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

Edited by

Aida R. Librero
William L. Collier

Proceedings of the
Second Biennial Meeting
of the
Agricultural Economics Society of Southeast Asia
November 3–6, 1977
Tigbauan, Iloilo, Philippines

Agricultural Development Council
Philippine Council for Agriculture and Resources Research
October 1979

IMPACT OF POLLUTION ON THE FISHING INDUSTRY IN INDONESIA

APRILANI SOEGIARTO[1/]

Introduction

The Indonesian waters, an area of almost seven million km, cover two-thirds of the Indonesian territory. Therefore, how fully and wisely these waters are utilized in the coming decade will profoundly affect our security, our economy, our ability to meet the increasing demands for food and raw materials, our position and influence in the regional community of nations, and our environmental quality in this country in which the seas are the dominating physical factor.

One of the many uses of our aquatic environments is fisheries. At present fisheries in Indonesia are still considered to be artisanal which means small scale as opposed to large corporations and deep sea fishing. In fact, about 90 per cent of fish production in Indonesia is derived from artisanal fisheries. In the last ten years the average annual rate of increase of total fish production was about 5 per cent. This increase is urgently needed to supply the increasing demand for animal protein for the people and also to contribute foreign exchange to the economy. Unfortunately, as a result of the Indonseian efforts to develop the other sectors of the economy, the aquatic environment has experienced severe pressures, either directly or indirectly. One of these pressures is environmental pollution. Although at present the pollution problem is still localized, conditions are expected to become worse unless steps are taken in the right direction.

The Status of Fisheries in Indonesian

The rate of increase in the total production in Indonesia was estimated five per cent per year. However, in general this increase was confined to the marine sector only. The production from the inland waters slightly declined from year to year due, in part, to urbanization, the labor force being absorbed in other sectors of the economy (e.g. logging industries in East Kalimantan), siltation and eutrophication in many lakes and swamps, reduction of the rice field paddy-fish mixed-culture caused by the increased application of pesticides in agriculture. In 1970, for example, the total fish production was 1.23 million tons. Out of these 66.8 per cent were marine fishes and 33.2 per cent were from capture and culture of freshwater species. Five years later (1975) a total of 1.39 million tons of fish was recorded, which consisted of 71.9 per cent from marine fisheries and only 28.1

1/Director, National Institute of Oceanology, Jakarta, Indonesia .

per cent from inland fisheries (Table 1).

Although subject to substantial annual variations, a strong upward trend has become apparent in the volume and value of fresh fish exports. The upward trend of exports is dominated by the shrimp and prawn industries. Export of fresh prawns were negligible

Table 1. Fisheries Production in Indonesia, 1970-1975 (in thousand of metric tons)

Production	1970	1971	1972	Year 1973	1974	1975	1965
Marine	825.2	828.7	844.7	895.3	960.4	999.6	661
Fresh water	409.4	412.8	420.6	368.2	375.3	389.9	370
Total	1,234.6	1,241.5	1,265.3	1,263.5	1,335.7	1,389.5	1,031
Index (1970 = 100)							
Marine	100	100.4	102.4	108.5	116.4	121.1	80.1
Fresh Water	100	100.8	102.7	89.9	91.7	95.2	90.4
Total	100	100.6	102.5	102.3	108.2	112.5	83.5
Composition (%)							
Marine	66.8	66.7	66.8	70.9	71.9	71.9	64
Fresh Water	33.2	33.2	33.2	29.1	29.1	28.1	36

Source: Directorate General of Fisheries

during and before 1966. In 1967 the export was valued at a low US $ 25,000. – and rose quickly to US$877,000. – in 1969, US$3,630,000 – in 1970 and US$13,742,000. – in 1972. The value of export as of last year (1976) was about US$ 100 million fresh prawns.

Slowly marine fisheries in Indonesia are growing and expanding not only to meet the increasing demands of inexpensive animal protein for the people, but also to contribute to the urgently needed foreign exchange. It is realized, that in order for the fishery industries to grow more rapidly many contraints have to be overcome such as the widespread need for developing technical skills, modernizing equipment and fishing methods, expanding the existing fishing grounds while looking for new ones, studying the life cycle, migration and population dynamics of the more economically important species and seeking new exploitable species. Yet, all of this is treatened by the possible pollution of the inland and marine waters.

Major sources of pollution

The following have been identified as major sources of pollution in the aquatic environment of Indonesia (Anon., 1975, Soegiarto, 1975 and 1956).

Sedimentation

Erosion is a natural process without which there would be no soil. However, accelerated erosion due to poor land management not only will rob the land of its fertility, it will also destroy the freshwater and marine communities on which the sediment settles. Excessive siltation associated with poor land management probably is the single worst form of pollution in the tropical aquatic environment. Indonesia appears to be no exception. Dredging and mining also contribute to the problem.

In Java excessively rapid run off and erosion are recognized to be serious problems leading to flooding of the lowland fields, to damage of the irrigation networks, and to loss of the topsoil. In Java, notwithstanding the extensive terraces on sloping lands, erosion occurs on the higher slopes which are too steep to terrace. Delta build-up along the north coast is accelerating and is likely to be adversely affecting subtidal marine communities that require clear water.

Soemarwoto (1974), for example, has monitored the silt contents of Citarum river, where the Jatiluhur dam is located. He found that the silt content had increased six fold in a two-year period. He reported that on the average the silt content was 3.5% in 1970, 9.3% in 1971 and had increased to the average of 20.9% by 1972. Preliminary measurements of other major rivers in Java had shown a similar pattern.

In Sumatra and Kalimantan (the Indonesian part of Borneo), where the population pressures on agricultural and forestry land are still lower, major erosion problems are probably of more recent vintage. They are largely due to the rapidly expanding logging and lumbering industries. It can be anticipated that fisheries in the vicinities of the mouths of many rivers here will decline, if this has not already begun.

Chlorinated Hydrocarbons

The amount of pesticides and herbicides distributed in Indonesia has increased since 1968, when Indonesia launched the agricultural intensification (INMAS) and extensification (BIMAS) Programmes. A few high yielding rice varieties, such as IRI-5 and IRI-8, were used in these programmes. Due to their greater vulnerability to pests, these strains had received an intensive treatment with pesticides. Although it seemed that the volume of pesticides imported slightly declined in 1970 and 1971, but it started to increase again in 1972 (Table 2).

Table 2. Pesticide Distribution a/ in Indonesia, 1968-1972 (kg).

Insecticide	WS 1968/69 c/	DS 1969 d/	WS 1969/70	DS 1970	WS 1970/71	DS 1971	WS 1971/72
Dimicron	750000	373073	778309	719	–	–	3355
Diazinon	–	851373	27982	125479	145479	28357	64490
Thiodan	–	21494	760476	35703	91386	21333	56810
Lebaycid	–	–	67250	12750	–	–	256
B H C b/	–	–	–	497899	270869	350333	737082
Endrin b/	–	–	–	5290	274669	57697	116592
Sumithion	–	–	–	–	2359	18406	19208
Aldrin b/	–	–	–	–	7815	2734	10352
DDT b/	–	–	–	–	650	388	1116
Total	750000	1245940	1634017	670176	793227	479249	1009261

a/ Distribution signifies distribution for use. It does not mean that the chemicals have been plied.

b/ Organochlorine insecticides.

c/ Overlapping years correspond to the wet season (WS) crop and single year to the dry season (DS) crop.

d/ Irrigated dry season crop.

Hydrocarbon

As of last year (1976) the toral petroleum production in Indonesia was about 1.5 million barrels per day (bpd) and is expected to reach 2.5 million bpd by 1980. Although most of the production is still derived from the land based oil-fields, yet an increasing proportion is coming from the offshore fields. At present about 30 per cent of the production is derived from offshore wells.

Concurrent with the increase of oil production, petrochemical industries are also mushrooming. Generally they are still dumping the effluents in the nearby rivers, lakes or estuaries. Some of the effluents it was found out later, contained hazardous materials, such as sulphuric acid and arsenic. As an illustration it can be mentioned that soon after the Gresik (Surabaya) petrochemical plant started to operate complaints from local fishermen were received due to the fouling of their brackish water ponds and tinting of the fisheries products around the effluents in the estuaries and putting their hazardous materials in containers and then had these containers dumped in deep waters.

Table 3 shows the volume of soil transported through Indonesian water in 1969. The volume probably will be tripled by 1980. Over 90% of the crude oils from the Middle East and Africa for Japan are transported through the relatively shallow and treachenous strait of Malacca. Many accidents and near accidents have taken place in that strait. The biggest one was the grounding of the super tanker (237,690 DWT) SHOWA MARU on January 6, 1975, in Singapore Strait just inside the Indonesian territorial waters (position of the grounding was 01°09'24" N and 103°48'06" E). SHOWA MARU spilled almost 7,000 tons of Middle East Crude into the Indonesian, Singapore and Malaysian waters.

On 17 April 1975, a tanker (TOSA MARU, 62,000 DWT) collided with still another one (CACTUS QUEEN), 132,000 DWT in front of Singapore Harbour. The first tanker broke into two but luckily it was empty, except for the water balast. Still, however, by the 5th day a thin film of oil covered about 30 square miles of Indonesian waters, including the beaches of Sambu and Batam islands.

In 1972 and 1973 the Indonesian Institute of Petroleum (LEMIGAS) made spots checking on the level of hydrocarbon pollution in some Indonesian waters. The following table (Table 4) shows their findings.

Table 3. Volume of oil transported through the Indonesia Waters.

Item	Tonnage (10^6)
Domestic Supply	2.25
Indonesia Crude to Japan	14.41
Middle East Crude to Japan	126.68
African Crude to Japan	2.27
Total	145.61 x 10^6 tons

Source: W. Wisaksono, *et. al*, Beberapa pertimbangan dan saran tentang pengadaan "Prohibited Zone" di perairan Indonesian, 1974).

Table 4. Preliminary inventory on the hydrocarbon level in some Indonesian waters (Wisaksono, 1974)

Location	Hydrocarbon Concentration	Date of Collection
West coast of Kalimantan	20 – 48	May, 1972
Bangka Strait	20 – 40	May, 1972
South coast of Bangka	30 – 200	May, 1972
Around Jakarta Bay	3 – 25	1972
North coast of Java (Cirebon, Semarang and Surabaya)	35 – 60	February, 1973
South coast of Bali	40 – 50	November, 1972
South coast of Bali	14 – 18	November, 1973
North coast of Bali	40 – 70	November, 1973
Eastern Indonesian waters	40 – 60	January, 1973
Jakarta Bay		
– Off Tanjung Priok Harbour	60 – 100	1972
– Around Minyana Island	19.6	September, 1972
– Around Ayer Besar Island	14.1	September, 1972
– Around Kelor Island	20.6	September, 1972
– Around Sakit Island	17.1	September, 1972
– Around Pari Island	4 – 10	August, 1973
Cilacap Oil Terminal	34	October, 1972
Bali Oil Terminal	30	October, 1972
Merak Oil Terminal	6 – 20	April, 1973
Musi River	23 – 54	April, 1972
Around Wonokromo refinery	17 – 33	October, 1973
Around Plaju and Sungai Gerong refineries	9 – 15	May, 1973
Around Balikpapan refinery	8	June, 1973

Source: Wisaksono, et. al, 1974.

Domestic and industrial wastes

At present there is no single sewage system in the entire Indonesian archipelago. All wastes are literally dumped into the natural environment. Rivers and streams traditionally were used as waste baskets. When the human community was still small these waters were able to absorb the waste materials. However, when the community grew in size these natural water environments were unable to assimilate what was dumped in the environment. The eutrophication process started, at first rather slowly, but later accelerated quickly and, if necessary steps are not taken these waters will die and be useless. Many natural water environments in Indonesia are approaching that stage, particularly those that are located in or around population centers or industrial estates. For example, Bilal, and others in 1975 had made a preliminary investigation into the quality of surface waters in the metropolitan city of Jakarta. Their findings showed that almost all surface waters of Jakarta had been severely polluted (Table 5).

Potential sources of pollutants

The following are a list of some potential pollutants that will be of importance in the near future in Indonesia.

Industrial wastes.

At present industrial wastes in Indonesia are still very minor as compared to other sources of pollutants. However, it can be expected that they will be very important sources in the future. Particularly with the curren government drive for industrialization in many sectors of the economy.

Table 5. Preliminary data on the surface water quality of Jakarta.

Parameters	Rivers and Streams in the city (Ppm)	Estuarine (Ppm)
Dissolved Oxygen	2 – 4	4.8 – 6.3
Biochemical Oxygen demand	50 – 100	13.9 – 30.7
Chemical Oxygen demand	99 – 125	–
Ammonia	10 – 20 (or 8.2 – 16.5 as N)	0.7 – 1.1
Nitrate	2 – 6 (or 0.5 – 1.7 as N)	1.6 – 3.4
Phosphate	20 – 31 (or 10 – 15 as P)	1.0 – 3.2
Hydrocarbon	10 – 18	0.0 – 0.39
Ph	6 – 7	6.5 – 7.3
Mercury (hg)	0.004	0.004
Cu	0.01	0.01
Cd	0.01 – 0.03	0.05 – 0.07

Sources: J. Bilal, et. al., *Inventarisasi data perairan Teluk Jakarta,* 1975.

Thermal wastes

Only a few steam power electric generators are operating now in Indonesia with total capacity of about 200 MW. Therefore, the volume of thermal waste from these plants is still very unimportant. however, this condition will change rather drastically when the Indonesian government starts to implement her plan to multiply the electric power in Indonesia.

In 1974 the Indonesian government through the National Seminar on Energy made a projection that by the year 2,000 the electric power in this country will be increased from about 3,000 MW currently operating to 64,000 MW (See Table 6). Out of this sum it was expected that 23 to 39% or 15,000 to 25,000 MW, will be from nuclear power plants. The first nuclear power plant is expected to operate in 1983. It means by the 2,000 the annual volume of hot water being discharged from these nuclear power plant year 2,000 the annual volume of hot water being dicharged from these nuclear power plants alone will be about 657 x 10^6 to 1,095 x 10^6 m^3. Almost all of this hot water is expected to be discharged into the coastal water environment. In addition it is expected also that there will be a tremendous increase in the volume of hot water being discharged from the electrical steam power plants as well as from other industries.

Radioactive wastes

Concurrent with the expected increase in the thermal pollution from the nuclear plants, it is only logical that there will be an increase in the amounts and kinds of radioactive wastes released into the environment. Hopefully, by that time the level of technology has reached such a stage that no radioactivity is released into the environment from any nuclear power plant.

The Indonesian Atomic Energy Agency plans to construct heavy water type reactors for most of the nuclear power plants built in Indonesia. Out of the projected 15 to 25,000 MW, 80%, or about 12 to 20,000 MW, will be built along the coasts of Java.

Table 6. Electric power generation projected for Indonesia by the year, 2,000.

Sources	Capacity (MW)	Percentage
Hydropower	4,000 – 5,000	6 – 8
Oil	12,800 – 39,000	20 – 61
Geothermy	500 – 6,000	1 – 6
Coal	8,000 – 16,000	12 – 25
Nuclear	15,000 – 25,000	23 – 39

Source: National Seminar on Energy, Jakarta, 1974.

Possible Effects of Pollution On Fisheries

Pesticides

The negative effects of pesticides on fish being raised in rice paddies is well known in various parts of the world. The Indonesian Department of Agriculture has tested the effect of Thiodan, Endrin and other pesticides (e.g. diazinon, carbaryl, ferri throthion, surecide, tiptophos) on various fresh water fishes, such as *Puntius javanicus, Ciprinus carpio* and *Tilapia mosambica.* The results showed that even after seven days, the Thiodan toxicity still persisted. With a concentration of 3 ppm after seven days the mortality is 93.3% on P. *javanicus* 60% on C. *carpio* and 56.6% on T. *mosambica.*

Except *Tilapia mosambica,* there have not yet been experiments carried out in Indonesia to test the effect of various organochlorine pesticides on species that are cultivated in brackish water ponds. According to Djalal of the Faculty of Biology, University of Gajahmada-Yogyakarta (personal communication) T. *mosambica* is the most sensitive to DDT, followed by Dieldrin, Lindane and Phenol. Even fishfarmers claimed that decreasing yields in some brackish water ponds in East Java may be caused by the application of pesticides (mainly Thiodan) on rice fields upstream of their ponds located in the coastal areas.

Koeman, et. al. (1974) made a study of heavy metals and chlorinated hydrocarbon pesticides in samples of fish, ricefields, duck eggs, crustaceans and molluscs collected in West and Central Java (including some coastal species). Their findings showed that DDT and DDE were found in the duck eggs, but there was no apparent correlation between the thickness of the eggshells and either the DDT or DDE contents of the eggs. DDT and DDE were also found in samples of fish, crustaceans and molluscs. In some of these samples also dieldrin and endrin were found in trace amounts. BHC isomers and Thiodan were not detected in the samples. They concluded that the low residues found in the samples analyzed very probably ware connected with a relative high rate of natural degradation of the compounds. It probably indicates that toxic effects are likely to occur mainly or exclusively at the time of application and shortly afterwards.

It is further suspected that a certain percentage of the pesticides applied in the agricultural intensification and extensification programmes leaked out to the coastal and estuarine environments. These waters are the most important marine zone in terms of their indispensable functions as habitat, nursery and fishing grounds. Many juvenile forms of fishes and crustaceans, such as *Chanos chanos* and penaeid shrimps, take shelter and grow in these waters. About ninety per cent of the marine fish production in Indonesia derives from traditional artisanal fisheries which, in most parts, operate in coastal and estuarine waters.

Oil

In many areas of the world, and in isolated cases also in Indonesia, the impact of oil pollution on recreational beaches and waters is clearly evident and has resulted in costly clean-up operations. The biological impact of oil pollution on the tropical aquatic environ-ment, however, is difficult to assess. The number of research studies and surveys in tropical seas are so few and fragmentary that useful evaluations cannot be made. Knowledge of the impact of oil on temperature aquatic environments cannot be applied with confidence to the tropics. The impact of oil on the tropical aquatic environments requires separate investigation and special attention.

It is obvious, of course, that major oil spills, such as SHOWA MARU accident, are disastrous to fisheries. For days or perhaps weeks fishermen could not fish, because the catch was tainted with oil, their nets and boats were covered with tar. Benthic communities and mangroves along the beaches normally perish and recover will be slow and uncertain. At this stage there is very little information concerning the long term impact of oil pollution in the tropical aquatic environments.

Concern about biological damage due to the oil industry in Indonesia probably can be concentrated in five areas (particularly marine):

- physical disruption of nearshore shallow water habitats where oil exploitation is carried out.
- damage to the spawning grounds of economic species such as milk fish and pengeid shrimps.
- severe damage, possibly localized, due to massive nearshore oil spills, particularly adjacent to brackish water ponds.
- tainting of fish and fouling of fishing gear.
- refineries dumping wastes into slowly renewed receiving water which may cause local degradation of the environment, especially tidal marshes.

Sewage

The effect of sewage on aquatic resources is too complicated to examine in detail here. Sewage in appropriate dilutions can actually enhance aquatic productivity through fertilization, for example the outer parts of Jakarta Bay. However, when the concentration is too high it may change the species diversity and even reduce fish production.

Sewage pollution poses a potential public health problem, especially through the exposure of filter feeding molluscs to pollutants, including human disease pathogens such as typhoid virus and coliform bacteria. The potential is especially high if the flesh is eaten raw. For example, the *Anadara* bivalve is collected just off the Jakarta coast.

Siltation

The effects of siltation on fisheries probably is more indirect. It is true that heavy siltation can wipe out coral and other benthic communities, reduces the availability of light in the water for photosynthesis, and thus reduces productivity. However, excessive siltation clearly will reduce the volume of water in lakes, rivers and streames. For example, the Fisheries Service in West Java estimated that the fish production decreased about 5 per cent last year due to this kind of process.

Other kinds of pollutants

Rather intensive surveys and investigations are currently being carried out in Indonesia to determine the effects of detergent on the biological communities in the water. Reports from various cities indicate that the sudge persists in the aquatic environment for long time. Sometime, it even appears in drinking water. Therefore, the Jakarta metropolitan government has banned the use and production of such detergent in Jakarta. From the literature on this topic it was reported that detergent affects the chemo-sensory of many species of fishes.

There are, moreover, other kinds of destructive forces that in the long term will affect fisheries in particular and the quality of the environment in general. Beaches and reefs adjacent to centers of human settlements are being destroyed at an alarming rate. If they are not subjected to heavy pollution of domestic and industrial waste from those centers, people directly destroy the beaches and reefs by taking out tons of sand and physically removing hundreds of coral heads daily for road and building construction. During heavy seas these beaches and reefs are slowly eroded away by uncontrolled wave action. Habitats for many economically important species are destroyed.

Conclusion

Although subject to annual variations, but an upward trend has become apparent in the total fish production in Indonesia. In general, however, this increase is confined to the marine sector only. The increase in the total fish production can fill the much needed inexpensive animal protein in order to improve the food quality intake of the people and also the need for foreign exchange.

It is fully realized that in order for fisheries to maintain such growth or to grow more rapidly many constraints to development have to be overcome. One of these constraints is pollution, which may hinder the healthy development of the fishing industries. At present the pollution problem in the aquatic environments in Indonesia is still minor in scale and localized. However, the number of pollution incidents are increasing at an alarming rate and these conditions are expected to worsen. Therefore, various sectors in the Indonesian government are currently trying very hard to formulate policies, and regulations to combat the growing problems of pollution.

References

Anonymous 1975. Coastal zone pollution in Indonesia with emphasis on oil. A reconaissance Survey Workshop held in Jakarta on August 21-24, 1973. The Smithsonian Institution and the Indonesian Petroleum Institute.

Part I : Summary, Findings and Recommendation, 18 pp

Part II : Joint Study Report, 70 pp + Appendices

Part III: Annotated Bibliography on the Biology and Ecological effects of oil pollutation in tropical waters, 82 pp.

Arismunandar, A. 1975. Some notes on a national energy policy for Indonesia. Lembaga Lembaga Masalan Ketenagaan Perusahaan Unum Listrik Negara, 200 pp.

Bilal, J.: S. Wahyu, Mulyono and Aboeyuwono 1975. Inventarisasi data perairan Teluk Jakarta. Environment Newsletter 1(1): 3-6.

Koeman, J.K.; J.H. Pennings; Ross Rosanto; O. Soemarwoto; P.S. Tjios; S. Blanche; Santosa Kusumadinata and R. Roestami Djajadiredja 1974. Metals and chlorinated hydrocarbon pesticides in samples of fish, sawah-duck eggs, crustaceans and molluscs collected in West and Central Java, Indonesia. Publications on Ecology and Development, Institute of Ecology, Padjadjaran University, No. 2: 14 pp.

Saanin, Hasanudin 1960. Toxicity of insecticides and herbicides to some Indonesian cultivable fish species. Proc. 4th Pan Indian Ocean Sci. Gongr. Sect. B. Sci.: 297-303.

Soegiarto, Aprilani 1973. Impact of human activities upon coastal environment in Indonesia. In B. Morton (Ed.) Pacific Science Association Special Symposium in Marine Sciences, Hongkong 8-14 December 1973, Symposium Papers: 111-113.

Soegiarto, Aprilani 1975. The state of pollution in the coastal environment of Indonesia. Paper presented at the 13th Pacific Science Congress, Vancouver-Canada, 18-28 August, 1975.

Soegiarto, Aprilani, 1977. Dispersion and transport of pollutants in the aquatic environments. Paper prepared for the 5th FAO/SIDA Workshop on Aquatic Pollution in Relation to Protection of Living Resources, Manila, Philippines, 17 January – 27 February 1977.

Soemarwoto, O. 1974. Pendekatan ekosistem terhadap permasalahan waduk. Paper presented in the Environmental Week, Jakarta, 21-26 January 1974, 11 pp + 5 figures.

Wisaksono, W. 1974. Beberapa aspek pencemaran minyak di perairan Indonesia. Paper presented in the Environmental Week, Jakarta, 21-26 January, 1974, 25 pp + 4 maps.

Wisaksono, W., B. Sakyo; J. Bilal; J. Punjanan and M. Hutomo 1974. Beberapa pertimbangan dan saran tentang pengadaan "Prohibited Zone" di perairan Indonesia. Study Group on Pollution, Indonesian Institute of Petroleum, 66 p.

APPENDICES

Welcome Address

Opening Remarks

Summary of AESSEA Activities

Brief Remarks

Keynote Address

Closing Address