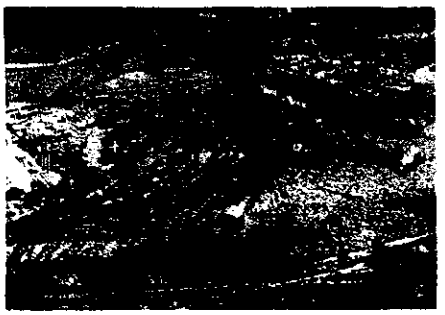
Chapter 17 DOKAI BAY

1. Introduction

Dokai Bay located in the northern part of Kyushu island had once been called as "the Dead Sea", because of no aquatic organisms could live in the bay due to the harmful effects of untreated industrial waste water flowing into the bay. However, after the enforcement of waste water purification measures instigated by the joint efforts of citizens, industry, scholars and government, the improvement of the aquatic environment, shown not only by chemical analysis but also by the rebirth of the aquatic ecosystem, was dramatic. The recovery of Dokai Bay is evaluated as one of the most successful instances of water purification measures reviving a terribly polluted and damaged aquatic environment in a short period. This drastic improvement of the aquatic environment is therefore called the "Dokai Bay Success Story".

In this paper, I consider and discuss the Dokai Bay success story, including the status of Dokai Bay's serious industrial pollution, the contents of the purification measures devised through trial and error, and finally the lessons learned from the experience.



The later half of the 1960's when Dokai Bay was heavily polluted

Present day when water quality of the bay is improved

Fig. 17- 1 Improvement of water quality of Dokai Bay.

2. From "A Rich Sea, Dokai Bay" to the Industrial Port of Kitakyushu's Heavy and Chemical Industrial Area[1,2]

Although Dokai Bay is a fairy small bay, with a total length of 13 km, it had been a rich source of marine products for the inhabitants living along the coastal line of the bay for 5,000 to 6,000 years. Dokai Bay was so rich with marine life that it was called "a rich sea, a treasure chest of Kuruma prawns" in the Meiji era about a hundred years ago.

In the beginning of the 20th century, as part of the national government's efforts measure to enrich and strengthen the country, the government managed Yawata Steel Company (now Nippon Steel Company) was constructed in 1901 along the coastal line of the bay for the purpose of providing the country with iron. After construction, land reclamation and dredging activities intensified in the bay, and eventually the Kitakyushu heavy and chemical industrial area developed as one of the four biggest industrial areas of Japan, supporting Japanese key industries. In this period, a lot of factories, as many as 1,035, were constructed along the coastal line of the bay. These factories were mainly related to the steel, metal working, machine, shipbuilding, chemical industry, ceramic, cement, and food industries.

3. The Degradation of Water Quality Leading up to the " Dead Sea" [1,2]

With the increased demand for fishery products from Dokai Bay that accompanied the industrial development, the peak fishery catch from Dokai Bay was reported in 1928. However, fishery catch decreased rapidly from 1928, and in 1932, just 4 years later, for the catch of fish was reduced by half. It was revealed by a simple bioassay as shown in **Table 17-1**, that the cause of serious damage to marine organisms was due to the effect of untreated industrial effluent from factories. This is a very important point when tracing the history of pollution in Dokai Bay.

After that, water conditions became worse and worse with the development of many heavy chemical factories along the coastline of the Bay. After 1942, the fishermen of Dokai Bay could not catch anything except for the few years immediately after the Second World War. Then due to the rapid progress of serious water pollution with industrial development after the war, the no catch phenomenon was repeated and eventually fishing from the inner part of the bay to the area under the present Wakato Bridge was abandoned between 1951 and '63.

Table 17-1 Bioassay of seawater sampled from Dokai Bay in 1933

Sampling station	Average minutes for test fish* to die
Near the drainage mouth of a glass factory	12
Near the drainage mouth of a food factory	34
Near the drainage mouth of a sulfuric acid factory	46
The inner point of the dock of Factory A	57
The outer point of the dock of Factory A	63
Old Wakamatsu port	75
Near the Tobata fish market	83
Near Hirase	90
Under the harbor police station	115
Near the drainage mouth of the bandage factory	164
Near Wakamatsu light house (Unpolluted sea water)	180<

* Juvenile sea bream etc.

Thus water pollution of Dokai Bay became a serious issue among fishermen as early as the 1930's, however at that time, citizens were not so aware of such issues as water pollution. In 1965、residents near the inner part of the bay began to complain to the city government about offensive odors produced by Dokai Bay's heavy water pollution. Later, the news paper reported that marine life, such as mollusks, attached to the bottom of ships would die and drop from ships entering Dokai Bay after just a few days. After this report, citizens finally recognized the seriousness of the environmental crisis. Consequently, citizens including Women's Associations began to petition the local government to improve the water quality in

Dokai Bay.

4. Three Big Purification Measures

In the period of groping for effective purification methods for water pollution in this country, three major measures for the improvement of the aquatic environment of Dokai Bay were executed. These were the control of industrial waste waters, the establishment of a sewage system and the dredging of polluted sediment. These new projects developed as follows.

4.1 Control of Industrial Waste Water

4.1.1 Devastating Water Pollution in Dokai Bay[1,2]

Kitakyushu City carried out the first examination of the water quality in Dokai Bay in 1966 to meet the strong demand from citizen and this added to the crisis concerning water pollution. With the results of the examination, it was revealed that Dokai Bay could no longer be called "a sea" because the water color was reddish black or yellowish black. At that time, chemical analysis of samples taken at the depth of 3m from inner most to middle parts of the bay revealed the following results: DO 0 mg/l, SS 765～1,082 mg/l, and pH 6.6～7.2 etc.

In order to begin combating such horrible water conditions, Kitakyushu City enthusiastically petitioned the Economic Planning Agency (at that time, the Environment Agency had not yet been established and the Economic Planning Agency had taken charge of environmental administration) and Dokai Bay was eventually appointed a designated sea area. "The Water Quality Conservation Law", the environmental law of those days, required that polluted bodies of water had to first be appointed as a designated area based on the results of water quality investigations carried out by the Economic Planning Agency before any measures to control waste water would be implemented.

The water quality of Dokai Bay and waste water was investigated twice, a preliminary survey in 1968 and the main survey in 1969. The level of COD in the sea water was as high as 74.6 mg/l and harmful substances such as cyanide and arsenic were analyzed at levels as high as 0.64 mg/l and 0.15 mg/l, respectively. From these results, it was revealed that Dokai Bay was polluted with different kinds of organic matter and harmful substances of a very high concentration. After these investigations, Dokai Bay was reported all over the country as "the Dead Sea".

4.1.2 Structure of Dokai Bay's water pollution[1,2]

With these investigations by the Economic Planning Agency, it was also reported that the total volume of effluent, sewage and waste water discharged into Dokai Bay from the twenty biggest companies was about four million and eighty thousand cubic meters a day in 1969 and the total load of COD of them was about two hundred and thirty three tons a day, as shown in **Fig. 17-2**. As 98.5 % of the total volume of effluent and 97.3 % of the total load of

COD were produced by these twenty biggest companies, it was found that the cause of the serious water pollution of Dokai Bay was waste water from industrial plants.

According to test results of the water quality of waste waters from 75 drainage mouths of 22 industrial plants, COD and harmful substances such as phenol and cyanide were at levels as high as 400 mg/l, 45.0 mg/l, 25.0 mg/l respectively, as shown in **Table 17-2**. These results indicated that almost all waste waters from industrial plants to Dokai Bay were seldom treated at that time.

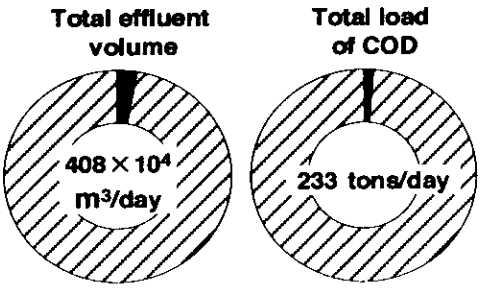


Fig. 17-2 The load of effluent and COD to Dokai Bay in 1996.
■, Sewage;
▨, Twenty big companies.

Table 17-2 Water quality of effluents from industrial plants to Dokai Bay

parameters	Number of samples	Unit	Concent-ration
Transparency	16	cm	1.0～27.0
pH	16		3.0～10.1
COD	16	mg/l	8.0～400
SS	16	mg/l	10～2,366
Oil	16	mg/l	0.6～5.5
Phenol	14	mg/l	2.0～45.0
Cyanide	18	mg/l	0.55～25.0

4.1.3 Appointment as a Designated Sea Area and the Strict Old Effluent Standard

After these investigations, an open hearing with local residents, companies and public bodies was held by an environmental advisory committee of the Economic Planning Agency. After that Dokai Bay was appointed as a designated sea area in November of 1970. The "effluent water quality standard (referred to as 'the "old effluent standard' hereafter) was also announced at this time. The designation of the sea area was broadened from Dokai Bay to the Hibiki Sea to where Dokai Bay's mouth opens. The old effluent standard had been established based on the assumption of categories of water condition(purpose of water use) which was applied on there the next year.

The old effluent standard set maximum limits on the amount of pollutants permissible in effluent. These varied depending on the kind of industry. For instance, the old cyanide standard of effluent for the steel industry and the organic chemicals manufacturing industry was set at 0.5 mg/l, which was a concentration standard stricter than the national uniform effluent standard of 1.0 mg/l based on the Water Pollution Control Law, the present environmental law" notified on September in the same year. Because there were so many factories discharging cyanide into the bay, it was estimated that implementation of the 1.0 mg/l standard would not be sufficient to load to improvement the water quality of the bay. Also the old COD effluent standard of 15-60 mg/l was much stricter than the COD national uniform effluent standard of 160 mg/l. This strict COD standard value was established according to the results of the box model equation used by the Economic and Planning

Agency. The model indicated the necessity of the reduction of the total COD load of Dokai Bay by a seventh in order to recover the self-purification action of the sea water within 5 years. On the other hand, the old oil effluent standard for the steel industry of 6 mg/l was not so strict compared to today's standards, because in those days sea water taken from Dokai Bay to be used as a coolant was already contaminated with oil at levels as high as 5 mg/l.

On May 1971, categories of water conditions of Dokai Bay, the Hibiki Sea and two rivers flowing into Dokai Bay were designated under the Basic Law for Environmental Pollution Control. Then Environmental Quality Standards (EQS) which are targets for environmental preservation administration, were applied. Although the national uniform effluent standards were established in June of 1971 under the Water Pollution Control Law, control of effluents from factories was carried out according to the old effluent standards because it was stricter than the new national uniform effluent standards. Afterwards, additional more stringent effluent standards were established by Fukuoka Prefecture in 1973. Thus effluents were controlled with these new effluent standards which had almost the same values as those of the old effluent standards.

Based on the Water Pollution Control Law, Kitakyushu City was authorized to inspect factories and business establishments. Furthermore, legal authority concerning effluent control including the handling of related official documents and reports, the inspection of effluent from specified factories, and issuing of orders for the improvement of facilities was transferred from the governor of Fukuoka Prefecture to the mayor of Kitakyushu City. Kitakyushu City was then able to carry out its own water quality conservation administration. Consequently, the number of effluent standard violations by the factories discharging effluents into the Bay decreased rapidly. In recent years, the number of violations has been reduced to one or two as shown in **Fig. 17-3**.

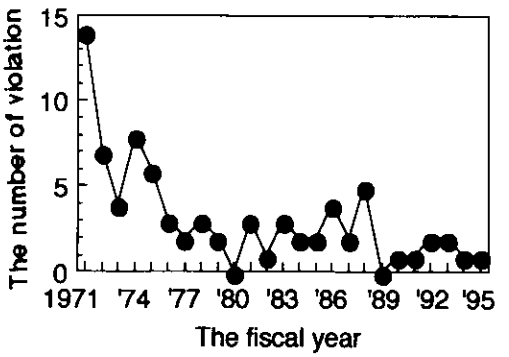


Fig. 17-3 The number of effluent standard violation in the Dokai Bay area.

4.1.4 Conclusion of "Agreement on Environmental Pollution Control"[3)]

The agreement on environmental pollution control, an administrative method used by the city based on the Municipal Pollution Prevention Ordinance system, is a non-legally binding pact made with companies. Some large scale companies which were planning to construct factories in the city were forced to conclude this agreement with the city. Also once the existing factories concluded the agreement, they were subject to strict checks such as reports on the water quality of effluents or on the spot inspections. The companies however received city's recommendation openly and then invested large amounts of money in order to establish effective industrial treatment plants. Fifteen agreements were concluded between Kitakyushu City and companies discharging effluents into Dokai Bay and the Hibiki Sea during the fifteen years from 1970 to '94.

4.1.5 Efforts by Companies [4]

Big companies locating along the coastal line of Dokai Bay had begun to recognize their social responsibility for industrial pollution. Since around 1968, each company started full scale research of effluent treatment methods by gathering the engineering technology accumulated by each company. Then new treatment methods were developed and effective treatment plants were constructed in the factories, one after another. For example, an activated sludge method had developed instead of a phenol extraction method for the treatment of the coke oven waste water from the steel industry and waste water contaminated with oil was treated by new separation technology. In this way, new treatment plants were constructed successively along the coast line of Dokai Bay. As shown in **Fig. 17-4**, the total quantity of both COD and oil in the effluent from Yawata Steel Company in 1971 was reduced by half compared with 1970 levels. These facts revealed that the construction of treatment plants was effectively reducing the load of pollutants to the bay.

The steel company's effluents control efforts had extended from reducing pollutants concentration to also reducing the effluent volume. For instance, as closed systems of water used in the manufacturing process had already developed, the circular rate(reuse rate) of water increased only 12 points during the 27 years from 1970 to '96, as shown in **Fig. 17-4**. However, the total volume of effluent including indirect cooling water had been reduced by 2% over a 26 year period, by employing such methods as the cascade method for water processing.

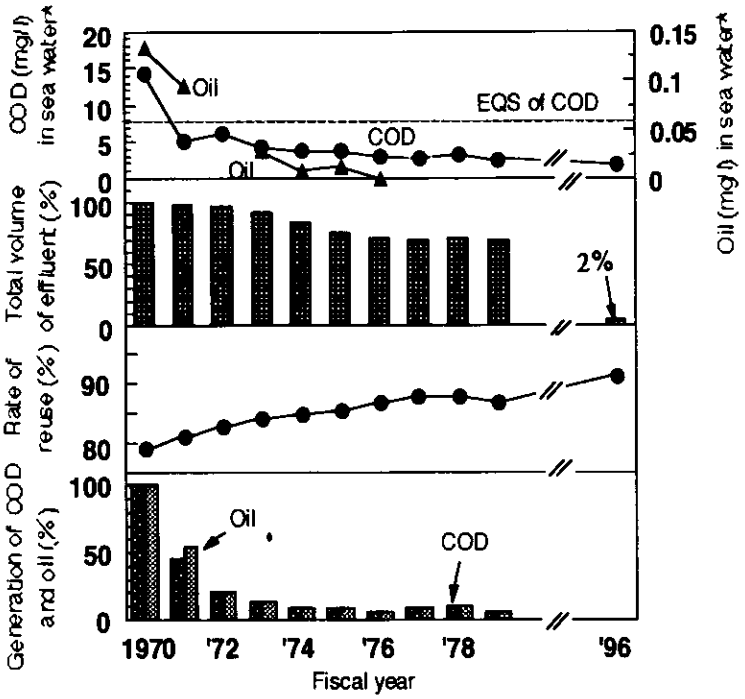


Fig. 17-4 The results of measures for the effluent from Nippon Steel Company Yawata
* The sea water was sampled from the surface layer of the middle part in the bay.

These results show that the amount of effluent itself was reduced, while processes for steel production were actually improved. Technological innovation concerning the steel production process not only made the total effluent volume reduction, but also saved energy and other resources, thus minimizing industrial waste and at the same time improving the quality of pig iron. It can be said that these positive developments in steel production resulted from the "cleaner production system" developed by the company over time.

4.2 Improvement of the Sewerage System

As a part of the preparation of the infrastructure of Kitakyushu City, improvement of the sewerage system had been started around Dokai Bay. Kogasaki sewage treatment plant located at the inner most part of Dokai Bay started its operation from 1963. This plant cleared the old effluent standards such as BOD 20 mg/l, SS 70 mg/l, and coliform group 3,000 ind./m^3 in 1970. On the other hand, as the effluent from night soil treatment plant could not clear the old effluent standards, improvement of the treatment was necessary. Incidentally, the percentage of sewered population in Kitakyushu City reached 95.4 % at the end of fiscal year '96 (shown in **Fig. 17-5**) as the improvement of the sewerage system was promoted under the Environmental Pollution Control Program.

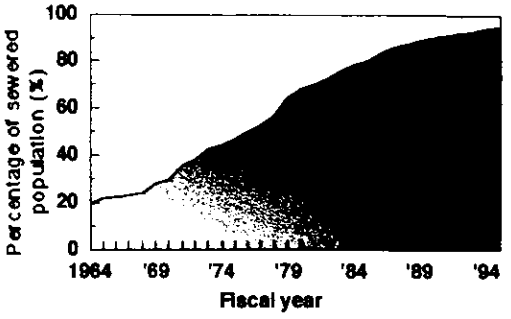


Fig. 17-5 Increase in the percentage of sewered population in Kitakyushu City.

4.3 the Dredging of Polluted Sediment

During the course of the investigations in Dokai Bay by the Economic and Planning Agency in 1968 and '69, the sediment quality was surveyed as well as water quality. From these surveys it was revealed that sediment pollution had progressed to include almost the whole area of the bay and had become serious as the concentration of N-hexan extract in the sediment was as high as 2.9-17.0 mg/kg dry. At that time, polluted sediment was called "Hedoro" in Japanese, and Dokai Bay was reported as one of the two most markedly polluted sea areas in Japan where tremendous amounts of Hedoro had accumulated.

Although dredging the polluted sediment had been proposed by the Economic and Planning Agency as the most effective means for purifying the aquatic environment of Dokai Bay, such a dredging project of so polluted sediment had never been executed before. Therefore the Kitakyushu Port Management Association (the former Kitakyushu Port and Harbor Bureau) had started the investigation of the physico-chemical characteristics of polluted sediment in Dokai Bay in detail from 1971, and then began discussing dredging methods[1,5].

4.3.1 Status of the Polluted Sediment [1,5]

The results of this detailed investigation recovered a thickness of the polluted sediment reaching 4 m, and the total volume of polluted sediment was estimated as much as 4,080,000 m^3. Vertically, the layer where the maximum concentration of hazardous substance such as cyanide had been detected was 2.25-3.05 m deep, not just on the surface layer. Geographically, harmful substances had been found to be concentrated at the inner part of the bay and the Yahata Basin, as shown in **Fig. 17-7**. The minimum concentrations of cyanide,

Fig. 17-6 Polluted sediment in Dokai Bay in 1971

cadmium and arsenic were as high as 327 mg／kg, 603 mg／kg, and 670 mg／kg respectively. These concentrations were the highest in Japan in those days. Other hazardous substances including total mercury (551 mg／kg), total chromium, lead, zinc, organic phosphate, and tar had also been found to contaminate the sediment of the bay in high concentrations.

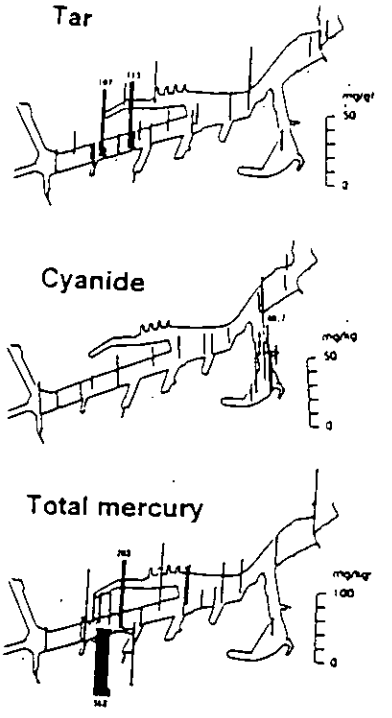


Fig. 17-7 The status of polluted sediment in Dokai Bay in 1971

4.3.2 Crisis Management and the Aim of Dredging the Polluted Sediment[1,6]

When a big project costing a lot of money is to be carried out, there is often a tendency to place more weight on minimizing expenditures than maximizing the effectiveness of the project. However, during the dredging of Dokai Bay, the effectiveness of the operation was given complete priority in on effort to reduce the risk of harmful after effects.

"In those days, there were no adverse affects on human health because no fishery products were being taken from the bay. However, when aquatic organisms begin to come back to Dokai Bay after the improvement of the water quality, there arises the anxiety that hazardous substances will be accumulated in the different kinds of aquatic organisms through the food chain and finally be passed on to humans. Also, though the elusion of mercury from the contaminated sediment was not observed in these days, there was concern that the dissolved oxygen in the aquatic environment would become overly rich, and the chance that inorganic mercury would be organized by bacteria and eventually be accumulated in aquatic organisms. Therefore, aiming for the prevention of such serious conditions, the dredging of the polluted sediment contaminated with mercury in high concentration had been decided. At that time, Japan was also dealing with effect of the environmental disaster in Minamata, such environmental problems and public safety was becoming the big issue. Thus while struggling with the difficulty for predicting the future risk scientifically, dredging the polluted sediment in Dokai Bay was begun in 1974.

4.3.3 Removal Standards for Polluted Sediment and Deciding the Areas to be Dredged[1,5]

The removal concentration standard for polluted sediment was calculated by referring to the elusion rate of hazardous substances and based on figures from the Environment Agency. However the mercury, which had an average concentration in the sediment of Dokai Bay was 49.5 mg/kg, never elutted from the sediment, therefore it did not meet this standard. Finally a removal standard was established based on the case of Tokuyama Bay. The bay was located in the Seto Inland Sea, where sediment had been contaminated with mercury at the average concentration of 22.6 mg/kg.

When environmental concerns about Tokuyama Bay surfaced, Minamata Disease had not yet broken out, but some persons who took a lot of fishery products from Tokuyama Bay had already accumulated high levels of methyl mercury in their hair. It was calculated by the arithmetical mean method that the mercury concentration in the sediment for dredging in Dokai Bay was to be at 60 mg/kg or above in order to reduce the mercury concentration to be no more than Tokuyama Bay's 22 mg/kg. Furthermore, the Environment Agency and the Kitakyushu Port Management Association had decided to dredge sediment contaminated with total mercury at the concentration 30 mg/kg or above, taking the safety factor into consideration. The total volume of the sediment for dredging was as much as 350,000 m^3 which covered nine areas as shown in **Fig. 17-8**.

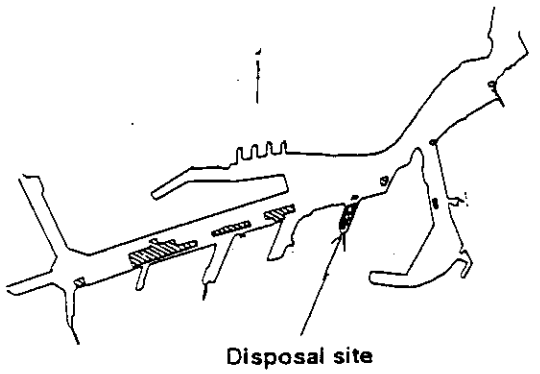


Fig. 17-8 Dredging areas and the disposal site of polluted sediment in Dokai Bay

4.3.4 New Dredging Method for Polluted Sediment [1,5]

Based on various investigations, Kitakyushu Port Management Association started the dredging project in 1974 and completed it in '75. As shown in **Fig. 17-9**, fences had been placed around the dredging sites to prevent the diffusion of polluted sediment. Improved closed type grave dredging ship and closed type burgs were developed to prevent the leakage of polluted sediment and a following second contamination.

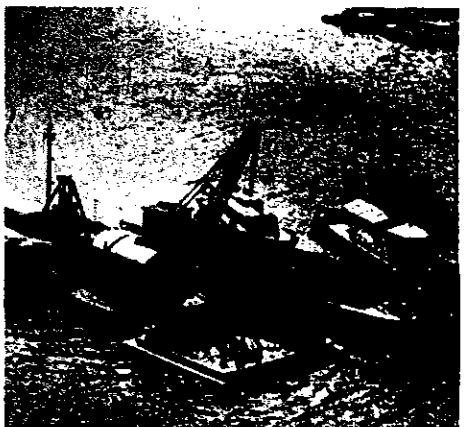


Fig. 17-9 Dredging of polluted sediment in Dokai Bay from 1974.

4.3.5 A New Method for Depositing the Polluted Sediment [1,5]

The disposal site chosen for the polluted sediment was Nishiyahata Basin with an area of 57,200 m^2. It was actually located in the middle part of the bay, not outside of the bay. Before the dredging, a barrier (a closing bank protection) was constructed in 1973 in order to wall off Dokai Bay from the disposal site.

A synthetic rubber sheet was spread on the ground of the deposit site to prevent the leaching of pollutants from the sediment into the ground, before the disposal of any polluted sediment. After the disposal of the polluted sediment, as much as 350,000 m3, ultra unstable ground was formed of 7 m thickness. As part of the sanding method of such weak ground, the bamboo net construction method was developed. This method involved the laying of a bamboo net, sheet, sand(1.0 m) and mountain soil(0.5 m) in this order on the unstable ground. This series of dumpings and sanding projects was completed in 1976. After that,

the sanded disposal site was bought from Kitakyushu City by a company located adjacent to the disposal site. It has been used as a storage place for materials ever since.

4.3.6 Cost for Dredging [5,6]

The dredging project cost a total of six million US dollars. These costs were shared by the public and private sector over 1972 and '73. The private sector's rate was calculated by referring to the two parameters of suspended solids and hazardous substances for human health, according to the "Polluter Pays Principle" (PPP). The remaining cost was covered by the public sector.

As shown in **Table 17-3,** the private sector (companies located along the coastal line of Dokai Bay) paid 4.3 million or 71% of the total costs, as the dredging expense originated primarily from industrial waste water. On the other hand, public sector paid 1.7 million or 29% of the expenses reflecting the public's share for domestic waste water as well as covering the share of bankrupt businesses. In the public sector, the national government paid a half, and the prefecture and the city shared a quarter respectively.

5. Drastic Improvement of the Water Quality and the Following Return of Aquatic Organisms [1,2]

Water quality in Dokai Bay improved rapidly since 1971, as shown by decreases in COD and oil concentration of sea water at D6, the middle part of the bay, in **Fig. 17-4.** Almost all the parameters of the EQS at all sampling points in the bay achieved each standard value by '73.

Kurumaebi Prawn were again harvested from the Bay in 1983, and then 527 kinds of species of organisms were confirmed to have returned to the bay by biological investigations carried out over 5 years from '89. Organisms conformed to have returned to Dokai Bay

Table 17-3 Cost sharing rate of dredging work of polluted sediment in Dokai Bay

Sector	Responsable for:	Proportion by pollution amount (%)		Total percentage to be shared (%)	Share in the cost (US million $)*
		Amount of suspended solids	Amount of hazardous substances		
Private sector	Industrial waste water	54	87	71	4.3
Public sector (Government, Prefecture, City)	Domestic waste water & the Industrial waste water of bankrupt businesses etc.	46	13	29	1.7
		100	100	100	6.0

*Exchange rate, 1$=300¥ in 1972.

included organisms from up and down the food chain; from phytoplankton,at the bottom to fish and birds at the top. This return of so many organisms has proved the improvement of water quality of the bay biologically.

6. Conclusion

Dokai Bay's experience in controlling industrial pollution has been evaluated as a "success story", nevertheless due to delays in implementing purification measures, there was a lot of damage to the aquatic environment of the bay. In the early 20th century, the Japanese sense of values had given way to the priority of economic development. Awareness of the water pollution that always accompanies industrial development had not yet spread among citizens, companies, and the government. Even if citizens had been more critical of industrial pollution, it would have been difficult to prosecute the companies because Kitakyushu City was very dependent of the local industries.

In that difficult situation, measures for controlling industrial pollution were only implemented after citizens suffered damage from water pollution. Citizens' compliants about offensive odor caused by the water pollution of Dokai Bay led the first survey of water quality by a city government. With the scientific results from this survey as a tuning point, efforts for the purification of the aquatic environment of Dokai Bay were increased. From this progress, it can be said that citizens' power made the first opportunity of the enforcement of the measures for purification by government and companies. The role of journalism also can not be ignored for making the citizens' consensus regarding the urgency with which measures against pollution needed to be enforced.

On the other hand, regrettably, in those days the local government of Kitakyushu City had not been given the legal authority for environmental administration. The only thing that the Kitakyushu City government could do was to try response to citizens' demands for the Economic Planning Agency to carry out the preliminary survey. The results of this survey were eventually used to judge whether effluent discharged into Dokai Bay would be controlled or not. After the preliminary survey of Dokai Bay, the Economic Planning Agency had expressed the opinion that " As Dokai Bay is a sea almost beyond rescue, this bay may never be appointed a designated area" . Even faced with such a negative response, the citizens and the local government earnestly appealed to the agency for the appointment until they finally won the appointment.

Companies had started the treatment of the waste waters with all their strength even before the establishment of the old effluent standards. Companies realized their social responsibility for the water pollution because the connection between polluters and the resulting damage was very clear. The development of waste water treatment technology and the enormous investment by plants in equipment led to the brilliant achievements of the satisfaction of environmental quality standards and the following development of cleaner production technology. It can be said that Dokai Bay's success story was the result of joint efforts by the citizens, companies, government and universities. Each branch played an important role, communicating amongst each other, and enforcing the protection measures with trial and

error.

Through the experience of combating industrial pollution, citizens group found that the most important role of citizens is to continually monitor the environment and to make mutual agreements on behalf of environmental conservation. Companies have also demonstrated that industrial water pollution can be overcome with the effluent treatment and furthermore have proved that saving energy and resources can be consistent with quality improvement of products if you consider the lower costs of cleaner production technology.

Government groups have formed or improved legal, institutional, and organizational systems. For instance, the national government established the Water Pollution Control Law which contains the idea of national minimum. Local government also established the Pollution Prevention Ordinance System which is adaptable to each local situation. Various other new methods, such as agreements of pollution prevention and favorable tax treatment and financing for pollution prevention projects were created. Then the Environment Agency and Pollution Measures Bureau were established in national government and local governments respectively to jointly manage environmental administration. Government groups have recognized that scientific research of actual conditions are important work and free access to such information is necessary in order to foresee the outbreak of serious conditions and to begin working towards the enforcement of corresponding measures. In order to facilitate more complete and real time environmental administration, local governments recognized that it is important to environmental administration authority transferred from national to local governments. Kitakyushu City plans to make use of these lessons and the technologies acquired in the course of the experience of Dokai Bay's Success Story for future international environmental cooperation.

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