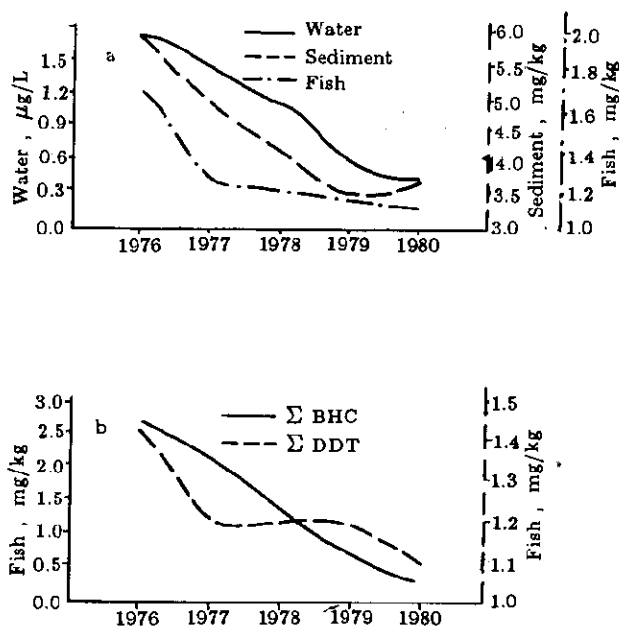


**Fig. 1** Amount of discharge of heavy metals (a) and organic pollutants (b) in wastewater (ton/a)

The total amount of discharge of wastewater containing heavy metals (a), phenol, cyanide and petroleum (b), has been reduced annually (Fig. 1). As compared with those in 1981, the discharged pollutants decreased by 22–62 percent in 1988 (Chinese EPA 1988).

During this period, an investigation on water pollution, water quality assessment and comprehensive control of water pollution has been completed for some rivers, lakes and other

water bodies including Xihu Lake, Guanting Reservoir, Jiyun River, Songhua River, Xiangjiang River, Bohai Sea and Huanghai Sea. The results indicate that the water quality of these water bodies have been improved. For example, during the period of 1976–1980, variations in concentrations of mercury and organochloride pesticides at lower reaches of Jiyun River (Fig. 2) show a major achievement in comprehensive control of water pollution. The water quality of the trunk streams of some large rivers, with the exception of partial sections of the Yangtze River, the Liao River and Hai River, remain relatively good.

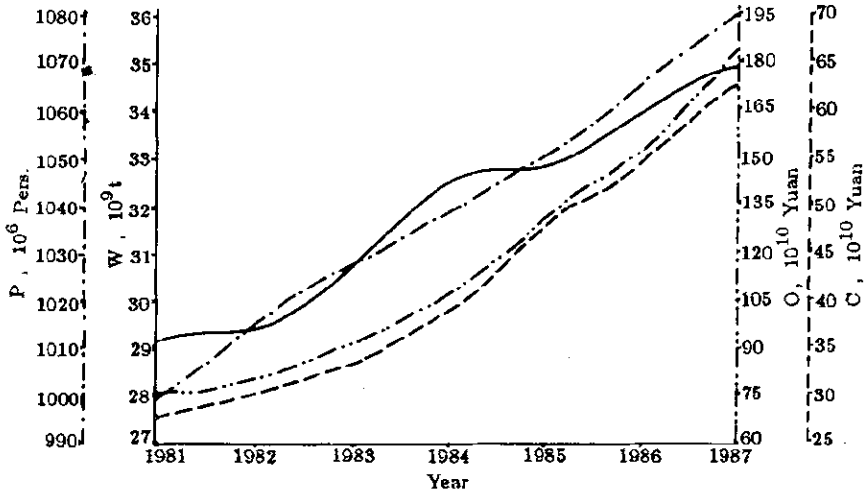


**Fig. 2** Variations in concentrations of mercury (a) and organochlorinated pesticides (b) in water at lower reaches of Jiyun River

## MAJOR CHARACTERISTICS OF WATER POLLUTION IN CHINA

In recent years, with the rapid development in China's national economy, urbanization, and increase of population there has been a concomitant growth in the consumption of energy. The discharge from industrial processes is the main source of water pollution. As a result, water pollution and aquatic ecological damage in some urban areas are quite serious.

During the period of 1981 to 1987, the annual amount of the discharge of wastewater increased together with rapid increases in population, industrial-agricultural output and consumption (Fig. 3). In 1987, the total amount of discharged wastewater was 34.9 billion tons, 80% of which was from urban areas into rivers, lakes and seas, most of which had not been treated (The Editor of Chinese Statistical Board, 1988).



**Fig. 3** Relationship between amount of wastewater (W), population (P), total value of industrial-agricultural output (O) and consumption of national income (C)

Consequently, the water quality in some rivers and lakes have changed greatly. Eventhough the per capita volume of wastewater in China is very low, being only one third of that of the world, while the ratio of the amount of wastewater to the amount of runoff (RSR)\* and the amount of wastewater per km<sup>2</sup> in the country are somewhat larger than that of the world. This is particularly true in northern and northeastern China where water shortages, rapid development on economy and large population density have added to the problem. Though the water qualities of the trunk streams of some large rivers, remain good, most of water bodies in urban areas, are polluted in varying degrees, mainly by COD, NH<sub>4</sub><sup>+</sup>-N, R-OH, CN<sup>-</sup> and organic pollutants and secondly by heavy metals and oil. In recent years, the amount of ammonia nitrogen, nitrate nitrogen and cyanide in surface water increased slightly, while harmful metals decreased. It is predicted that water pollution in surface water in China will be more serious because of the accelerated development of enterprises in towns and rural areas.

#### REGIONAL DIFFERENTIATION OF WATER POLLUTION IN CHINA

Differences in the degree and type of water pollution between urban and rural areas are very large. There are also significant differences between eastern monsoon and northwestern arid China. Those differences are not only resulted from the difference

climate, geology, topography and vegetation in China and its long history of human activities have created many different geographic regions.

Water pollution is closely related to stream runoff and the economic development of a given river basin. Different climatic and geomorphological conditions in China have formed extremely uneven patterns in stream runoff. Water is abundant in south China but scarce in the north. The economy is more developed in the east than in the west. Water pollution, therefore, is more serious in the north and northeast China than in the southwest. Water pollution in China could be characterized by RSR, a suitable index for comparing regional differentiation in water pollution (Tang Yijian, 1989). As shown in Fig. 4, the RSR values are extremely high in the Beijing-Tianjin and Shanghai areas (over 0.31), and are a bit lower in Jiangsu, Hebei, Liaoning, Shandong, Shanxi and Henan provinces (0.031-0.100), while the values in the south and northwest China is rather small (less than 0.03). China may be divided into two regions in term of regional differentiation in water pollution. The first region, north of the Yangtze River, includes the middle and lower areas surrounding the Yellow River, the Liaohe River and the Songhua River. The second region, south of the Yangtze River, includes the lower Yangtze plain and other rivers. Because of expanding industrial and energy resource bases, rapid urbanization and development of enterprises in towns and rural areas of the first region, greater amount of wastewater are discharged into rivers and lakes. The mean annual precipitation is around 600mm or lower. Nevertheless, evaporation is some times higher than the precipitation. The mean depth of the annual precipitation runoff is less than 200mm. The self purification capacities of many water bodies are rather limited because of low stream-flow. This limited amount of runoff is insufficient for dispersing and diluting pollutants in rivers. On the other hand, in the rivers of northern and northeastern China, the chemical composition of the water is mainly sodium-calcium carbonate-bicarbonate, with pH over 7.5. Under conditions of low temperature, the biodegradation of organic pollutants in the water is weak, while water pollution there is serious. The length of the Hai, Liao and Songhua rivers polluted by organic pollutants accounts approximately for 62% of the total length of polluted river in China. In contrast, 80% of the the Yangtze River meets established standards for surface water. This river system accounts for only 6% of all polluted water in China, with 1.5% of this serious pollution associated with cities. In northwestern region of China, the water quality of the trunk streams of large rivers including the Yellow and Urumqi rivers, with the exception of partial sections near or around cities such as Lanzhou, Xi'an and Urumqi, remains good. In rivers of the southwest, water quality also remains good due to large stream-flow and small amounts of wastewater.

## COUNTERMEASURES FOR CONTROLLING WATER POLLUTION

In order to promote environmental protection, the relationship between the economy and

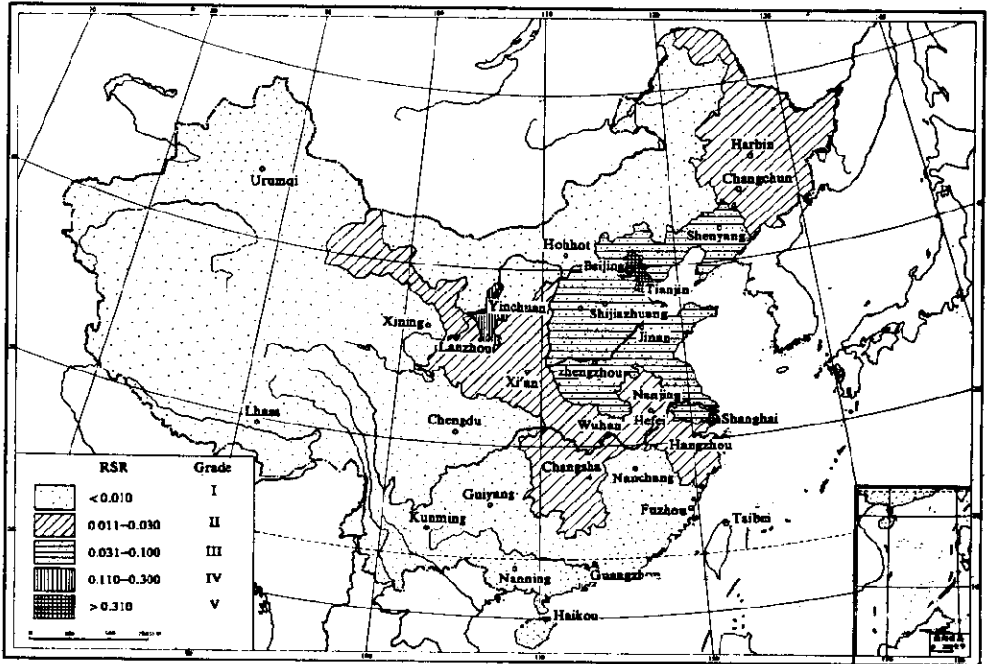


Fig. 4 Ratio of wastewater to runoff in China

the environment must be understood and handled properly. The key for China is to formulate a strategy for environmental protection. The main principles are as follows:

We should plan, develop and implement environmental protection together with the development of economy in urban and rural areas so as to realize economic, social and environmental benefits simultaneously.

We should adhere to the principle of prevention first and combine prevention with treatment when dealing with pollution. It is also necessary, at the same time, to adopt a plan for the comprehensive treatment of the environmental pollutants.

We should create an unified system for the planning, control and management of environment. This would facilitate the full coordination of these activities.

The following is an explanation of counter measures to control water pollution and improve aquatic environmental quality in three aspects.

#### *Overall planning and rational allocation*

The landscape-ecological system of basin is made up of natural, social and economic elements. Regardless whether its structure, composition and regional distribution are rational or not, it does exert great influence on the efficiency of basin production and the water quality of the basin as a whole. Therefore, when we design plans for regional development, placement of industrial enterprises and urban construction, we must also consider the following principles:

(1) Requirements of social development; (2) Suitability to natural conditions; (3) Environmental handling capacity; (4) Possibility for procuring economic and financial resources.

It has been recognized that an excessively dense population, in conjunction with industrial concentration, will lead to water pollution. At present, the irrational distribution of industry in some areas is mainly reflected in the following three aspects:

1. Distribution of industrial plants is not closely connected with natural conditions and geographic characteristics. For example, in semi-arid and arid areas of northern China there is shortage of water resources but there are many industrial plants which consume large amounts of water.

2. Industrial plants are concentrated in some urban areas.

3. Types of industrial production are not closely coordinated with the function of regional environments. For example, many heavy and chemical industrial factories have been constructed in Beijing. In some other cities, industrial plants are located within residential areas, water resource protected zones, and tourist areas.

#### *Comprehensive utilization and technical reform*

Generally speaking, the rates of industrial water reutilization is low in China. Owing to out-of-time technologies and old equipments, many valuable resources are lost as industrial discharge. The main measures to diminish the sources of pollution are to implement an effective readjustment and technical reform of industrial plants and enterprises. The authors have suggested the development of a chain of industrial production or a chain of industrial-agricultural production which would operate according to the law of cyclic processes of material and energy in the biosphere. This "chain" would promote the multi-purpose utilization of raw material and would reduce the discharge of waste. That is to say, something is considered as waste when not utilized, but is useful when utilized. An item which is waste in one factory or workshop can be useful in another factory, workshop, or in the countryside (for example wastewater reuse, sewage water irrigation). With the progress of society and the development of science and technology, more and more substances will become useful and can be utilized. Multiple utilization, therefore, has good prospects.

#### *Strengthening environmental management and the legal system*

In China, many water pollution problems are resulted from neglecting management. By strengthening management, we can ensure an honest implementation of policies and laws and can solve some environmental problems with very little money. In recent years, it was demonstrated that much success in protection of water resources has been achieved, not by large amounts of money, but mainly by intensifying aquatic environment management. In the future, the strengthening of supervision and management will be a key to improving environmental protection.

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