9. Administrative countermeasures for measures against eutrophication

To improve the prevention of eutrophication in lakes and marshes, which is developing progressively, each country, including Japan, is conducting various measures. Some representative samples are presented here.

9-1 Measures against eutrophication

9-1-1 Purpose of measures

In the era when the population was small, productive activities were low and people lived in harmony with nature, the natural purification ability was sufficient to deal with polluted water and industrial wastewater. There is an old saying, "Water becomes pure after flowing for three shaku (a Japanese scale, =0.994feet)," which plainly expresses the self-purification action of rivers. Once the amount of pollutants excreted into a water environment exceeds the content of the surrounding environment, environmental problems such as water pollution occur. Generally, the contents of water pollution are diverse. Roughly, there are harmful substances that have an adverse effect on the human body and pollution by pathogenic bacteria. Representative pollutants are harmful substances such as heavy metals and cyan, and infectious pathogenic bacteria such as dysenteriae. Next, there is pollution by organic substances deriving from everyday life and productive activities and discharge from human lifestyles. As a result, these various water pollutions generate phenomena such as river pollutants and bad odors, which consequently worsen the living environment. Nutritional salts continue to flow into closed water areas for a long period, causing the occurrence of red water and influencing drinking water and water products greatly. The situation is considered representative of water pollution as well, along with the phenomenon of eutrophication.

As for the efforts to preserve the water environment in Japan, keen measures have been taken as a socially urgent duty since the intense development of the 1970's. Consequently, for substances directly associated with human health (health items in the environmental standard) such as heavy metals, cyan, organic chloride compounds and agricultural chemicals in public water areas, the non-achievement rate of the environmental standard was 0.79% in fiscal 1995, almost its goal level. However, the achievement rate of the environmental standard for BOD and COD, living environmental items, has not yet been met sufficiently, and there is such a high proportion of pollution loads by lifestyles, commerce, livestock and small-scale factory wastewaters that measures for the reduction of those wastewaters have not progressed. Actually, the achievement rate of the environmental standard in rivers, lakes and marshes, and sea areas was 81.0% (80.9% in fiscal 1997), 40.9% (41.0%) and 73.6% (74.9%), respectively. The rate has not changed greatly over the past several years and that in closed water areas has tended to decrease. In closed basins such as lakes and marshes, bays, and inland seas and small and middle-sized urban rivers, improvement of the water quality is not progressing, and radical measures to reduce pollution loads have become social subjects that require urgent resolving.

In Japan, a main source of pollution loads on the water environment is living wastewater such as cooking, washing, bathing and excrement, and about 60% of the entire pollution loads flowing into closed water areas are derived from the living wastewater. Especially, the pollution loads from living wastewater excluding excrement are so great that the untreated living wastewater released from individual households has become a major factor of water pollution in public water areas. The great pollution loads of the living wastewater are due to small pollution from using a washing system and the fact that a single type private sewage treatment system from which living wastewater is released accounts for a high proportion of the septic tanks used in Japan. However, when measuring the sources of pollution loads not by BOD but by nitrogen and phosphorus, the proportion of excrement is as high as over 80% and over 60%, respectively. Thus, the degree of pollution indicates the importance of Domestic Wastewater Measures.

Besides the measures against the specific pollution loads of point sources represented by household wastewater, those against non-point pollution loads excreted widely from agricultural lands, forests and urban areas are also important. About 20-40% of the entire loads flowing into lakes and marshes is estimated as non-point pollution loads. When considering the high load of household pollution and the current situation where preservation and remediation of the water environment has become an urgent social issue, however, it is necessary to place stress on addressing the major sources of pollution loads.

Moreover, in Japan, in closed water area such as lakes, marshes and bays, the growth of primary products including algae and blue-green algae are promoted by inflow and the accumulation of nutritional salts such as nitrogen and phosphorus derived from household wastewater, and so-called eutrophication is under way. The eutrophication results from the abnormal growth of algae, especially blue-green algae, which causes the occurrence of water-bloom in lakes and marshes, dam lakes, holding ponds, and that of red water in bays and inland seas. Because water-bloom and red water fix and assimilate CO2 gas in the air under a light condition to synthesize organic substances, COD deriving from cells increases in lakes and marshes, which becomes a great factor in the reduction of the achievement rate of the environmental standard in closed water areas. Thus, measures against nitrogen and phosphorus in household wastewater have become a major social issue. Lakes, marshes and dam lakes are sources for tap water in many cases, where various problems including 2-MIB (dimethyl isoborneol) produced by blue-green algae, fungus odor caused by geosmin, disturbed filtration by water-bloom and the production of the precursor of trihalomethane are induced. The occurrence of water-bloom causes bad odor and a worsened landscape, and also causes much damage in the utilization of water.

As for the recent situation of water pollution in public water areas in Japan, because the pollution loads flowing into closed water areas such as bays, inland seas, and lakes and marshes with great pollution sources behind the water areas particularly apt to accumulate pollutants while exposed to the inflow of large pollution sources, the achievement rate of the environmental standard is still lower than other water areas. In addition to this, substances containing nitrogen and phosphorus flow in and other aquatic organisms besides algae grow. Looking at the achievement rate of the environmental standard in these closed water areas in fiscal 1988 by COD, a representative index of organic pollution, the rate in Tokyo Bay and Ise Bay is still low and that in Osaka Bay and Hiroshima Bay of the Seto Inland Sea is also still low (Fig. 9-1-1). The achievement rate in lakes and marshes is especially low, 43%. To deal with such a situation, the further promotion of water preservation measures in closed water areas is required.

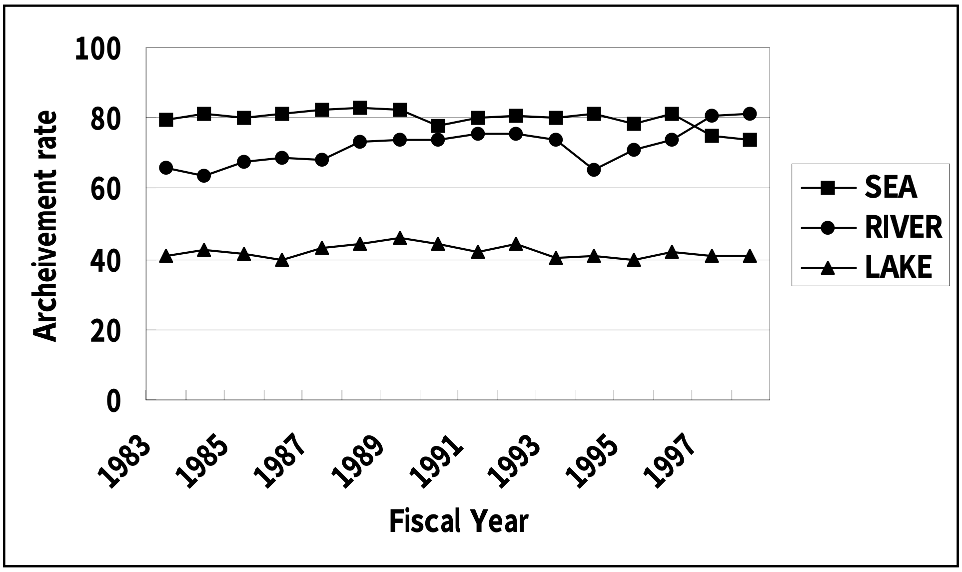

Fig 9-1-1 Succession of Achivement Rate for Environmental Standard in Japan
Succession of Achievement Rate for Environmental S

9-1-2 Outline of measures

Measures against water pollution in Japan are listed chronologically below.

(1) Discussion about the Problem of the Ashio Copper Mine Pollution in the Diet (1891)

(2) Enactment of the Agricultural Chemicals Regulation Act (1948)

(3) Enactment of the Basic Law for Environmental Pollution Control (1967)

(4) Setting of the headquarters for anti-pollution measures and holding a parliamentary session on environmental pollution (1970)

(5) Enactment of the Water Pollution Control Law (1970)

(6) Construction of the Sewage System (1958-1970)

(7) Inauguration of the Environmental Agency (1971)

(8) Enactment of the Law Concerning the Examination and Regulation of Manufacture, etc. of Chemical Substances (1973)

(9) Enactment of the Law concerning Tentative Measures for Conservation of the Environment of the Seto Inland Sea (1973)

(10) Enactment of the Law concerning Special Measures for Conservation of the Environment of the Seto Inland Sea (1978)

(11) Enactment of the Law concerning Special Measures for Conservation of Lake Water Quality (1984)

(12) Setting of a regulation standard for nitrogen and phosphorus related to lakes and marshes (1985)

(13) Amendment of the Law Concerning the Examination and Regulation of Manufacture, etc. of Chemical Substances (1986)

(14) Systemization of the prevention of groundwater contamination (1989)

(15) Systemization of measures against household wastewater (1990)

(16) Enactment of the Environment Basic Law (1993)

(17) Cabinet decision about Basic Environment Plans (1994)

(18) Law concerning Special Measures for Water Quality Conservation at Water Resources Area in Order to Prevent the Specified Difficulties in Water Utilization
(1994)

(19) Law concerning the Promotion of Projects to Preserve Water Quality in Drinking Water (1994)

(20) Strategies for the Purification of Polluted Groundwater (1996)

(21) Amendment of the Waste Disposal (or Management) and Public Cleansing Law (1997)

(22) Amendment of the River Act (1997)

(23) In addition to COD, the Removal Measures for Nitrogen and phosphorus started as the Fifth Total Effluent Control System (2002)

In Japan, water pollution by wastewater and air pollution by smoke from factories occurred due to industrialization during the high economic-growth period, 1955-1970, through the postwar reconstruction period after 1945. Consequently, serious social problems by industrial pollution occurred such as environmental destruction and the disturbance of human health. For example, for water pollution and the disturbance of human health, there was an occurrence of Minamata disease caused by dimethylmercury contained in wastewater from the Minamata factory (producing vinyl acetate) of the Shin-Nihon Chisso Co. in the watershed of Minamata Bay in Kumamoto Prefecture, and Itai-itai disease caused by cadmium contained in wastewater from the Mitsui Kamioka Mine in the watershed of the Jintsu River in Toyama Prefecture. To deal with these pollutions, the Basic Law for Environmental Pollution Control enacted in 1967was amended and strengthened in 1970, and the Environmental Agency was established in 1971. The 64th extraordinary Diet held in 1970 was called the pollution Diet and 14 bills related to pollution were enacted including amendment of the Basic Law for Environment Pollution Control. Thus, the legal system for anti-pollution measures in Japan has almost been established. In the Basic Law for Environment Pollution Control, air pollution, water pollution, soil pollution, noise, vibration, land subsidence and bad odor were positioned as the seven typical pollutions, and the respective related laws were enacted and amended. Among the seven typical pollutions, for air pollution, water pollution, soil pollution and noise, the standard desirable to protect human health and preserve the living environment, namely the environmental quality standard was determined. Moreover, for water pollution, the Water Pollution Control Law was enacted in 1970. Based on the Law, the effluent standard was determined and the emission control over wastewater from factories has been carried out. As a result, water pollution by organic substances and heavy metals derived from the wastewater of factories has definitely been alleviated. However, since more than half a century has passed since the enactment of the Basic Law for Environment Pollution Control, environmental problems have changed greatly in both quality and scale. During this period, the concentration of the population to urban areas has progressed further, and urban life with mass production, mass consumption and mass disposal abolition has settled under a stable economic growth. Consequently, in urban areas, life-style pollution such as air pollution by automobile exhaust gas and water pollution by household wastewater has become serious. In addition to the regional environmental pollution limited to polluted areas, global environmental destruction such as global warming and the destruction of the ozone layer has occurred. The era, where environment problems must be treated beyond one country's boundaries under an international coordination, has come. In such a situation, current environmental problems cannot be treated sufficiently by the Basic Law for Environment Pollution Control, and ideas for environmental measures were determined and the Environment Basic Act prescribing a new framework based on it was enacted in 1993.

The Environmental Basic Act prescribes the basic items of measures to preserve environmental and necessary items to promote the measures comprehensively and systematically under the following three ideas. The basic ideas are: (1) preservation and continuation of the environment formed on ecological balance (the third article), (2) construction of a society, which can sustain development with less loads on the environment (the fourth article) and (3) active promotion of global environment preservation by international coordination (the fifth article). Basic measures for environmental preservation based on these ideas include laying out the Basic Environment Plan (the 15th article), the setting of environment quality standards (the 16th article), laying out environmental pollution control programs (the 17th article), the promotion of Environmental Impact Assessment (the 20th article) and international cooperation for the preservation of the global environment (the 32nd article). To deepen national interest in and comprehension of environmental preservation, June 5 was set as an environmental day (the 10th article).

The Water Pollution Control Law aims at preventing water pollution in public water areas and groundwater by restricting the discharge of wastewater from factories and operation sites to public water areas and water penetration underground, along with promoting the execution of measures against household wastewater. The public water areas referred to in this Act are rivers, lakes and marshes, bays, coastal zones and creeks for irrigation. The wastewater, here, is the water discharged from factories and operation sites (specified operation sites) with specified facilities defined in government ordinance to public water areas. The specific underground-penetrating water is the water penetrating from specified operation sites with specified facilities for the production, use or processing of harmful substances such as cadmium to underground. The government will determine an effluent standard (a uniform standard) for effluent discharged from specified operation sites by ordinance of the Prime Minister's Office. For the areas where the water quality cannot be preserved sufficiently by this standard, the prefectural government can determine stricter standards than the national uniform standard (stringent add-on effluent standards) by individual ordinance (the third article). Moreover, in basins where it is difficult to achieve the environmental standard by only the effluent standard wastewater restricting the concentration, a standard for restricting total pollution loads will be determined (the fourth article). Among the specified water penetrating underground, water containing harmful substances is prohibited from penetrating underground (number three of the 12th article).

Among environmental quality standards based on the 16th article of the Basic Law for Environmental Pollution Control, standards related to water pollution are called the environmental standard of water quality. The environmental standard of water quality is promulgated as a notification by the Environmental Agency, and the current environmental standard of water quality in public water areas has been determined after the amendment in

1971 and at subsequent times thereafter. Moreover, in 1997, the environmental standard of groundwater quality was set. The environmental standards of water quality in public water areas are subdivided into Environmental Quality Standards Related to the Protection of Human Health (health items) and Environmental Quality Standards Related to the Preservation of the Living Environment (items related to the living environment). As for the health items, the standard related to the harmful substances of 23 items including heavy metals such as cadmium and mercury, organochlorine compounds such as trichloroethylene (TCE) and tetrachroloethylene (PCE), and agricultural chemicals such as simazine and thiobencarb has been determined. On the other hand, for the living environmental items, the standards for pH, BOD, COD and others in rivers, lakes and marshes, and sea areas are set with 3-6 steps such as AA, A and B according to the adaptability of the utilization purpose of the basin (type specification). For example, in the case of rivers, the whole watershed is divided into several small watersheds, in which the upper watershed with generally favorable water quality is determined as the AA type, followed by A and B types as the watershed goes down. As such, an achievable standard level is set and after its successful achievement, the types are reviewed to stricter types. As for lakes, marshes and sea areas, from the perspective of eutrophication prevention, the standards for nitrogen and phosphorus have also been set. The environmental standard of ground water is prescribed for health items associated with harmful substances, whose standard items and values are the same as the above.

The effluent standard by the ordinance of the Prime Minister's Office (a uniform effluent standard) is based on the third article of the Water Pollution Control Law and prescribes wastewater from specified operation sites separately for harmful substances and other items. The harmful substances in this effluent standard correspond to the health items of the water environment quality standard, but this effluent standard prescribes the standard value for organophosphorus compounds (4 kinds of organophosphorus insecticides) in addition to the health items. The largest standard values of the items in the effluent standard are set with a 10 times higher concentration than the standard value in the health items of the environmental standard of water quality on the premise that discharged wastewater is diluted more than 10-fold at the discharge point. As for the other items, the standard value of 16 items such as pH, BOD and SS are prescribed. However, this effluent standard is applied to the wastewater from specified operation sites with a mean discharged wastewater level of 50 m^3 or more (not applied to discharge on a smaller scale). There were about 303,000 specified operation sites in fiscal 1996, among which about 38,500 sites (only 13%) had the amount of 50 m^3/day or more. Namely, the standard of discharged wastewater has not yet been applied to many specified operation sites. To improve this situation, some municipalities lower the limit of the regulation of the discharged wastewater level. Also, some municipalities regulate their own effluent standard by adding items of the control subjects by ordinance in addition to the aforementioned stringent add-on effluent standards.

To improve water quality in a wide range of closed water areas, it is important to reduce total pollution loads flowing into the water areas effectively. For that purpose, the Basic Law for Environmental Pollution Control was amended in 1978 to systematize the Areawide Water Pollution Regulation aiming to ensure the environmental standard of water quality in a wide range of closed water areas. Since then, the areawide total pollutant load control has been implemented with chemical oxygen demand as a designated specified item in Tokyo Bay and the Seto Inland Sea.

The first areawide total pollutant load control was implemented with the target year of fiscal 1984. Subsequently, the second areawide total pollutant load control planned and enacted based on the new Fundamental Policy for the Reduction of Total Pollution Load by the Prime Minister was laid out and enacted with the target year of fiscal 1989, and the new Areawide Total Pollutant Load Reduction Plan was laid out and enacted in related prefectural and city governments. In the fifth Areawide Water Pollutant Regulation, nitrogen and phosphorus were newly added to the regulation subject, besides conventional COD. Namely, measures for nitrogen and phosphorus from operation sites and households have taken an important position.

As for measures against eutrophication, the environmental quality standard related to nitrogen and phosphorus, the causative substances of eutrophication, was notified in 1982, and a study for type specification was conducted both nationwide and at the local level. Each type was specified in a total of 44 water areas (40 lakes and marshes) including Lake Biwa (2 water areas) by 1989. The type specification of the environmental quality standard for eutrophication prevention in sea areas was implemented by the Environmental Agency by 1999.

As for measures against eutrophication, the general wastewater standard for nitrogen and phosphorus flowing into lakes and marshes was determined and the effluent control of the wastewater was started in July 1985. In July 1989, some lakes and marshes were added as subjects for regulation of the effluent control. At present, the control is being conducted in 1,066 lakes and marshes for phosphorus and 78 lakes and marshes for nitrogen.

Because lakes and marshes are water areas with a highly closed condition, pollutants accumulate easily and the achievement situation of the environment quality standard is poorer than that in rivers and sea areas. In accordance with eutrophication, various disturbances of water utilization have occurred. Factors causing water pollution in such lakes and marshes vary from industrial activities operated in watersheds with lakes and marshes to people's daily activities. In consideration of the fact that only the conventional regulation under the Water Pollution Control Law is insufficient to preserve the water quality, the Law concerning Special Measures for the Conservation of Lake Water Quality was established in 1984 and was implemented in May 1985. This law intends to preserve the water quality in lakes and marshes; lakes and marshes, where securing the environmental standard of water quality is urgently required, are specified, Plans For the Conservation of Lake Water Quality in the specified lakes and marshes are laid out and projects for the preservation of water quality such as the construction of sewer systems, measures such as regulation against various pollution sources and protection of the natural environment of lakes and marshes are promoted comprehensively and systematically.

Measures against household wastewater based on the Water Pollution Control Law are explained below. Pollution loads on water areas are roughly divided into industrial, household and others. Recently, loads by household pollutant are considered the main pollution source. For example, in Tokyo Bay, about 70% of organic pollution loads are household loads. Although reduction in the loads of wastewater from factories and operation sites is recognized in accordance with strengthened effluent control, because the construction of sewer systems is insufficient, the loads of miscellaneous household effluent from people's daily lives are notable. Especially, kitchen wastewater containing leftovers is estimated to account for 55% of the entire domestic wastewater excluding the wastewater from toilets. Against such a background where the treatment of domestic wastewater is urgently required, in the Environmental Agency, the Guideline on Measures to Cope with Miscellaneous Household Effluent was made in 1988, and the Water Pollution Control Law was amended partially to include measures against domestic wastewater in the Law in February 1990. The main contents are: (1) defining citizens' and administrative responsibility related to measures against household wastewater, (2) promoting systematic and comprehensive measures against household wastewater,

- Environment organic act
  - materialization on November 12, 1993, and proclamation on November 19
- Prescription of the environmental standards (water quality relation)
  - ○ Environmental standards regarding the health of person
  - ○ Environmental standards regarding the living environment
- Water pollution
  - Water pollution prevention law
    - ○ Drainage standard (the addition of regional government)
      - Regulation of a harmful substance
      - Regulation of the pollution of effluent (factory for each type of industry)
    - ○ the appointment of the special institution
  - Lakes and marshes water quality security special measure law, Inland Sea of Japan environment security special measure law
  - Sewerage law
  - Ocean contamination prevention law, Harbor regulation law (discharge regulation etc. of oil) , River law
  - Toxic substance and powerful drug regulation law, Agricultural chemicals regulation law
  - Electricity business law, mine preservation law
- Soil contamination
  - The law regarding the soil contamination prevention etc.

Fig. 9-1-2 Law for water quality preservation in Japan

Table 9-1-1 The law for water management in Japan

The jurisdiction government office； basis law

Prime Minister；

Country comprehensive development law, Country survey law, Environment security law, Environmental standards law, Pollution measure organic act, Countermeasures against calamities organic act, Water resources development public corporation law, Lakes and marshes water quality security special measure law, Lake Biwa comprehensive development special measure law, Seto Inland Sea environment security special measure law, Public civil engineering institution disaster recovery business charge on national treasury law, Heavy snowfall area measure special measure law

Country traffic minister；

Weather business law, Prevention of floods law, Beach contamination prevention and sea disaster regarding the regulation of the picking of the subterranean water for the prevention law, Flood disaster prevention association law, Afforestation and preservation flood control emergency measure law, Special multipurpose dam law, Water resources development public corporation law, Beach law, Surface of the water reclamation law, Sewerage law, Sewerage upgrading emergency measure law, Japanese sewerage corporation law, Purificatory cistern law, Structure such as country traffic minister land organic act, Country comprehensive development law, Water resources development promotion law, Water resources public corporation law, River law, City planning law, Sand arrestation law, Ground sliding prevention law

Environment minister；

Water resources development public corporation law, Industry water for irrigation law, Economy industrial minister industry water for irrigation business law, Water resources development public corporation law, Industry water for irrigation law, Hot spring law, Purificatory cistern law,

Agriculture and forestry marine product minister；

Water resources development public corporation law, Industry water for irrigation law, Forest law, Ground sliding prevention law,

Economy industrial minister；

Industry water for irrigation business law, Water resources development public corporation law, Industry water for irrigation law

Labor Minister of Health and Welfare；

Water supply law, Water resources development public corporation law, Sewerage law, Purificatory cistern law

(3) construction and dissemination of facilities related to the treatment of miscellaneous household effluent and (4) the promotion of public enlightenment. The promotion is expected greatly because of the following reasons: the household wastewater, which had not been considered legally, was included in the Water Pollution Control Law, and citizens may be more familiar with the issue of measures against household effluent because the measures are implemented chiefly by the municipalities. The prefectural governors specify important areas for domestic wastewater measures, based on the Water Pollution Control Law. 171 areas and 414 municipalities in 40 prefectures were specified as of Jan 30, 1998. The legal system related to the preservation of water quality in Japan is shown in Fig. 9-1-2, and the laws related to the water quality issued by the competent authority are shown in Table 9-1-1.

9-1-3 Expected effects of measures

Measures for the conservation of the water quality in closed water areas are conducted mainly in lakes, marshes and sea areas. In the future, to improve water quality, it will be important to spread the advanced wastewater treatment system and make plans to reduce nitrogen and phosphorus and set water quality standards irrespective of water areas. The loads of COD decreased in the three sea areas of Tokyo Bay, Ise Bay and Seto Inland Sea by execution of the first areawide total pollutant control (target year: 1984). However, the water quality did not improve sufficiently. Thus, the second (target year: 1989) and third (target year: 1994) areawide total pollutant controls were implemented, and in 1996, the fourth Plan for the Reduction of Areawide Total Pollutant Load (target year: 1999) was determined. In the third areawide total pollutant control, the goal reduction rate for each different load source was set at 12% for household loads, 9% for industrial loads and 2% for others, and for sea areas, the rates were given as 13% in Tokyo Bay, 8% in Ise Bay and 9% in the Seto Inland Sea, respectively. In the fourth Plan for the Reduction of Areawide Total Pollutant Load, the reduction of the year’s average was intended. As a result of such regulations, the pollution loads in subjected sea areas decreased considerably. Although the occurrence of red water and blue water tends to decrease, the achievement rate of the environment quality standard remains low. The reason for this is attributed to eutrophication. Although the Areawide Total Pollutant Load Control was effective for the reduction of COD, an external load, it didn't lead to a reduction of its internal generation. The COD loads due to internal generations are estimated at 40-60%, and because the reduction of nitrogen and phosphorus will be essential in the future, nitrogen and phosphorus were added as regulation items in the fifth Areawide Water Pollutant Regulation Standard. If various measures function effectively in organic cooperation, the formation of a resource-circulating type society as well as the sustention of its development will be realized. By transferring the environmental conservation and remediation technologies established in Japan to developing countries and feeding back from those countries, a global society coexisting in peace and prosperity can be constructed. As a place to transmit information and develop human resources, there are great expectations for the Bioechoengineering Research Center of the National Institute for Environmental Studies, an independent administrative institution,, and everyone awaits their achievement in the future.

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9-2 Measures against eutrophication in China

9-2-1 Objectives

The land area of China is 9.61 million km^2, which is about 25.3 times larger than that of Japan. China occupies 1/15 of global land area and it is the third in land area, after Russia and Canada. A tenth of the lakes in the world are distributed in China. According to census figures in 1990, the population of China was 1.13 billion, which is more than 20% of the global population. To support this huge population in China, the pollution of China's rivers, lakes and marshes has been increasing due to industrial waste and other waste containing hazardous substances (Table 9-2-1). In consequence of the pollution, the water contamination and eutrophication of lakes has increased at a faster rate and many problems have arisen. The main damages to lakes in China by eutrophication are the following:

1) The eutrophication of the lakes in the suburbs of cities significantly deteriorates the efficiency of water utilization and some lake-water can no longer be used for daily life. The depth of most lakes in the suburbs is shallow and large-scale aquiherbosa have become extinct in such lakes. The development of industry and urbanization has increased the flow of domestic wastewater and the hasty proceeding of eutrophication of algae has caused the eutrophication of the lakes described above. The eutrophication has eliminated the function of the lakes as service water resources and the lakes are now no longer used as water resources. Since the transparency of the lakes has plunged to 0.1 – 0.5 m, and the water has turned to black or brown-green and smells fusty, opportunities for sightseeing have significantly diminished. Moreover, the fishery industry has suffered a great loss due to the death of fish.

2) The development of tourist resources and urbanization near lakes has increased the amount of untreated polluted water and it has accelerated the eutrophication of the lakes. (Ex. The Jingbo Lake in Heilongjiang Province, Dianchi Lake in Yunnan Province, the East Lake in Wuhan Province)

3) Foreign odor and tastes due to the deterioration of filter efficiency caused by a plague of algae have become an

object of public concern. Algae that have bloomed in an intake dam clogged a filter basin of a filtration plant in Fushun city, which wrought great economic loss. Development of eutrophication in the Chao Lake at Anhui Province caused a plague of algae and their consequent elimination was responsible for a disgusting odor. Since the odor still remains after the treatment of a filtration plant, the water is undrinkable and complaints are rife.

Table 9-2-1 The changes in the water pollution index in China

	1983	1984	1985	1986	1987
Chemical oxygen demand	98.82	254.85	296.81	360.57	374.14
Biochemical oxygen demand	52.55	100.14	145.62	152.72	174.42
Ammonia nitrogen	182.14	311.97	377.12	283.34	569.61
Nitrite nitrogen	10.12	94.19	43.36	20.65	24.14
Nitrate nitrogen	0.64	1.26	0	0.15	0
Volatile phenol	155.47	1165.92	588.06	713.67	707.38
Cyanide	1.53	2.99	3.98	3.25	4.89
Arsenic	0	0.1	0.87	2.63	2.55
Mercury	5.92	3	0.22		10.3
Hexavalent chromium	0	0	0	0	0.75
Lead	49.47	29.5	16.66	15.52	4.04
Cadmium	0.66	8.47	0.17	5.53	4.88

4) Some algae in an eutrophicated lake produce toxic substances. If these algae glow in large quantities, the toxic substances produced by the algae could kill domestic animals when they drink the water, and fish will be killed while the toxic substances decompose. It was reported that a lot of domestic animals were killed by drinking the water of Dalai Nur Lake in Hulunbeil, Mongolia. The algae known as toxic algae are *Aphanizomenon flosaquae, Anabaena flosaquae, Microcystis aeruginosa, Anabaena circinalis, Microcystis flosaquae, Gomphosphaeria lacustris, Gloeotrichia echinulata, Lyngbya contorta* etc. Besides this problem, there are many influences such as the radical reduction of the number of fish and water organism species, extinction of high grade fish, and decrease of water resources caused by a build-up of sludge at the bottom of lakes, which silts up the lakesso forth. For example, the Ci Lake in Huangshi, the Hillside Lake in Guangzhou, the Lake Wuliangsuhai in INNER MONGOLIA, and the Nansihu Lake in Shandong have suddenly become shallow. On the other hand, lakes in plateau areas have not yet been affected, probably because these areas have not been so affected by human activities.

The development of the eutrophication of lakes in China is a serious situation and development of laws and implementation of measures are urgent.

9-2-2 The general outlines of the measures

Protection and improvement of the environment are one of the basic policies in China and Article 11 of the

Constitution stipulates that the nation protects environment and natural resources and controls and prevents environment pollution and other kinds of pollution. To control the eutrophication of lakes: 1. Preventive measures, 2. Comprehensive measures, and 3. Proper management of lakes is required.

(1) Preventive measures

(1) Biological septic lagoons are installed at the vents of sewage-treatment plants to eliminate nitrogen and phosphorous by using the functions of water organisms efficiently. (2) Some factories near lakes have moved or closed. (3) Equipment that prevents oil leakage from ships has been installed to reduce oil contamination. (4) Sludge of fish firms in lakes is dredged away to decrease the digression of nutritive salt. (5) Protection of agroecosystem of lakes is required. (6) Afforestation and protection in areas surrounding lakes, and prevention of sediment discharge are required. (7) Administrative structure of lakes is required. (8) Development should be observed. In addition, water quality standards that vary related to the function of lakes need to be established for the partial improvement of water quality. Water quality standards have been established for Lake Gucheng in Jiangsu Province. The standards are different according to the functions of each area of the lake such as water source area, aquaculture area, and wastewater inflow area. Small lakes also require an adequate water quality standard depending on their main function. For example, the main function of the Mi Yun Reservoir in Beijing, Yuqiao Reservoir in Tianjin, and the Chao Lake in Anhui is regarded to be water resources for drinkable water. The main function of the Xuanwu Lake in Nanjing, the West Lake in Hangzhou, and the Jingbo Lake in Heilongjiang are mainly regarded as tourist resources. The Dudu Lake in Hangzhou etc. is mainly regarded as fishery waters (aquiculture using wastewater) and it has no function as either a water resource or a tourist resource. Moreover, the measures to reduce the degree of eutrophication are implemented which harness the ecological environment of lakes. At the Changchun South Lake and the Xuanwu Lake in Nanjing, aquiculture is performed utilizing their high degree of eutrophication and at the same time, measures to remove nitrogen and phosphorous from the water utilizing harvesting aquatic plants are also implemented. At Lake Gucheng, submerged plants are preserved to control the conversion to phytoplankton (algae) type of eutrophication.

(2) Comprehensive measures

The measures for the preservation and improvement of water quality of lakes can be listed according to the process of water pollution that is Source – Reach process – Deterioration of water quality in lakes: (1) Measures for pollution source, (2) Measures for controlling wastewater load, (3) Measures for the reach process, (4) Technologies for the improvement of water quality of lakes, and (5) Others. Results when some measures are implemented may differ depending on the features of each lake. Therefore, it must be noted that technology that is effective for one lake may have no effect on anotherlake. It is important to establish a systematic procedure to select an adequate control method considering the characteristics of lakes similar to the characteristics of the catchment area, hydraulics, water quality, and biotic factors. Comprehensive study is required that focuses on the response mechanism of lakes to the conservation measures for water quality and its control factors through experiments and case studies. Since nutrient salts in wastewater are point sources, it is easy to control compared to fields that are real sources. This is why the importance of denitrogenation and dephosphorization of wastewater has emphasized recently. General methods to reduce nutrient salts flowing into lakes are: (1) High-order treatment (Tertiary treatment) of wastewater (removal of nitrogen and phosphorus,) (2) Alternation of flow paths, (3) Alternation of the method of land utilization, (4) Treatment of river water flowing into lakes, (5) Banning the use of synthetic detergents, and others. Methods to remove the nutrient salts, which already flow into lakes, are; (6) Removal of the nutrient salts resolving into water, (7) Dredging and containment of sludge, (8) Dilution and drawing off water of lakes, (9) Mowing algae and aquatic plants etc. In addition to these measures, symptomatic treatments to maintain eutrophicated lakes at a certain degree of good condition are (10) Treatment using algicides or chemical herbicides, (11) Artificial aerification and circulation and so forth. China has taken measures against eutrophication at important lakes (The West Lake in Hangzhou, The East Lake in Wuhan, the Changchun South Lake etc.) (1) Reduction of wastewater flowing into lakes. Sanitary sewers of 9.1 km were laid down along the west side of the West Lake to drive the wastewater that should have flowed into the lake to a sewage-treatment plant. It eliminated almost all loads from point sources and most loads from area sources. Likewise, in the Changchun South Lake , the pollutional load of the lake was reduced to 26%, and the amount of nitrogen and phosphorous was also reduced by half. (2) Exchange of lake water by feeding clean water and the control of the accumulation and elution of nitrogen and phosphorous from sludge. The water of the Qiantang River (one of the tributary rivers of the Yantze River) is feeding into the West Lake (the amount of feeding water per day is about 1/33 of the total pondage of the lake,) and it greatly changes the water quality of the lake. However, as this kind of project needs a lot of funds, it is possible to apply only important areas. (3) Sediments and sludge of lakes in which nutrient salts are inactive include a great amount of nitrogen and phosphorous and there is the possibility of elution of the substances under an anaerobic condition. Therefore, in some cases, even the source is eliminated, eutrophication is still advanced because of the sludge. The sludge needs clearing out of lakes and could be used as fertilizer for agricultural land. (4) According to the experiments of removal of nutrient salts by using water organisms, Indian lotus reduces T-P from 1.00 mg/l to 0.33 mg/l and T-N from 3.89 mg/l to 0.8 mg/l in an eutrophicated lake. Phragmites, cattail, and water chestnut have a high absorption capacity of nitrogen and phosphorous. The contents of nitrogen per dry weight of phragmites and cattail were 1.176%, and 1.708%, and the contents of phosphorous were 0.264%, and 0.298% respectively. Mowing of these kinds of large aquatic plants could reduce the loads of nitrogen and phosphorous. At Lake Wuliangsuhai in INNER MONGOLIA, 300 km^2 of uliginous phragmites and 100 km^2 of submerged plants absorbed a lot of nutrient salts that come from pastureland and these plants were used as fertilizer after mowing. This enabled the reduction of nutrient salts and the livestock industry at the same time. The measures of reduction of nutrient salts by using water organisms are also applied, and the method of using spirals that consume soluble nutrient salts and algae are effective for purification. (5) Few sewage-treatment plants perform tertiary treatment and the diffusion rate of the sewer system is less than 2% in China. Most sewage-treatment plants in cities use the activated sludge process, but this process requires high energy and high construction cost and it is susceptible to many factors. Technologies of the oxidation pond and oxidation ditch are also used for swage treatment. Rotating biological contactor (RBC) is used for industrial wastewater treatment in dyeing, paper manufacturing, the leather industry, and the petrochemical industry but few are applied to human sewage treatment. Treatment using anaerobic microbes for concentrated organic industrial wastewater produced by fermentation industries (wastewater of alcohol, beer, chemical additive, starch, lemon acid and others), paper manufacturing, sugar manufacturing, and the leather industry have been studied. This method is effective for measures for pollution control and energy saving. Biological treatments (oxidation ditch, two-step aeration, technology of dephosphorization and denitrification of city wastewater, and treatment method using enhanced absorption organisms) have also been studied. These treatments require less energy, few construction costs and easier operation than the activated sludge method. The Tianjin Jishuangzi sewage-treatment plant having 0.26 million $m^3 \cdot d^{-1}$ throughput was built in the early 80s' and then the construction of large scale sewage-treatment plants were implemented in Dairen, Guangzhou, Chengdu, Xiamen, Kunming and others. The researches of sewage treatment technologies (methane septic tank, oxidation tank, soil-crops system etc.) that combine natural biological purification methods based on natural purification and artificial biological purification methods have been studied. Enforcement of legal system is required so that factories must treat their wastewater to meet the effluent standard before draining away to the city sewerage system. The implementation of secondary and tertiary treatment of city sewage will also be important in the future. Catalytic oxidation method combining biochemistry and the technology of physicochemistry has been studied to apply to the treatment of industrial wastewater. The applications of reverse osmosis and ultra filtration to the treatment of industrial wastewater of dyeing, paper manufacturing, and the photograph industry are also being investigated. Oxidation pounds, oxidation ditches, and soil treatment have been introduced for dephosphorization and denitrification. Yunnan has introduced the oxidation ditch method to remove nitrogen and phosphorous from water flowing into lakes and it is having some effect. Many cities don't have sufficient water resources. Therefore, it is essential to control water pollution and preserve water resources. Conserving water, controlling sewage and wastewater, and reasonable utilization of water resources are fundamental measures for the improvement of water quality and the shortage of water resources. For example, the reduction of water consumption, control of the amount of wastewater and its quality, treatment of wastewater, introduction of sewage treatment system to cities, and the technical improvement of sewage disposal facilities are under consideration.

(3) Proper management of lakes and marshes

Every organization, individual, and society as a whole has the responsibility to prevent eutrophication and the elimination of nutrient salts. The Chinese government has made efforts in the management of lakes and marshes to prevent eutrophication based on this awareness. Beijing issued "The Mi yun Reservoir's Water Resource Conservation Regulation," Kunming issued "The Lake Dianchi Conservation Regulation," Nanjing issued "The Xuanwu Lake Pollution Wastewater Standards," Shandong established "The Nansihu Lake Environment Management Office," and Huangshi issued "The Ci Lake Conservation Regulation" for comprehensive management of eutrophication. Among these measures, comprehensive measures and management of the West Lake in Hangzhou was the most effective and showed characteristic changes. They have conducted water from the Qiantang River, tried to reduce feeding water, implemented the dredging of sludge, and strictly regulated the construction of factories. More than 20 factories polluting water were moved or closed. In addition, the management of tourist industry (changed the motor power of tour boats from oil to electric,) and the management of aquiculture (restriction of feeding and breeding) have been implemented. Comprehensive management is effective to control eutrophication. Since the Chinese government delegation attended the United Nations Conference on Environment and Development in 1972, the environment protection process has accelerated rapidly in China. The environment protection process reached a new stage after the "Environmental Protection Law of the People's Republic of China (tentative)" was declared at the 11th conference of the 15th Standing Committee of the National People's Congress on September 13 in 1979. Environmental conservation has become one of the fundamental policies of the Chinese government. The condition of the environment has deteriorated less and become more stable in the last decade, although the GNP of China has more than doubled. The main factor of this result is the reinforcement of the environmental standard system, environment management, and environmental education.

Environmental standards in China prescribe the requirement of unification of related technologies for the prevention of pollution and ecosystem disruption, and health maintenance. It is fundamental to enforce all environmental laws as well as concrete technological measures of national environmental policy. The environmental standards are categorized by their function and target: (1) environmental quality standards, (2) polluted matter emission standards, (3) environmental protection equipment standards and methodology, (4) criteria for sample and its base standard. The environmental quality standard is a main standard that prescribes regulations and limitations of toxic substances and factors in the environment with consideration for technical and economical conditions for to sustain people's health, preservation of the ecological system, and protection of public property. The effluent standard of polluted matter that is an important index to restrict the discharge of polluted matter (or harmful substances) for the preservation of the environmental quality is grounds for environment management and supervision.

Environmental standards are classified into national environmental standards and rural environmental standards according to the application range and jurisdiction. The national environmental standards are the nationwide (or for specific areas) requirements related to unified environmental protection technology. The rural environmental standards are requirements related to unifying environmental protection technology for provinces, autonomous regions and demesnes (or specific areas). They were established in consideration of rural environmental function, polluting condition, characteristics of geography, organization, and ecological system, and rural economical and technological condition. China has implemented the nationwide standardization of environmental standards since the government published the first environmental standard "Tentative Standard on Industrial 'Three Wastes' (Wastewater, Waste Gas, and Waste Material) Discharges" in 1973. The environmental standards have been expanded from simple emission standards to a systematic environmental standard system including environmental quality standards, polluted matter emission standards and methods, base and sample standards. These standards play a big part in the control of environmental pollution, the reinforcement of environmental management, the improvement of environmental quality and others. The environmental standards that China had established grew from 263 items in 1992 to 325 at the end of 1994, which is a 62 item increase. In 1992, 31 items were newly established. A breakdown of environmental standards until 1994 shows: 10environmental quality standards, 59 polluted matter emission standards, 183 analysis methods, 29 standard samples, 7 basic indexes, and 22 other items. These environmental standards are classified by types of polluted matter: water, which is 153 items, makes up 58.2%, air, which is 58 items, makes up 22.1%, noise and vibration, which is 14 items, makes up 5.3%, waste material, which is 18 items, makes up 6.8%, radioactive substances, which is 12 items, makes up 4.6%, and others, which is 8 items, makes up 3% of the standards. Local governments such as province, autonomous regions, demesnes also establish many rural standards according to their characteristics. Scientific researches of environmental standards and educational campaigns have been conducted and have shown great results. The establishment and modification of environmental standard and the development of human resources for research and management that play an important role in standardization of the environmental standard and environmental management are being implementing. Water environment standards are divided into national and rural. The national water environmental standards examined and announced by the State Environmental Protection Administration of China are the indexes used nationwide or in specific areas. It is also a guideline for rural standards. The rural water environmental standards having regional characteristics are the indexes used in prescribed areas and complement the national standards and makes the concept concrete. According to the standardization of administrative regulations published by the Chinese State Council, rural standards should be harmonized with the national standards and it should stay within the range of the national standards. The water environmental standards prescribes the limitation of toxic substances and their sources for the prevention of pollution of rivers, lakes, marshes and sea, the protection of human health, the preservation of aquatic ecological system, the effective utilization of water resources, and the development of industry, agriculture, livestock, and fishing.

The water environmental quality of China is divided into 6 categories according to its function, management, water quality, and intended purpose. Water quality standards are established for each function: a) Nature preserve; protective zone with overriding priority for natural resources and precious animals and plants, which is established by nation or local governments; b) Areas of water resources for drinking water; water resources for drinking and their protective zones including water for people and livestock in firms; c) fishing zone; spawning, feeding, overwintering, and aquaculturing zones, migratory fish path for every fish and shellfish; d) waters for recreation and sightseeing; the areas that the nation preserves and rural areas for sightseeing, swimming and other water sports; e) waters for industrial use; supply source of industrial water; f) waters for agriculture; irrigation water, and supply source of forestry and livestock industries and soil treatment.

As described above, China established 313 items of the standards until the end of 1993, many of the standards are the environmental quality standards and emission standards related to water and air. This section introduces the feature of 8 standards related to water pollution: “Standard on Industrial ‘Three Wastes’ Discharges”; “Standard for Comprehensive Drainage of Sewage”; “Environmental Quality Standard for Surface Water”; “Drinking Water Quality Standards”; ”Standards for Irrigation Water Quality”; ”Water Quality Standard for Fisheries”; “Sea Water Quality Standard”; and “Water Quality Standard for Recreation Area”.

The Standard on Industrial ‘Three Wastes’ Discharges” was established based on the Tentative Standard on Industrial ‘Three Wastes’ (Wastewater, Waste Gas, and Waste Material) Discharges Promulgated by the State Planning Commission, the State Capital Construction Commission, and the Medical Department in November, 1973 before the establishment of the “Environmental Protection Law.” This standard was established for the prevention of air, water, and soil pollution, the protection of human health, and the development of industry and agriculture. For the waste gas, 13 toxic substances are designated tentatively according to the degree of damage to human health defined in Article 10. For the wastewater, the maximum allowable emission standards for toxic substances are classified into 2 categories. The first category contains toxic substances having long-term effects that could accumulate in the body of animals, plants, or the environment. The second category contains toxic substances having less long-term effects to the human body. For waste material, Articles 17, 18, and 19 regulate the reduction of discharge waste material and restrict dumping areas only at the regulated places for the prevention of the air, water resources and soil pollution. Materials including mercury, cadmium, arsenic, sexivalent chrome, lead, white phosphorus, cyanide, or other soluble toxic substances must be kept in specific treatment facilities to prevent leaking of the substances to ground water.

The Standard for Comprehensive Drainage of Sewage was published by the State environmental protection administration of China in April, 1988 and put it in force on January 1 in 1989. The purpose of this standard was the prevention of water pollution, the preservation of good water quality of surface water and ground water such as rivers, channels, lakes, marshes, reservoirs, sea, the protection of human health, the conservation of the ecological system, the development of the national economy, and the acceleration of urban construction. This standard is applied to all companies and organizations in China that discharge wastewater and sewage. The standard for swage flowing into surface water and the city sewerage system is categorized into the 1st, 2nd, and 3rd-class standards according to the purpose of surface water and the place of discharge. The categories of the standard are as follows; (a) Special preserved waters, 1st and 2nd-class waters of the environmental quality standard for surface water. For example, new construction of vents for discharging wastewater is prohibited, and existing companies discharging sewage have been strictly supervised by local environmental preservation departments to maintain the water quality of the first class preservation areas of the water resources for drinking water, priority waters for sightseeing designated by China, preservation areas of rare species of fish, the waters for aquaculture, and swimming beaches. (b) Priority preservation waters. The first grade standard is applied to wastewater discharging into 3rd-class waters of the environmental quality standard for surface water and 2nd-class waters of the sea water quality standard. (c) General preservation waters. The second grade standard is applied to wastewater discharging into 4 and 5th-class waters of the environmental quality standard for surface water and 3rd-class waters of the sea water quality standard. (d) The third grade standard is applied to wastewater discharging into city sewerage systems having secondary biological treatment. (e) The first or second grade standard is applied to wastewater discharging into city sewerage systems without secondary biological treatment based on the regulations described (b) and (c). The standard value of wastewater discharging is classified into 2 categories according to its property. The first category of polluted substances, which are toxic substances accumulating in the body of animals and plants, or environment, and having long-term adverse effects on human health. The sample of the wastewater containing toxic substances from treatment plants must satisfy the concentration of maximum allowable emission standards irrespective of the type of industry, and the methods and places of emission. The second category of polluted substances, which are toxic substances having less adverse effects than the toxic substances in the first category. These must satisfy the standards according to its kind of industry and others. Some industries such as oil resource development, light manufacturing, hospitals have their own standards for wastewater.

The Environmental Quality Standard for Surface Water published on September, 1983 and put in force since January 1 in 1984 was revised in June, 1988. It regulates the Environmental Preservation Law and Water Pollution Control Law for the control of water pollution and preservation of water resources. This standard is applied to rivers, lakes, marshes and surface water that can be used for reservoirs etc. in China. This standard is divided into 5 categories according to the intended purpose of surface water and the target of preservation(Table 9-2-2) .

Table 9-2-2 Environmental Standard for Surface Water in China

(unit : mg/l)

Item		class I	class II	classIII	classIV	class V
Basic environmental condition		All water is never permitted to introduce by artificial causes the materials described below; ・harmful sediment forming materials ・suspended solid, flagment, broken piece, oil, and so on ・bad color, odor, taste, turbulamce ・harmful materials for human, animals, plants ・materials introducing toxic aquatic creatures				
water temperature (℃)		The limit of water temperatute change by artificial causes is described as below; Maximum increase range in summer is under 1℃ Maximum increase range in winter is under 2℃				
pH		6.5～8.5				6～9
nitrate[a)] (SO_4^{2-}conversion)	<	250	250	250	250	250
chloride[a)] (C^{l-}conversion)	<	250	250	250	250	250
dissolved Fe[a)]	<	0.3	0.3	0.5	0.5	1.0
total Mg[a)]	<	0.1	0.1	0.1	0.5	1.0
total Cu[a)]	<	0.01	1.0 (fishing 0.01)	1.0 (fishing 0.01)	1.0	1.0
total Zn[a)]	<	0.05	1.0 (fishing 0.1)	1.0 (fishing 0.1)	2.0	2.0
NO3-N (N conversion)	<	10	10	20	20	25
NO2-N (N conversion)	<	0.06	0.1	0.15	1.0	1.0
NH_3-N	<	0.02	0.02	0.02	0.2	0.2
Kerdale-N	<	0.5	0.5	1	2	2
T-P	<	0.02	0.1 (lake 0.025) (dam 0.025)	0.1 (lake 0.05) (dam 0.05)	0.2	0.2
permanganate index	<	2	4	6	8	10
dissolved oxygen	>	saturation 90%	6	5	3	2
COD_{Cr}	<	15	15	15	20	25
BOD_5	<	3	3	4	6	10
fluoride (F^- conversion)	<	1.0	1.0	1.0	1.5	1.5
Sl	<	0.01	0.01	0.01	0.02	0.02
total As	<	0.05	0.05	0.05	0.1	0.1
total Hg[b)]	<	0.00005	0.00005	0.0001	0.001	0.001
total Cd[c)]	<	0.001	0.005	0.005	0.005	0.01
Cr6+	<	0.01	0.05	0.05	0.05	0.1
total Pb[b)]	<	0.01	0.05	0.05	0.05	0.1
total cyanide	<	0.005	0.05 (fishing 0.005)	0.2 (fishing 0.005)	0.2	0.2
phenol[b)]	<	0.002	0.002	0.005	0.01	0.1
petroleum[b)]	<	0.05	0.05	0.05	0.5	1.0
anion surfactant	<	0.2	0.2	0.2	0.3	0.3
total E.coli[c)] (N/l)	<	-	-	10,000	-	-
benz (a) piren[c)] (μg/l)	<	0.0025	0.0025	0.0025	-	-

a) adjusted by characteristics of background of each water area in local government
b) not archeived the standard level by standard analysis method
c) test pilot standard

Category 1; water resources, and national nature preserve. Category 2; the first grade intensive preservation areas of water resources for drinking water, the preservation areas for rare fish, spawning grounds for fish etc. Category 3; the second grade intensive preservation areas of water resources for drinking water, general preservation areas for fish, and swimming areas. Category 4; the areas for general industrial water and recreation areas having no contact with people. Category 5; agricultural water and general areas for sightseeing. In the case of having some functions in the same area, it is classified in the highest category, and if the function varies with the seasons, it is classified in adequate category according to the season.

The Drinking Water Quality Standards was published by the State environmental protection administration of China in August, 1985, and put it into force in October 1 in 1986. It was established to conserve the quality of drinking water, hygiene of water resources, to select water resources, and to meet hygiene demands. It has been applied to central and distributed water supply of domestic non-commercial water in cities and rural areas.

The Standards for Irrigation Water Quality was published in January, 1992, and put into force in October in the same year. This standard is based on the Environmental Preservation Law was established for the prevention of soil, water, and agricultural product pollution, the protection of human health, the conservation of ecological system, the promotion of economical development. The scope of application of the standard is surface water, ground water, treated wastewater, and agricultural irrigation water using industrial wastewater. Agricultural irrigation water using treated sewage coming from factories that produce biological or pharmaceutical products, chemical regents, agricultural chemicals, petrochemical products, and organic compounds stand outside the scope of the application. The standard is divided into 3 categories. Category 1: paddy field. For example, paddy rice, irrigation water 12000 m^3 / year / ha. Category 2: dry field such as wheat, field corn, and cotton. Irrigation water, 4500 m^3 / year / ha. Category 3: vegetables such as Chinese cabbage, green chive, onion. The amount of irrigation water varies according to the vegetable.

The Water Quality Standard for Fisheries was published on August 12, 1989, by the State environmental protection administration of China and put into force on March 1, 1990. This standard was established according to the Environmental Preservation Law, the Water Pollution Control Law, the Maritime Environment Protection Law, and Fisheries Law for the prevention of water pollution of fishery waters, the conservation of normal growth and breeding of fish, shrimp, shellfish, and seaweed, the maintenance of fish catches. This standard is applied to spawning and feeding grounds, wintering spots, migratory fish paths, aquaculturing waters, and freshwater fishery zones. Regulations for the preservation of water quality for fisheries are following: (a) Every industrial wastewater from companies and organizations, domestic wastewater, and hazardous waste must meet this standard. (b) Discharge of untreated industrial and domestic wastewater to spawning and feeding grounds, wintering spots, aquaculturing waters and others is strictly prohibited. (c) Discharge of wastewater containing pathogenic organism is strictly prohibited. When this kind of wastewater is discharged, it must be sanitized and treated properly.

The Seawater Quality Standard was published on April 6, 1982 and put into force on August 1 in the same year. This standard was established for the control and prevention of seawater pollution, the protection of human health, the preservation of sea life and resources, the conservation of ecological system, and the rational development and utilization of ocean. The scope of application is sea area being under the jurisdiction of China. There are 3 categories of seawater quality according to its purpose, and water quality demand. Category 1; for the preservation of sea life and resources, safe utilization. (Water for salt field, food processing, seawater desalination, fishery industry, and aquaculture etc.), and sea nature preserves. Category 2; for swimming beaches, sightseeing and recreation areas. Category 3; for general industrial water, waters of port entrance, and ocean development areas.

The Water Quality Standard for Recreation Area was published by the China State Bureau of Quality and Technical Supervision and the State environmental protection administration of China on March 18, 1991 and put into force on February 1, 1992. This standard is based the Water Pollution Control Law and the Maritime Environment Protection Law is for the improvement of scenery, the preservation of water quality for recreation, the recovery of water quality of natural ecosystem, the promotion of tourism. The scope of application is rivers, lakes, marshes and part of sea using sightseeing, recreation, and recuperation. This standard is categorized into 3. Category A; Natural bathhouses, and waters for sightseeing and recreation where people directly contact with water. Category B; National intensive sightseeing and recreation areas and waters for sightseeing and recreation where people don't contact with water. Category C; General waters for sightseeing and recreation.

In addition to those standards, many discharge standards, criteria of methodology and others have been established by contamination and industry. The collection system of pollutants emission cost, which is one of the environmental administrative management system in China defines the collection standards for wastewater, waste gas, and waste material.

9-2-3 Expected achievement

The main factor of the progress of water pollution in China is sulfur oxides (SOx) discharging from flues into the air as well as clay soil, notably the Yellow River. SOx discharging to the air dissolves in rainwater and then flows into rivers, lakes and marshes. PH decrease caused by SOx turns the lakes, marshes and rivers into acid lakes, marshes or rivers and has a great effect on ecological system. It was reported that 30% of acid rain falling in areas along the Sea of Japan comes from China. Therefore, Japan having advanced technology with abundant funding shouldn't ignore the miserable state of China. Transfer of technology from Japan is an essential factor.

Over 20 years, China has put considerable effort into environmental preservation projects and yielded great results in this difficult situation. Many countries have suffered economic depression though, industrialization and economic expansion have rapidly developed in China. Economic growth rate of China is 7% in 1991, 12.4% in 1992, 13.4% in 1993 and 11.8% in 1994, which shows significant growth. However, this significant growth produces serious environmental pollution issues arising from industrialization, which developed countries experienced before. The reinforcement of environmental policy and administration has been implemented, however, many problems still remain and economic loss caused by environmental pollution reaches 100 billion Yuan (about 1.5 trillion yen) every year. 22% of the world population is supported by only 0.7% of the cultivated acreage in China. 0.086 ha, which is average demesne for each person in China, is far smaller compared with the global average 0.3 ha. Although the population of China has increased by over a hundred million in recent decades, the cultivated acreage has decreased by an average of 0.3 million ha annually (run-off 31%, salination and turned into bog 18%, desertification 5%.) The current average cultivated acreage for each person has reduced by half the acreage of 50 years ago. Even land, which isn't cultivable, has been cultivated as the population increases and it causes many run-offs or flood disasters. In addition, the development of economy and industry has produced environmental issues such as acid rain and water pollution. Since the Earth Summit (UNCED) was hold in Brazil in June 1992, environmental issues have become international issues regardless of countries. Environmental issues of East Asia have significant meanings in terms of the global environment and regional environment from the international viewpoint. Therefore, the environmental issues of China having a population of 1.2 billion, which is the largest in the world, has come to international attention. The GNP (gross national product) of China was $ 370 per head (as of 1992) that is much less that that of developed countries like Japan. The area of cultivated land, grassland, and forests are 1000 m^2, 2860 $m^2$and 1200 m^2 respectively, which are only 27%, 38%, and 12% of the global averages. The amount of surface water for each person in China is 2700 m^3, which is 25% of the global average, on the other hand, the population has been increasing 17 million every year, which is almost same as the population of Australia. China has endured trials and tribulations such as the lack of funds, environmental technical capabilities, and labor under the pressure of a huge population. To support further development of the economy and the increase of population, environment conservation and measures are essential issues. It has been pointed out that the environment will deteriorate if only 0.5% of the GNP is invested in measures for environmental conservation, it will maintain the status quo if 1% of the GNP is invested, and it will improve if 1.5% is invested. There has been a growing interest in pollution control and water environmental preservation recently however, the investments in environment are still not enough. The environmental standards, which are effective measures to prevent environmental pollution, play an important role in promoting the environmental policy and environmental management. Thorough the implementation of environmental standards, environmental policy responding to Chinese circumstances, legal administration and certification will be further required in the future. Future development of environmental issues and policy in China must have great influence to global environment as well as Asian environment due to its potential amplitude of pollution source. Therefore, China is required to make greater efforts to improve its environmental policy and administration, and enhance environmental education and researches for solving the environmental problems as a member of .the developing countries. At the same time, as international cooperation is also essential, the cooperation of Japan in technology, funds, and experience, are expected. International cooperation needs mutual understanding about every environmental problem among countries. Economic support, and the international exchange and support of labor and techniques from developed countries are needed more than ever. The cooperation and leadership of the neighboring country Japan, an advanced country in pollution prevention is fundamental.

The current situation of the water environment in China is widespread organic pollution in main rivers and aggravated eutrophication in lakes and marshes. The quality of ground water has slightly improved or in stable condition in most part of China, however, the quality of ground water in some cities has deteriorated. The major part of Chang Jiang and northward suffered spring drought in 2000, and spring of 2001 that was the worst drought of the decade. The drought-affected regions were 22 provinces, autonomous regions and cities and the area reached 20.67

million ha in short term. More than 20 million people were short of drinking water. It demonstrated afresh that China has come under threat of water shortage. The amount of water resource in China is one of the 13 countries at the lowest level, and water resource for each person is a quarter of global average. China ranks number 121 in the world in terms of water possession. The imbalance of precipitation and the rainy season accelerates the water shortage. The water shortage has become a big threat against the ongoing China West Development and future economical development as the economy and life of the people have improved.

There is the danger that the deterioration of the water environment will worsen the water resource shortage. Future development of environmental issues and policy in China will have great influence on the global environment as well as Asian environment due to its potential amplitude of pollution source. Therefore, it is required that China should make greater efforts to improve its environmental policy and administration, and enhance environmental education and researches to solve the environmental problems as a developing country. In addition, international cooperation such as technology transfer related to environmental preservation from advanced countries is also required.

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9-3 Eutrophication strategies in the U.S.A.

9-3-1 Purpose of the strategies

To organize the social system to maintain a water environment, using water at a high degree, the plan must be made with consideration given to the major circulation cycle of water and the water-use cycle in urban and rural areas. River water is used for agriculture and industry, and moreover, for human lifestyles. After use, the polluted water is returned to the rivers again. Besides that water, livestock-related wastewater and polluted substances deriving from forests also flow into the rivers. The pollution of the rivers caused by these influences the ecological system, and also has a great influence on human health, because the downstream water may be used as drinking water. To minimize these influences, daily living-related drainage is released into the river through sewage-treatment plants, and factory-related drainage is recycled after treatment within the factory. Moreover, in office buildings in urban areas, suppression of the wastewater amount and reduction of the pollution load is made by the circulatory use of water. Since the river has natural purification (self-purification effect), making the best use of these actions is also effective for reducing the influence of pollution. However, it is necessary to make an integrated plan in which individual strategies are connected systematically, as the whole watershed is taken into consideration, and these strategies are not carried out separately. In this paper, the legal system of water-environment management in the U.S.A. is explained and the protection of the natural environment in the Everglades marshland basin is discussed along with the wide-range water environment or circulation recovery projects, which have been promoted by the Southern Florida Water Management Bureau, in Florida state.

9-3-2 Outline of the strategies

Among the Acts concerning the protection and preservation of water areas in the U.S.A., the historical shift related to rivers and water areas is summarized as follows:

* Rivers and Harbors Act (1899): A federal Act enacted for management and the preservation of water areas to promote the first commercial activity in the U.S.A.
* Water Pollution Control Act (1948): An Act systemizing technical supports and grants for the preservation of water quality in States and local autonomous entities.
* Water Quality Act (1965): An Act imposing on States to set a standard of water quality, which is related to sailing among States.
* The Clean Water Act (CWA) (1972): Understanding biological, chemical and physical factors in water areas, it presents goals for the preservation and repair of water areas. Moreover, with the reinforcement of the standard of water quality, a huge revision was made in 1977. However, this Act is more important for basically preserving water quality in the U.S.A. In this Act, the drainage permission system and the promotion of constructing sewage-treatment plants are prescribed. Strictly speaking, this Act has taken effect as the "Clean Water Act" in the United Code Title 33 Navigation and Navigable Waters Chap.26 Water Pollution Prevention and Control.
* Clean Water Act Amendments (1977): In this amendment, the enforced management of toxic substances and the State's responsibility for the water quality preservation programs by the Federation are clearly described.
* Water Quality Act (1987): Revision of the CWA has been made in connection with this Act. Consequently, it has

been decided to promote strategies against the outflow of pollutants during rain, the establishment of financing grants for the construction of treatment plants, understanding of urban non-point pollution problems, the preservation programs of low-water areas and others, which are necessary to achieve the goals of water quality.

* Safe Drinking Water Act Amendment (1996): The U.S.A. Safe Drinking Water Act enacted in 1974 was greatly revised. In this amendment, new approaches and efforts for the preservation and protection of water sources are prescribed. These approaches and efforts will be carried out in an integrated manner with the prevention of the pollution of water quality and the Clean Water Program in CWA.

Table 9-3-1 Achievement of purification of water quality 25 years after CWA enactment

Items	1972	Present
Basins suitable for fishing and swimming	1/3	2/3
Reduction rate of marshland area (areas / year)	460,000	70,000-90,000
Corrosion rate of soil (10 n / year)	2.25 billion	1.25 billion
Population using sewerage (10,000 persons)	8,500	17,300

Next, the outline of the Clean Water Action Plan is summarized below. The Clean Water Action Plan is an action plan that was proposed by the Vice president in 1997, 25 years after the enactment of the Federal Clean Water Act (CWA) in 1972. Its main purpose is to achieve water areas where all nations can enjoy fishing and swimming, as an original goal of the CWA, and important proposals have been made about the extraction of subjects, reinforced strategies of the water-resource purification plan and the overall strategic framework. Table 9-3-1 summarizes the achievement of 25 year's of water purification, comparing the current situation with that when the CWA was enacted.

The main points in the Clean Water Action Plan are arranged around the following four items: (1) management based on watersheds, (2) strategies and management which are aware of the ecological system and the protection of natural resources, (3) strategies of pollution sources according to a strict standard of water quality and (4) providing appropriate information. Especially, for (1) management based on watersheds, this is based on the idea that clean water can be ensured in a watershed where sound management is conducted. It is also considered that the subject of a watershed should be an area or a border where the most cost-effective strategies against pollution are studied for achieving the goal of water purification. That is, in order to consider the expenditure of contaminated substances moving with water as well as the expenditure of water, the watershed unit must be applied hydrologically. Although the necessity for management of this watershed unit was pointed out previously, its proposal as a federal action plan is very significant. However, the condition of this watershed management cannot be said to have been established completely as it is in Japan. In the U.S.A., in such a stream, the management is actually going to be established. In 1996, one year prior to the proposal of this action plan, the EPA presented the Watershed Approach Framework. To break through the current situation in which the improvement of water quality in the country has stopped according to the proposal, an integrated cooperation among different departments and fields is necessary. Thus, regardless of whether it is a public or private enterprise, the building up of a cooperative system with each community and each watershed is emphasized. This idea has resulted from the development of an idea of the Watershed Protection Approach by the HPA's Office of Water in 1991, and was presented as the EPA's Watershed Approach in 1998. Moreover, in 2000, the Unified Federal Policy for a Watershed Approach to Federal Land and Resource Management was announced as an integrated federal policy assigned as a common recognition of the necessity of watershed management in the framework of cooperation among the EPA, and the Departments of Agriculture, Commerce, Defense, Energy and Interior. As for (5), providing appropriate information, the necessity for cooperation between regional inhabitants and administrative organs is indicative. Because the information about a watershed must be shared to achieve cooperation, new programs for disclosing information have been developed. When the regional inhabitants provide information and the administrative organs cooperate with each other and make decisions about a watershed, it is expected that a management method with high quality will be executed. Inhabitants' participation, which becomes possible by providing information, appropriately results in cooperation among persons interested in a watershed and moreover, the driving power of an action plan with community involvement.

The restriction of drainage in the U.S.A. is conducted for the purpose of human health and protection of the water environment as it is in Japan. As is prescribed in CWA, for sources excreting contaminated substances, it is their assigned duty to obtain approval for the discharge according to the National Pollutant Discharge Elimination System (NPDES) program. Pipe conduits such as sewer systems and water canals are treated as pollution sources. However, no approval is necessary for home-polluted water connected to urban sewage treatment systems. This approval system functions as a method for reducing water pollution, as the wastewater standards are set in Japan. However, it has been recognized that this restriction only of wastewater cannot achieve the CWA goal of making watersheds fishable and swimmable, namely the meeting of the environmental standard. That is, it is necessary to shift from the water management of the restriction of wastewater as a pollutant to the management which focuses on an environmental standard of water quality reflecting a desirable water environment and usage. Originally, in Article 303(d) of the CWA enacted in 1972, the State government was requested to make a basin list where the water quality was disturbed and the environmental standard of water quality was not met. When the State government has executed strategies against point pollution sources (point source), but the standard has not been met, the government can decide a priority order of disturbed basins and meet the standard of basins at the same time. Or, the setting of the allowable Total Maximum Daily Loads (TMDL) is determined. At that time, non-point source loads as well as specific pollution sources are usually taken into consideration. The basic concept of this idea is the same as that of pollution loads and analyses in an integrated plan of the arrangement of sewage systems. When the EPA judges that the list and TMDL made by the State government is insufficient, the EPA shall set a new list and TMDL. Thus, the Acts promoting the management of water quality based on an environmental standard of water quality have already been arranged previously. However, the regulations are not actually in effect, and the EPA thus set a regulation for revising TMDL programs in 1985, actually revising a part in 1992. Moreover, it began to work for its further revision in 1996 and submitted the final draft of an active time schedule in July 2000. The contents include the necessity for actively promoting strategies against non-point sources clearly, as well as strategies against point-pollution sources such as sewage treatment plants. In relation to strategies against non-point sources, it is interesting that the policy to apply this approval system to flow-out water during rain was set forth in the CWA's revision in 1987 and the Act was enacted in 1990. Polluted water in urban basins during rain contains overflow water (CSO) from combined sewer systems, which is also a subject. As such, it is recognized that the reduction of loads deriving from non-point pollution sources from urban basins as well as point pollution sources must be executed legally. This approval system is also applied to the discharge of pollutants from livestock feedlot, and strives to prevent the nutrient salt pollution of surface water and underground water accompanying inappropriate management and the pollution of supply water sources. In addition, in relation to strategies such as those against CSO, the EPA's CSO Control Policy was presented in 1994.

Recently, in Japan, the importance of water management with watershed units has begun to be re-recognized. In the U.S.A., water management with watershed units is actively progressed, which is the first in the world. A map showing each watershed across the entire U.S.A., which made use of GIS, has already been arranged. Water management and nature protection according to natural borderlines are tackled progressively at each administration level of Federal and State governments and regional self-governing bodies. For example, they execute environmental protection strategies of a whole watershed including lakes, marshes and bays, as well as rivers, such as strategies against non-specific pollution sources and natural restoration of straight rivers as re-naturalization.

The Watershed Protection Center striving to protect urban area watersheds appeals against the pollution of surface water, which has become a serious problem in relatively small urban area watersheds, and their strategies. The river network with a firm achievement in the protection of the river environment appeals for the necessity of protecting the watershed scale and unit and its effects. Although cooperation among ministries and government offices is essential for executing a sound water management in each watershed, agricultural fields are greatly involved in water management such as collecting water for irrigation and the problems of non-specific pollution with agrochemicals and chemical fertilizers. The Ministry of Agriculture promotes protection of the watershed in the agricultural field, such as the "Small Watershed Program," promoting and supporting the joint works of farmers who intend to protect small scale watersheds of 100,000 ha or less. The Department of Fish and Wild Organisms of the Ministry of Internal Affairs is a governmental organ executing protection policies all over the U.S.A., including the checking of developmental projects. Here, policies and legal systems for the protection and recovery of aqueous animals and plants have been arranged, including the "Act for Species at Risk of Extermination," which has the strongest restriction among the Acts for the protection of wild animals and plants in the U.S.A. For example, in the Chesapeake Bay, which has the highest level of brackish water in the world, the environment worsened temporarily due to agriculture and the development of residential land. However, the ecological system of the bay has recovered more than was expected by means of "critical area programs" setting various developmental regulations for areas situated at 1,000 feet from rivers and long-term efforts to arrange and promote protection strategies against rivers flowing into the bay by state governments and NGOs. To protect and recover nature in Florida, the State government investigated the residual situation of nature in each area of Florida, collected data in each habitat area annually and made a map. The Florida Natural Regional List Association has established a utilization method of the GIS data, which is essential for the procedures and for making maps to elucidate ecologically important areas requiring protection. Under the 2000 Water-resource Developmental Act, the integrated Everglades Restoration Plan (CERP) will be carried out with a total budget of about 150 billion yen (under negotiation with the Federal government). The Ministry of Environmental Protection boldly tackles the protection of habitat areas of wild animals, such as the "Program for Florida Forever" through the purchase of natural land on a large scale. In Florida, endeavors are being made to protect nature all over the state using gap analyses and analyses of the appropriateness of individual numbers, in which important habitat areas are extracted with wild animals, such as species at risk of extermination, as an index. The State Ministry of Fish, Birds and Animals promotes the tackling of advanced natural environmental protection such as the purchase of lands based on these analyses' results. Moreover, in Florida, the whole state has been divided into five watershed units and water management has been executed with each governmental management department. In the Southern Florida Water Management Department, to which the Everglades, a great marshland area occupying an area about 40% of the size of the whole land mass of Japan belongs, the river routes which were made straight once in the past, were filled in, the floodgate was broken and natural restoration projects were conducted to recover the natural weave of the Kissimmee.

9-3-3 Effects expecting strategies

As for water problems or problems of a basin's natural environmental protection, the contents and areas are set to expand and are becoming increasingly serious in Japan. Resolving such problems with a view toward the next era cannot be avoided. The strongly motivated systematic efforts for recovery of the natural environment of the Everglades marshland area as a central subject by the Southern Florida Water Management Department and related whole communities provide some indication of the direction in which protective policies of the water environment and regional plans in Japan should go. Such policies and systems are characterized below. In Florida State, there are five water management departments, which are divided according to the jurisdiction areas of each watershed, regardless of the administrative division such as district and city. Each management department integratively manages all fields related to water resources and environment, including flood prevention in the area, the water supply to agricultural and urban areas, the protection of water quality, the protection and maintenance of a basin's habitat environment and organism resources and the preservation and creation of a recreation basin. As such, one-dimensional management of various fields related to the water environment in each basin unit of a watershed has a very important significance for the purpose of reasonable and efficient strategies. Various subjects related to the protection of the water environment are not treated individually, but subjects such as river improvement, water utilization, protection and the maintenance of wild animals and their habitat environment, and the recovery of the recreational environment for citizens are understood to be in mutual relation mainly with the recovery of natural water circulation and environment, and strategies aiming at multiple effects have been set. In relation to this, although it is important to have the perspective of understanding problems widely when the protection of the water environment is considered, here, subjects are understood as the "Satellite's Eye," and an integrated thinking takes the ecological system into consideration from the view of field works. The satellite picture showing the area 500 km south and north of the Everglades watershed in the southern area of the Florida peninsula is displayed on the wall of the meeting room for the governing board, as if it is inspiring attendants to promote diverse ideas. To elucidate causes and the mechanism of occurrence of water environmental problems, a joint team consisting of many research institutions of related fields, researchers and technicians was formed, and multi-faceted and efficient investigation and researches are carried out. The results obtained are analyzed and studied intergratively to understand the core for resolution of the problems. In the Southern Florida Water Management Department, there is a Governing Board as the highest decision organ to decide strategies and projects for the management of the water environment in the jurisdiction area, which has higher authority in this field than the state congress. The nine members are appointed after the state governor has taken certain areas and fields into consideration. They are not interest representatives and receive no pay during the four years of the service term. All discussion is conducted publicly and residents and private organizations can present documents with rationales and state opinions directly. Only the Southern Florida Water Management Department has this Governing Board system among the five water management departments. In the Water Management Department, the entire process is proceeded publicly including drafting, deciding and executing projects, and evaluating the projects and results, planning basic investigation and research, and studying the achievement with the participation of residents as a prerequisite. Moreover, to help residents understand problems, public hearings and issues for public announcement with sufficiently specialized contents are conducted frequently. Obtaining information through the Internet and attending meetings with the members of the governing board or staff of the department is guaranteed for residents. When a critique or opinions by specialist groups independent of natural protection groups and governmental bodies seems to be rational, strategies for management of the water environment may be changed, a new administrative organ or research institution may be set and an Act may be revised or a new Act enacted when necessary. Such external power has been more than a little involved in the new establishment of the Environment and Ecology Department, the enactment of the "Sunshine Act" for transparent administration and the "Everglades Forever Act" for restoration of the marshland environment of the Everglades.

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9-4 Strategies of eutrophication in Europe

9-4-1 Purpose of strategies

Nitrogen and phosphorus are listed as nutritional salts for promoting eutrophication in watersheds. As their treatment method, the underground penetration method is conducted. However, this method may contaminate the underground water resource by nitrogen and phosphorus. Because sunlight does not reach the underground water, the internal production by photosynthesis activity of plant plankton (organic pollution) does not occur. However, phosphorus is absorbed by soil and nitrogen is accumulated in the underground water. Especially, the concentration of nitric acid becomes high. When the underground water containing a high level of nitric acid is taken orally, it may induce methemoglobinemia causing cyanosis symptoms in infants, and there is also a risk of producing nitrosoamines, a carcinogen. It is already reported that nitrate nitrogen may be reduced to nitrite nitrogen and cause the formation of nitrosoamines. Thus, nitrate nitrogen is very dangerous as a potential precursor of methemoglobin and carcinogen. As such, the nitrate pollution of underground water is an important problem because it affects the human body. There are two forms of supply sources of nitrate nitrogen to underground water: point source deriving from the treatment of soil penetration such as living or factory wastewater, and non-point source deriving from the eluviation of fertilizer

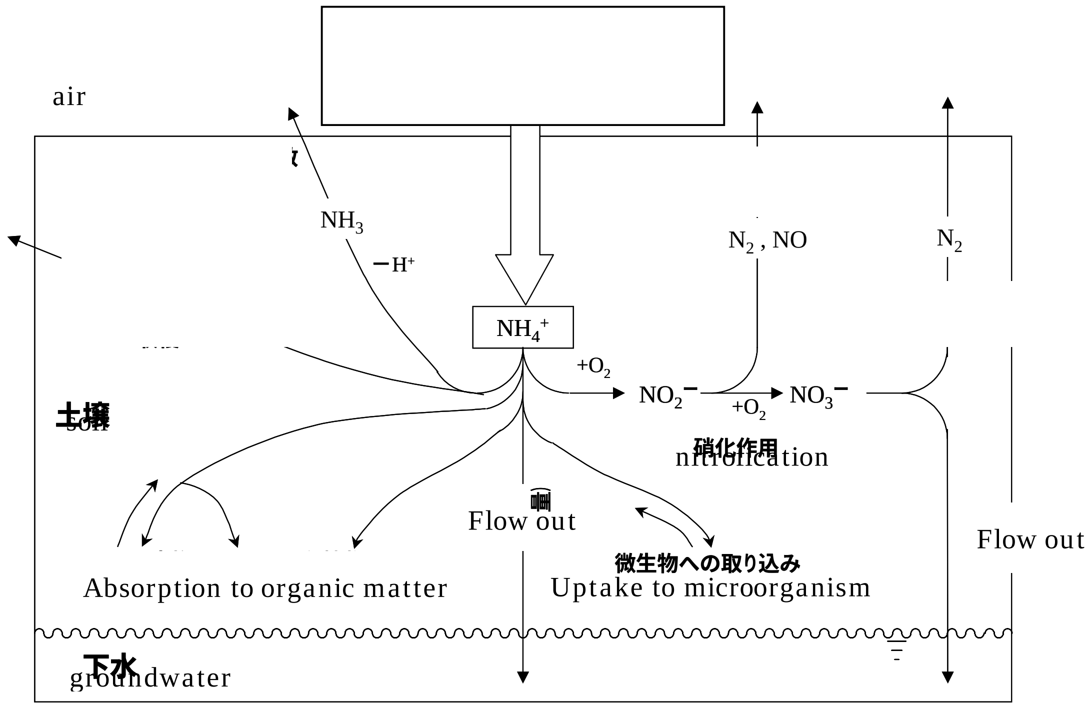

Fig. 9-4-1 Form change of soil nitrogen

components used for agricultural ground. As for living or factory wastewater, countermeasures by elimination strategies of TN: 10 mg/1 are necessary so as not to exceed the 10 mg/1 or less in the guideline of water quality for drinking and the 10 mg/1 of the health item of the environmental standard. Because the supply source of the pollutant giving fertilizer to an agricultural land expands two-dimensionally, it is necessary to optimize the amount of fertilizer used. The elimination strategy of the nitrate pollutant of underground water by bioremedation is necessary as a direct purification strategy. Fig. 9-4-1 shows the morphologic changes of soil nitrogen supplied from ammonium nitrogen. Here, the legal systems of the management of the water environment in European countries are explained and the strategies of underground water, in which the management of the watershed is taken into consideration, are also described.

9-4-2 Outline of strategies

The legal arrangement in Europe can be divided into three steps: (1) the legal arrangement of water relations during the period from the 1970's to 1980's, (2) the legal amendment for strategies of nutritional salts and (3) the Water Framework Directive for new water strategies. As the history of the EU direction is cited, the pollution of water and the shift of its strategies in Europe are arranged. The reasons why European water policy is discussed within the EU framework are because efficient management is impossible in a European country unit and the necessity for a constant standard and strategies in the whole of the EU is reflected, as there is a limitation in the environmental management of water quality at the state unit in the U.S.A. The history up to the Water Framework Directive, which is a new water strategy mentioned above in (3), is described by the chronological table method below.

First generation

1967: Directive on Dangerous Substances (Introduction of management of dangerous and toxic substances)

1975: Surface Water Directive (Water quality of rivers, lakes and marshes related to collecting drinking water)

1976: Bathing Water Quality Directive (Setting of goal of water quality for bathing)

1978: Fish Water Directive (Setting of goal of water quality for fish)

1979: Shellfish Water Directive (Setting of goal of water quality for shellfish)

1980: Drinking Water Directive (Setting of goal of water quality for drinking)

Second generation

1988: Summit about water in Frankfurt

1991: Urban Waster Water Treatment Directive (Necessity of biological treatment and application of high-level treatment)

1991: Nitrate Directive (Strategy of nitrogen pollution from agricultural area)

1996: Directive for Integrated Pollution and Prevention Control (IPPC) (Strategy against pollution from a large-scale industrial area)

1998: New Drinking Water Directive (Reconsideration of standard items of drinking-water quality, and reinforcement of standard level)

From 1995, as the water strategies were reconsidered, the necessity for a global-scale approach to water management was pointed out in meetings of the environmental committee of the European Parliament and with environmental ministers. In May 1996, the Water Conference, in which there was a wide range of attendants, as well as various governmental attendants, was held. Although great efforts for the resolution of individual pollution problems of water quality were made through such negotiation processes, it was conceded that there was no mutual cooperation in current policies, which was a problem. That is, although action policies in the EU such as the Drinking Water Directive and the Urban Waster Water Directive have been presented, the necessity for conducting constant procedures in water strategies and management has to be emphasized at the same time. Consequently, it is now at the stage of changing to new EU water strategies in the framework. As the first work for that, the European Commission (EU) structured a new European Water Policy draft and proceeded to a negotiation process with related organizations. The EU has proposed the Water Framework Directive. Formally, negotiations were conducted with the environmental committee of the European Parliament and environmental ministers, and then adjustment work was proceeded through taking opinions from related organizations, regional and district governmental departments, water users and NGOs. Then, after 25 year's of arranging the legal systems, the EU restructured water policies and adopted the Water Framework Directive in the summer of 2000.

As such, the Water Framework Directive proposed by the EU was finally approved as an effective regulation after being arbitrated by the two legal enactment bodies of the European parliament and council. In Europe, the request for purer water (rivers, lakes and marshes, underground water and coastal areas) has increased from the following three perspectives: (1) as drinking water, (2) for water bathing and (3) for precious regional property in the natural environment. Compared with the perspective of the CWA (Clean Water Act) in the U.S.A., the differences are listed in the points for clearly treating underground water as a part of the watershed and presenting the need for awareness on the cleaning of the watershed as a water source for drinking, which is related to the former. In addition to the "watershed enabling the enjoyment of bathing" presented as a goal in the CWA, it is interesting that a watershed is regarded clearly as a property in the natural environment. The purposes of this water policy are presented below:

(1) Returning polluted or contaminated watersheds to a clearer condition.

(2) Protecting the current clear watershed and preserving it.

To achieve these purposes, it was recognized that conventional strategies of individual pollution sources are insufficient and it was judged that rationalization of the legal systems should be considered. In addition, it was confirmed that the roles of residents and residential bodies are essential from the perspective of watershed management. Consequently, this direction has the following purpose and characteristics.

(1) A unified watershed management accompanying harmonized strategy programs.

(2) All watersheds including surface water and underground water are subjects and the protection of the quality, quantity and ecological system is aimed at.

(3) Strategies against pollution by methods connecting excretion regulations and the standards of water quality

(4) Increase of pricing (policy of market price)

(5) Reinforcement of the participation of residents

Some of the above points are similar to those of the Clean Water Action Plan in the U.S.A. The most important point is to have set forth integrated strategies that are aware of the watershed management as is being done in the U.S.A. In other words, it was recognized that the effects of the direction introduced since the 1980's were limited because of the non-integrated individual strategies against pollution. This new direction is placed as a central pole of the integrated watershed policies for making the existing EU water legal system more perfect. The Nitrate Directive and Urban Waste Water Directive, which are conventional directions individually corresponding will continue to exist through combining with the new directions. However, within the framework of watershed management, some directions have been abolished or unified to maintain this consistency.

It is desirable to conduct management with the watershed base, which is a natural unit both geographically and hydrologically, but not management with an administrative or political borderline. In some countries, management with the watershed base has already progressed and a River Basin Management Plan has been formulated. This plan requires renewal every six years. The situation necessary for cooperative adjustment (cooperative relationship) will become clear. Specifically, watershed management projects of international rivers (Maas, Schelde, Rhine rivers), which are progressed by the related countries, are a good example. Important purposes for preserving clean basins and recovering basins with polluted conditions are the protection of the basin ecological system, protection of the habitat of precious species, protection of the tap water source and protection of the bathing area. As for the latter three, although specific basins are subjects, the management of the basins must be conducted from an integrated perspective. On the other hand, for protection of the basin ecological system, all basins are related and protection of the environment is requested, which should be protected in a complete form by the agreement of the protection of organisms. It seems that the environmental preservation of water quality is not discussed in individual items, and there seems to be room for the water quality environment to be discussed from the perspective of preservation of the ecological system.

Preservation of the quality of underground water including watershed management in EU countries is described below.

(1) Preservation of the quality of underground water in Germany

In 1953, technical directions for preserving tap water sources were first presented in Germany after modern laws were arranged. Then, the laws were revised and now the "German Federal Water Balanced Act" is in effect at present. In this Act, it is prescribed that a landownership is not applied to the utilization of water and the expansion of surface water, which need permission or approval by laws or State Acts. When water is protected from unprofitable influence for public supply at present or in the future, underground water is cultivated or an outflow of falling water is prevented, the zones to be preserved can be set. The preserved zone is furthermore divided according to the two indices of reach time and distance, and various activities are prohibited or restricted in each preserved zone of underground water. In the preserved zone, it is prescribed that landowners and users have certain duties for examinations of water quality and soil. The first zone is the most important zone for protecting underground water from any pollutants, and the range is within a 10-m radius from a water source. Usually, the water source is surrounded by a fence and only authorized persons are allowed to enter it. The second zone aims at preventing the pollution of underground water by pathogenic microorganisms and the zone is prescribed with a range in which it takes 50 days for underground water to reach a pumping well. The number of 50 days was determined empirically as the mean number of days until pathogenic microorganisms die in underground water. The third A zone was set within 2 km from a pumping well, and aims mainly at the pollution of underground water by industrial activities. In this zone, land utilization related to the use or storage of non-easily degradable substances is restricted. The whole zone of cultivating a water source external to the third A zone is the subject zone of the third B zone, which is protected from water sources with non-degradable substances and radioactive substances.

(2) Preservation of the quality of underground water in France

In France, the original form of strategies for preserving the quality of underground water was arranged by the "Public Sanitation Act," and the strategies were determined by a governmental ordinance as follows. First, in the first type (direct) protection areas where all economic developments are prohibited and fencing off is required, a tap-water operating company must purchase the land as a principle. For example, in Paris, 1,850 ha of land including the areas surrounding regions for collecting spring water and the area along aqueducts has been purchased. The reasons why the land along aqueducts is protected are because the aqueducts are a natural flow-down type made of plate stones and weak to external shock, and the internal water pressure lowers without a full-water condition. In the second type (adjacent) protection areas (100 m to several km from a well), the following activities are prohibited or restricted: digging wells / quarrying stone materials at open places / digging holes or landfill; accumulation of human waste and duct from homes, radioactive substances and other substances influencing water quality; excavating canals / storage and the accumulation of liquid and gas carbohydrates, and all chemicals and waste water; construction of ground and underground structures; spraying composts, organic chemical fertilizers, all soil modifiers and dusting powders; raising animals; and all activities which are harmful directly and indirectly to water quality. In the third type (distance) protection areas, which are set when it is insufficient to apply only the first and second types, the same activities as those in the second protection areas are prohibited or restricted. Although excavating a canal and the storage and accumulation of liquid and gas carbohydrates, radioactive substances, all chemicals and wastewater may be restricted, for the third type areas, almost none have been actually determined. In France, the setting for the first and second protection areas are regarded as a matter of importance; in both cases, the hydraulic, geological relationship between places to collect surface water and underground penetrating layers must be considered. In the second protection areas, landowners are forced to undertake considerable duties, and whether or not security money has to be paid is determined in each case.

(3) Preservation of the quality of underground water in Holland

In Holland, wells for homes hardly exist and tap water is used in almost all homes. These tap waters are supplied from 240 wells by about 100 operating companies. The main aquifers are structured mainly by sea and river sediments non-coagulated. Because the underground water level is high, 0-2 m under the ground surface, the underground water is contaminated very easily. The initial preservation system of underground water quality in Holland referred to the German system. However, because the hydrogeological conditions differ from Germany's, it was likely to be argued that the scientific rationale was weak in setting regional divisions. Ensuring safe drinking water caused conflicts with other interests in many cases and it was difficult to restrict land utilization. Therefore, an original standard was set after Holland's special hydrogeological conditions, social conditions and natural purification ability were taken into consideration.

(4) Preservation of the underground water quality in Switzerland

In Switzerland, about 80% of the industrial water and tap water depends on underground water. Although these underground waters were good quality, because the pollution of underground water has advanced recently, the setting of zones for the preservation of underground water quality was first considered in 1966. Moreover, in 1972, a Federal act was put into effect, in which states were assigned the duty of setting zones for preserving the quality of spring water and pumping water, and tap-water operating companies were also assigned the duty of submitting related documents after conducting hydrogeological investigations for setting zones. On the other hand, in 1971, the study committee consisting of specialists in the fields of microbiology, chemistry, hydraulics, hydrogeology, sanitary science and law was organized and a guideline for setting preservation zones based on reports by the committee was presented in 1977. At the time point, 1990, the preservation zones were set in about 50% of the whole water-source areas. The first zone is a preservation zone for preventing the pollution of underground water by bacteria and chemicals, and is set in regions surrounding water source and spring water wells. In areas without a water supply or with limestone, the zone is set even in areas connecting directly to water sources such as holes for aspiring water. Basically, land utilization of the entire range within a 5-20-m radius of a well is prohibited. The second zone is set to prevent the pollution of underground water by pathogenic microorganisms and non-easily degradable chemicals. In addition to the restriction of scattering livestock's raw sewage, the storage of harmful liquid and reclamation, the discard and sewage from waste, and the construction of roads and railways are prohibited. This zone is prescribed as a range such that the distance from a point collecting water is 100 m or more and pollutants stagnate in aquifers for at least 10 days or more before they reach the point collecting water. In areas where the corrosion of limestone advances, and splits and hollows are developed, the second zone may cover an entire cultivated area. Thus, in areas with limestone, detailed hydrogeological investigations are carried out as a prerequisite and a trial zone is set according to its actual situation. A similar size of an area to that of the second zone is designated as the third zone for the purpose of providing a buffer zone to preserve the quality of underground water in the second zone. Although agriculture and construction are possible in the third zone, special restrictions such as those for sewage facilities and the storage of harmful chemicals are set. However, in areas with limestone, there have been cases where a range double the size of the second zone was set as the third zone. In any case, the remaining cultivated area is designated as the zone called sector A.

In addition, besides these countries, there are some countries where preservation areas are set, based on an original standard. For example, in England, an area with a radius of 500 m from a water source is set for the protection of the water source, and purchased.

9-4-3 Expected effects of strategies

As explained previously, nitrate pollution of underground water has a very serious influence on the human body. If the strategies in European countries described above function effectively, the pollution of underground water can be prevented. However, even if a sense of security is felt, 100% safety can still not be guaranteed. Thus, in the future, reinforcement of its monitoring systems and development of a treatment method for preventing penetration underground will be required. In the EU, there are international long rivers flowing down among multiple countries such as the Rhine River and the Donnau River, and regional problems between the upstream and downstream occur at the level of countries. While strategies against problem sources are being strengthened, the concept of not flowing down water polluted beyond national boundary frontiers is important. Especially, for nitrogen and phosphorus, if they are not treated at the original sites, lakes and bays existing at the terminal points may be damaged, and the pollution of water quality advances beyond the national boundary frontier. That is, to prevent the progress of environmental pollution on a global scale, strategies that are aware of the environment of distant areas beyond national boundary frontiers as well as domestic watershed management are essential.

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