ECONOMICS OF AQUACULTURE, SEA-FISHING AND COASTAL RESOURCE USE IN ASIA

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Chapter 29

THE IMPACT OF EXPANDING ENVIRONMENT POLLUTION ON JAPANESE FISHERIES IN THE COASTAL ZONE

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Present Condition of Environmental Pollution in Japan

In October 1977, the Environmental Agency of the Japanese Government disclosed the findings of their recent environmental survey.[2/] This survey was carried out with the objective of finding out the present distribution of 78 major chemical substances in order to make it possible for the Agency to take preventive action against probable environmental pollution before it could spread and reach critical levels in Japan. Of these 78 chemical substances, PCN (Polychlorinated Naphthalene) as a substitute for PCB (Polychlorinated Biphenyls) and 39 others were discovered to be potential pollutants which are extensively spreading in Japan, particularly in the major industrial complexes located mainly in the coastal zone, on river sides, and on lake beaches.

Based on these findings, the Agency announced that these chemicals would be another source of chemical pollutants, for which a long term plan of consistent investigation and quick policy measures would be essential. After this announcement, the Agency declared that it would set up an environmental chemical assessment system beginning in fiscal 1979.

In recent years, new chemical substances have emerged for industrial use and have been added to the list of existing substance which has reached a total of more than twenty thousand. The above mentioned 78 chemicals were among those new additions which have made their debut only in the last few years.

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2/ This survey team was composed of scientists from 25 domestic institutions as members of the All Japan Pollution Research Institutions Association, headed by Dr. Motohide Murata, Chairman of the Association as well as President of the Mie Prefectural Environment Science Center.

We should make note of these findings too, because it was only in 1972 that PCB[3/] use was banned by the Government and its substitutes entered the market only after this date. During this short period, six such substitutes, particularly PCT and PCN, were heavily concentrated in the fish of the inland seas and waters which were investigated.

According to this proposed assessment system, primarily three measures are to be taken: (1) to develop a simple method of measurement in order to eliminate soluble matters from the check list thereby focusing only on the important substances; (2) to select the most highly dangerous substances on the basis of the information obtained from the network of national pollution research institutions and from the international system of environmental research institutions; (3) to keep a constant watch over the progress of pollution abatement of chemical substances at the 50 chosen critical locations in Japan.

According to the Labor Ministry's survey findings, one out of 100 workers at sixty factories handling PCB had already been contaminated and had experienced "black pimples" on their skin. Ironically, Japan is now confronted by another serious wave of chemical pollution generated by the various substitutes for PCBs.

It was reported that the Environment Committee of OECD recommended in July 1977 to all its member governments that each member government should formulate guidelines for the chemical assessment. PCB, one of the insoluble chemical substances has thus demonstrated that it is one of the typically dangerous chemicals associated with "cumulative pollution" which spreads easily but is very difficult to eliminate.

Unfortunately, it is extremely difficult to assess the aggregate loss or damage caused, directly or indirectly, by environmental pollution in Japan. This situation is the same with respect to other developed countries. Nevertheless, from legal sources, we have clear evidence of the increasing number of sufferers from pollution in general. Such people fall under the legal category of "certified victims for the purpose of the compensation law scheme". A brief account of this is shown below:

	Non-specific (air pollution related) diseases	Specific (water pollution related) diseases	Total
31st March, 1970	962	203	1,165
31st March, 1971	3,219	211	3,430
31st March, 1972	6,376	312	6,688
31st March, 1973	8,737	728	9,465
31st March, 1974	13,574	1,184	14,758
31st March, 1975	19,340	1,325	20,665
31st March, 1976	34,190	1,550	35,740
Dead	1,062	185	1,247

Source: OECD, Environmental Policies in Japan, 1977, p. 43.

3/ PCB is an insulating substance, which is heat resistant and has chemical characteristics and a DDT-like chemical structure. For this reason, it was widely used by industries such as steel-making, thermal plants, chemical plants, etc. In its peak year of extensive use the total amount of PCB consumed was 14,000 tons at 338 factories in Japan. Starting with the first discovery in Sweden of PCB in 1966 in the bodies of birds and fish then it was also found that rains in England, seals in Scotland, penguines in the Antarctic Ocean, and seals in the Arctic Ocean had been contaminated with PCB. Because of its insolubility,the waste disposal technique is extremely difficult and Japanese scientists have also witnessed its accelerated accumulation in many living organisms. Specifically a high degree of PCB had already been discovered as early as 1970, in the fish in Tokyo Bay, Seto Inland Sea and Lake Biwa. Tuna in the Kuroshio Current too were discovered to contain a high degree of PCB.

To meet this emergency, a large-scale team of scientists was organized in June 1971 to check the extent of PCB impact. Based on their extensive findings and their analyses, it was concluded that PCB was in practically all the foodstuffs of Japanese daily use, i.e. mother's milk, meat, fish, rice, etc. Responding to the team's report, the Special Committee for Public Hazard/Environment Protection of the House of Representatives resolved to "banish" PCB, in April, 1972.

During the period of the high rate of economic growth which occurred during the sixties and early seventies (see Table 1) its adverse effect had also been taking place concurrently, not only in urban but in rural, areas as a whole. In other words, the Japanese people have been losing many things, tangible and intangible, while pursuing the tangible material grains measureable in terms of economic growth [4/]. We are only now beginning to understand how seriously fish within the coastal bay and pelagic fish far off in the ocean have already been contaminated by chemicals in the course of the transformation of their ambient ecosystem.

Rapid industrial expansion located primarily in the coastal zone in such an insular country as Japan which is surrounded by the seas and dominated by uninhabitable rugged mountains (over 80 percent of the total area), caused a more concentrated and intensified

Table 1. Growth rates, Japan and selected OECD countries, 1960-1970 (Percent per year).

Country	GNP	Industrial Production	Energy Consumption	Stock of Automobiles in use
Japan	10.8	14.8	11.6	25.3
U.S.A.	4.2	4.8	4.5	3.7
U.K.	2.7	2.8	2.3	6.6
France	5.6	5.9	5.3	8.2
Italy	5.5	7.0	8.9	24.1
Sweden	4.6	6.1	5.0	6.4
Netherlands	5.3	7.3	8.4	15.7
OECD	5.0	5.9	3.0	6.2

Source: OECD, *Environmental Policies in Japan*, Paris 1977, p. 9.

production in the coastal zone. Such a concentration was accelerated by many large-scale reclamation projects promoted by individual prefectural governments. This kind of spatial maximization was however, as mentioned earlier, concomitantly destroying otherwise very rich grounds for demersal and benthos organisms, depriving them of plankton-rich egg-laying beds, jeopardizing the remaining fish by discharging great quantities of oil and other organic and inorganic matters. Exacerbating this condition, the contaminated rivers and atmospheric pollution have increased the pollution in the marine environment. Accidental collisions of oil tankers gave the last and fatal blow to these marine organisms.

The extent of such pollution in the developed countries appears to have shifted from "visible" to invisible" pollution and from "single" to "combined"-factor pollution. To the layman , for example, the waste water discharged from a chemical plant which had removed the color of the contaminants from the water would appear to be clean, but actually, and in many cases, it contains even more poisonous chemical substances. Citizens of Tokyo are often misled by the fact that the Sumida River cutting through Tokyo looks to them to be more transparent these days than it used to be a few years ago. It may be an indication of the quality improvement of the water. At the same time, it may also be true to surmize that a considerable degree of economic activity abatement has brought about a proportionate decline in the factory operations discharging the industrial waste into the river.

[4/] This high rate of growth of the Japanese economy was propelled by the industrial sector, particularly by such "pollution industries" as oil refineries, thermal power plants, chemical factories, cement, foodstuffs, pulp and paper, paints, etc.

Spatial concentration should be emphasized in connection with this economic activity in Japan. If large spaces had been more easily available for the "pollution creating industry" domestically, they could have avoided acute cases of pollution damage. If they had obtained an uninhabited bay area for building a huge industrial complex, it could have been without a serious court struggle with the fishermen and their community living on aquaculture production in the bay. The critical seriousness of this situation can be seen in Table 2.

Table 2 clearly demonstrates the very unique position of Japan in terms of the concentration of economic activity as compared to some of the other OECD countries on a per km^2 basis. For example, the United States generates only 0.09 million dollars worth of industrial output per km^2, while Japan does 2.04 million dollars from the same space. In the same way, the number of automobile is 331 for Japan and the corresponding number is 27 for the United States.

Because of this intensive concentration as illustrated by Table 2 the Japanese system of technology for pollution abatement and environmental protection is bound to react in a more sensitive way than the other much less density populated industrialized countries in the sense that the residents, the manufacturing enterprises and the government (central as well as local) must somehow agree to co-existence within this limited space.

Marine Pollution – Impact of Red Water on Aquaculture

It has been estimated that approximately 30 per cent of the total coastal beach area of Japan has been transformed from natural beach into cemented artificial coast. This has definitely adversely affected the coastal ecosystem not only the living creatures near the shore but also those migratory, pelagic and offshore organisms. The Extent of the impact

Table 2. Selected economic indicators per km^2 of inhabitable area [c/] in Japan and selected OECD countries, 1974 or 1975.

Country	GNP (10^6 $U.S.) 1975 1975	Industrial output [a/] (10^6 $U.S.) 1974	Energy [a/] Consumption (10^3 TOE) 1974	Number of Automobiles [b/] 1974
Japan	6.05	2.04	4.12	331
U.S.A.	0.32	0.09	0.36	27
U.K.	1.04	0.26	1.00	80
France	0.87	0.25	0.47	47
Italy	0.81	0.24	0.66	74
Sweden	1.67	0.44	1.09	69
Netherlands	3.10	0.83	2.38	146
OECD	0.31	n.a.	0.27	21

Source:

a/ OECD.

b/ International Road Federation, *World Road Statistics*, 1975.

c/ Inhabitable areas are defined here as utilized agricultural areas + urban area + non-utilised agricultural area.

of this artifical coastline is beyond our reach at this primitive stage of marine ecology science. At the same time, as everybody agrees by far the most extensive cause of damage in fisheries is due to oil pollution, both offshore and inshore. Table 3 shows an increasing trend of "damage measurable" cases in fisheries in recent years. The "Others" category implies that most of these cases were caused by oil discharge but it was not possible to identify how and what ships were responsible for the leakage (or waste disposal). If "Oil Pollution" and "Others" were combined, then oil pollution was responsible for 80-90 per cent of the damages to the aquaculture industry in Japan. Since it appears that the frequency of red water [5] (or red tide) is increasing throughout Japan of course supposed to be harmless to the fish in aquaculture production, there is a strong reason for more frequent, more extensive and more persistent occurrences of red water unless even stronger policy measures checking eutrophication are taken. In the light of the extremely variegated and complex characteristics of the mechanism of red water a network of international exchange of information is greatly needed.

Table 4 shows the actual picture of damaged aquaculture production of 1,053 small aquacultural enterprises raising young yellow-tails in four prefectures, Hyogo, Kagawa, Tokushima and Okayama, located in the Seto Inland Sea where expanding industrializa-

Table 3. Accidental damages to fisheries by water pollution, 1971/72 to 1975/76, Japan.

Water	Cause of damages	1971/72	72/73	73/74	74/75	75/76
Sea Water	Red water					
	No. of cases	21	33	27	30	26
	Damage in US $ '000,000	1.78	24.62	1.97	0.35	0.69
	Oil pollution					
	No. of cases	74	57	58	91	77
	Damage in US $ '000,000	6.44	7.09	5.89	86.09[a]	8.99
	Others					
	No. of cases	40	81	51	82	74
	Damage in US $ '000,000	3.65	5.19	4.73	6.34	2.40
	Sea Water total					
	No. of cases	135	171	436	203	177
	Damage in US $ '000,000	11.87	36.90	12.59	92.78	12.08
Inland water	Factory Effluent					
	No. of cases	78	40	42	52	65
	Damage in US $ '000,000	0.28	0.99	0.14	0.26	0.27
	Others					
	No. of cases	93	134	135	216	201
	Damage in US $ '000,000	0.32	0.16	0.95	1.97	0.98
	Inland Water total					
	No. of cases	171	174	177	268	266
	Damage in US $ '000,000	0.61	1.73	1.09	2.23	1.25
Grand Total	No. of cases	306	345	313	471	443
	Damage in US $ '000,000	12.48	38.63	13.68	95.01	13.32

Source: *White Paper on Fisheries, Fiscal 1976 (Gyogyo Hakusho)*. 1977

[a] Due to the flow-out of heavy oil from Mizushima Petrochemical complex. This accident alone caused a loss of $US 70.7 million equivalent to the adjacent fisheries.

[5] Commonly used English names are red water, red tide, brown water, yellow water, and weedy water, etc. From the smell it is called stinking water or baccy water. In Japan too, it is named in different ways at different places.

Table 4. The level of damages and young yellow tails killed by pollution in the aquaculture enterprises in the Seto Inland Sea, 1972.

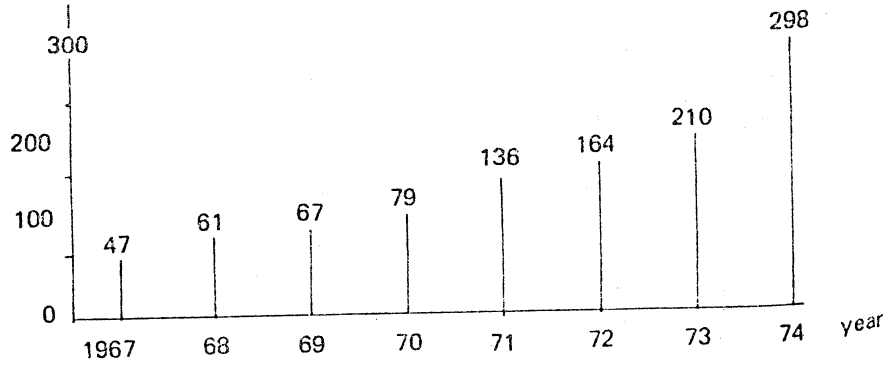
Prefecture	Age of the fish	Affected number of enterprises	Number of fish killed (millions)	Estimated monetary damage ($US millions)
Hyogo	1 year old	126	2.53	2.36
	2 year old	70	0.38	2.54
	3 year old	24	0.04	0.89
	Sub-total	220	2.95	5.78
Kagawa	1 year old	238	4.82	4.48
	2 year old	120	0.66	4.18
	3 year old	28	0.05	0.91
	Sub-total	386	5.53	9.58
Tokushima	1 year old	227	4.97	4.62
	2 year old	219	0.81	3.80
	Sub-total	446	5.79	8.43
Okayama	1 year old	1	0.02	0.01
Total		1,053	14.28	23.79

Source: Akio Murakami, Red Water and Eutrophication, 1976, Tokyo, p. 158.

tion, reclamation of the beach and increasing oil and chemical pollution forced these aquaculturists to convert from once rich fishery in the grounds of the Sea into this culture, rather than capture type of livelihood. 6/

This Red Water phenomena is not a recent occurrence as proved and recorded in ancient history, including the Old Testament. Atmospheric and ecological balance appears to have given rise to this phenomenon. Nevertheless, statistics reveal that as far as Japanese coastal areas are concerned, its frequency has shown a distinct upward trend since the beginning of the sixties which is shown in Chart I.

Chart I. Number of cases of Red Water in the Seto.



Sources: Fishery Agency of the Japanese Government.

6/ Red Water that occurred in the summer of 1977 in the Seto Inland Sea and Harimada killed an estimated three million head of young yellow-tails. It has been reported that most of the aquaculturists may have to give up their business because water deterioration had progressed to such a critical point of eutrophication.

This Chart indicates that red water occurs now either as man-made pollution or as combination of natural and man-made causes. Also, this phenomenon has become a "chronic disease" in many Japanese bay waters and inland seas, requiring the scientists, fishermen involved in inshore fisheries, and the local governments concerned to conduct coordinated study and to launch counter-measures to fight this type of pollution.

Faced by more frequent cases of red water in the early sixties, the Ministry of Education organized a study team on poisonous planktons in 1964. In 1966, confronted with widening damage by red water that ocurred in Western Japan, a research association on red waters was organized by the concerned scientists. Thus, in April of the same year, a symposium was held sponsored jointly by the Japan Fisheries Society and Fishery-Marine Research Society where many studies on this problem were discussed.

Costs of Environmental Pollution

To estimate the cost of pollution one can use an environmental damage function to estimate the relationship between given levels of environmental quality and monetary estimates of the environmental damage associated with these quality levels. Hence, for a given air and sea water quality, the appropriate environmental damage function would estimate the cost of the damage to health, vegetation, materials, etc. resulting from the given air and sea water quality. 7/

When pollution abatement is achieved by employing additional equipment or specific treatment, it is relatively easy to single out the related expenditures for pollution control, but it is more difficult when pollution abatement is achieved by means of different processes. These may also happen to be more productive, or more capital-intensive, or may require larger production units. It then becomes very difficult to disentangle cost increases due to pollution abatement from cost increases due to other considerations.

The notion of "cost" can be made more precise, by distinguishing between three cost concepts:

- investment costs, i.e. the value of pollution abatement investments made during one given year; added over time, investment costs make up a stock of pollution abatement capital;
- operating costs, i.e. the expenditures in manpower, energy, etc. made necessary by pollution abatement, also during one given year;
- economic costs which include: operating costs, depreciation of pollution abatement capital, and opportunity costs of the pollution abatement capital.

Table 5. Anti-pollution investment and GNP, 1975.

Item	$US Million	% of GNP
Central government a/	950	0.2
Local government b/	4,000	0.8
Private enterprises c/	4,677	1.0
Total	9,627	2.0

Sources:

a/ Environment Agency.

b/ Ministry of Home Affairs; the figure is estimated on the basis of 1970-73 data.

c/ Appendix I of *Environmental Policies in Japan*, OECD, 1971.

7/ Karl Goran Maler and Ronald E. Wyzga, *Economic Measurement of Environmental Damage*, A Technical Handbook, OECD, Paris, 1976, p. 13. The authors of this book further mention: "The idea of a damage function is not a new one: similar estimates have been constructed for generations and the concept has been widely applied to the area of environment in the last decade. The lack of conceptual framework associated with many of the past attempts to construct environmental damage functions has contributed to their misuse and inaccuracy.

Some data on pollution abatement investment costs are available in Japan,, [8/] can be utilized to analyze these costs in terms of (1) improtance, (2) trends, and (3) structure. Table 5 shows the anti-pollution investment costs in Japan. The figures appear to be high in comparison with the other developed countries as showed in Table. 6.

Table 6. Relative importance of anti-pollution investments by private enterprises, Japan and selected OECD countries, 1971.

Country	Anti-pollution investments by private enterprises Total investment by private enterprises (%)	Anti-pollution investment by private enterprises GNP (%)
Japan[a/]	4.0	1.0
U.S.A.[b/]	3.4	0.4
Netherlands[c/]	2.7	0.3
Sweden[c/]	1.2	0.1
Germany[c/]	2.3	0.3
Norway[c/]	0.5	0.1

Sources:

a/ Appendix I of Environmental Policies in Japan, OECD, 1977 as stated above, the figures given here are the lower of the two estimates arrived at.

b/ United States Department of Commerce, *National Expenditure for Pollution Abatement and Control*, 1972, *Survey of Current Business*, 55 (2), February 1975, adjusted by the OECD Secretariat.

c/ Calculated from replies to an OECD questionnaire on Procedures for Notification for Financial Assistance in Relation to Pollution Control Expenditures.

It appears that the investment to defend the environment has become a "fashion" in Japan. Indeed, anti-pollution investments are a significant component of GNP. They are of course an even more significant part of investment. For the country as a whole the ratio of antipollution investments to total investments appears to be about 7 per cent in 1975. It was higher for government than for private investments.

It should be noted that there has been a strong urge by citizens' voluntary organization refectural authorites, journalists, and scientific and academic associations in motivating the central government and private enterprizes to make anti-pollution investment decisions throughout Japan which evolved before this high level of spending of public and private resources was mobilized for fighting pollution.

Some information on the relative importance of anti-pollution investment in various OECD countries is available and presented in Table 6. The figures for Japan are much higher than for most other countries though such data should be handled with great care.

The Outlook and Implications for Southeast Asian Countries

Japan is catching at present about 10 million tons of fish. This is 14 per cent of word's total catch (70 million) which places Japan at the top for the world. Yet, due to the adoption of the 200 mile limit Japan's fishing industry, its policy direction, its pattern of catch, structure of fishing technique, its emphasis, priority setting, etc. will and must drastically change.

8/ OECD, Environmental Policies in Japan, Paris, 1977, p. 69.

The author has in this paper rather excessively referred to the "red water" issue. In fact, there was a reason for this emphasis. After the initiation of the age of the 200 nautical-mile limit, in our estimation, Japan will lose its pelagic fishing grounds located in other countries' 200-mile limits and this will cause a reduction in the annual by some 3.7 million tons. Consequently, the Fishing industry will manage to catch only 6.3 million tons.

To view this from another angle, her total catch within her own 200-mile limits will be 5.5 million tons, other conditions being equal. Some 0.8 million tons will be captured in the high seas outside individual coastal countries' 200-mile limits. By mutual negotiations, agreement may be reached between major coastal countries and Japan for the latter's continued operation within their 200 mile limits at least for some time to come.

To whatever extent Japan can obtain concessions, it is still very clear that she must withdrew from most of these fishing grounds unless she offers something else in exchange for her authorized catching under specific conditions. From the Japanese fishery industry point of view, this new ocean regime means a fatal blow to her pelagic fishing industries, especially for those operating in the "traditional" North Atlantic fishing grounds.

Nevertheless, in the long term context of the Japanese fishing industry, sustained and managed fishing within her own 200-miles limits will bear more profound implication that "vested interests" being claimed by some Japanese fishing firms, because, while it is the only fishing ground for the Japanese to ultimately fall back on under the framework of national jurisdiction where she is fully able to exercise her sovereign rights, she is responsible for checking sea pollutions to a minimum extent.

Arresting further marine pollution has several serious implications both for Japan itself and for other Asian and Pacific countries: (1) unless she fails to check further marine pollution, fisheries within her economic sea limits will be jeopardised, particularly so with respect to the developing aquacultural industry which is the last hope for Japanese fisheries; (2) because of the pelagic and migratory nature of some kinds of fish, pollution generated in a highly industrialized country can easily spread in other areas; therefore, a maximum effort should be applied to arresting such pollution particularly chemical pollutants within the inland seas and bay areas; (3) in view of the combined and multi-faceted nature of present-day pollution of sea waters, it is essential to study, carry out investigations, collect data, disseminate information, organize multi-disciplinary task force teams, legal and administrative network to effectively deal with pollution cases should be strengthened; (4) at no time in history have we felt the dire need for selecting types and products of industry based on an anti-pollution view point; (5) basic policies for land use and planning for industrialization have a special bearing on the country's responsibility to the people in supplying "safe" fish to every household.

Japan has been spearheading the world's development of modern aquaculture, both in quantity, variety and quality. We recognize that the most vicious enemy of Japanese fisheries is marine pollution created within Japan and that we shall be able to fill the gap caused by the lost fishing grounds by means of increased aquacultural production and more direct use of such cheap fish as sardines, the bulk of which used to be consumed as feed for young yellow tails and other high-priced cultivated fish. There have been many other cases in which the fish caught were very uneconomically processed (pollock to make fish cake, for example). By our aggregate calculation, it was found that the Japanese are extracting only 9.2 per cent of the total protein from the total 10 million catch. The corresponding figure was 12.0 per cent in 1955 when the Japanese people used to eat sardines directly.

In this new era in which 40 per cent of the once open seas has come individual coastal country's jurisdiction, we are standing at the threshold of two major alternative

directions: to put the oceans and their resources under internationally agreed management 9/ and control, or to pay no concern just sticking to the status quo. From the very nature of the sea, manking must choose the former in some way or another, and before it is too late. Diffusion of sea pollution will probably force manking to manage this resource at the time when more ferocious and powerful sources of pollution which include the expanded use of atomic energy on the land and in the sea for one thing, and large-scale deep-sea fossil exploration and development, for another are threathening the oceaous. The world is faced with a challenge requiring coordination and cooperation in fighting environmental pollution for our fisheries and for our future generations.

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