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WATER POLLUTION PROBLEMS IN THAILAND

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Introduction

Thailand has a total land area of about 510,000 km^2 and a coastline of 2,600 km, of which 1,875 km are along the Gulf of Thailand including about 480 km along the Inner Gulf. It is bounded on the south and west by the Andaman Sea and on the east by the South China Sea. The Gulf of Thailand covers an area of 320,000 km^2, extending from the shallow part of the South China Sea over 750 km to the N.W. between the Thai – Malaya Peninsula and Indochina. The coast of the Central Plain of Thailand is its northern boundary. The average depth of the Gulf is 45 m and maximum depths in the central part are 70 to 85 m. Towards the coasts the depth gradually decreases. The Inner Gulf of Thailand receives freshwater runoff from several large rivers. Through the vast Central Plain of Thailand the largest rivers, the Chao Phrya, contibutes the major drainage to the Gulf, at an average of about 127 million cubic metres per day. The natural sediment load reaching the Gulf of Thailand by way of the Chao Phrya is in the order of 1½ million tons per year. Most of these solids deposit near to the river mouth. Sludge deposits alter the normal benthos activity changing the diversity and biomass of the bottom flora and fauna. This may be brought about by toxins, direct burial and suffocation, interference with normal feeding and reproduction processes and the predominance of species which are more tolerant of suspended solids or sludge deposits.

Many areas in the Gulf of Thailand support a rich population of edible shellfish. These fishes are capable of concentrating bacteria, viruses and other pathogenic organisms which may be introduced into their environment thereby reducing their commercial value and endangering public health. The deposition of sludge blankets may preclude their culture altogether as they require a clean bottom.

Abbreviations: BOD, Biochemical Oxygen Demand, 5 days, 20 °C, a measure of organic pollutants in terms of their oxygen demand; DO, Dissolved Oxygen.

Apart from harmful effects on commercial fishing, water pollution gives rise to many public health hazards. While it may not be possible to restore "natural" conditions in streams that are polluted, the objective should be to control pollution so that there is no significant interference with the normal uses of water. To this end, legal powers are required so that polluting discharges may be controlled. Technological competence is essential for the efficient and economic handling of wastewater problems.

Sources of Pollution

The water pollution problems is Thailand, as well as other cases of environmental degradation, is largely due to the rapid population growth and accelerated pace of industrial activities since the early part of 1960's. The major sources of water pollution are:—

1) *The general public* which generate domestic sewage discharged into rivers and other bodies of water after undergoing primary treatment or no treatment at all. It was estimated that Bangkok and the towns up river annually dispose of more than 50 thousand tons of BOD into the Chao Phrya River[1].

The BOD reaching the river undergoes biological stabilization in the river on its way to the sea. Hence the BOD reaching the Inner Gulf will be equal to that amount which reaches the river less the removal due to self purification by the river. The degree of this removal will depend primarily on the travel distance or travel time from the point of entry to the river to the sea.

2) *Industries* which discharge process wastes including by-products of various types of industrial operations. Many toxic elements such as mercury, lead, cadmium, copper and zinc are common industrial waste components.

At present, many industries are located in high population density areas or mixed with residential areas in the city. There are some 15,000 industrial establishments of varying sizes, carrying on a wide range of activities, located within the Inner Gulf. They produce a range of products including sugar, tapioca starch, paper, food and processed food products, alcohol and beer, cloth, etc. Those producing white sugar, paper, alcoholic beverages, textiles, and tapioca starch are main contributors of river and coastal water pollution. In April 1970, 4,000 tons of sugar refinery waste was dumped into the Mae Klong River causing an estimated 10 million baht damage downstream[2]. Anaerobic conditions killed fish and crab. At the river's mouth, cockle clam farms suffered heavy losses. About two years elapsed before conditions in the farming area returned to normal.

3) *Agricultural activities* such as the use of chemical fertilizers, pesticides and animal wastes from feedlots. Pesticides are used extensively in agriculture and for control of disease vectors. In Thailand DDT is still used because of its effectiveness and comparatively low cost. A considerable part of the fertilizer used for rice paddy fields is washed away by irrigation water and flows into rivers, estuaries, or other bodies of water. This fertilizer causes eutrophication and supports the

growth of water hyacinths. This unwanted plant grows very fast, covering the major area of water bodies, clogging the gates, and disrupting the beneficial uses of water bodies.

4) *Mine tailings*, mostly in the southern part of Thailand, which cause rapid siltation of stream beds due to the discharge of inorganic wastes which sometimes carry toxic substances thus choking rivers and other waterways, making the waters unfit for any other use. While the immediate effects on aquatic life are traumatic, little information is available on the long-range effects, i.e. how long before the natural ecology is restored. Such study has been recommended for consideration of the Marine Biological Research Center at Phuket in southern Thailand, operated jointly by the Governments of Thailand and Denmark.

5) *Oil discharges* from oil refineries, oil depots and water crafts. Deballasting, cleaning of oil tanks and bilge water pumping are common causes of oil reaching the water environment. Several small spills have occurred from time to time. There has fortunately been no major oil spill in the Gulf.

Estimates of Present Pollution Loads

Of the five major pollution sources previously mentioned, sanitary wastes and industrial wastes are the two principal sources that pollution loads can be quantified. Ludwig[3] estimated the total BOD load from sanitary and industrial wastes draining into the Inner Gulf from the five major rivers and along the coastline as in Table I.

TABLE I: ESTIMATED BOD LOAD REACHING INNER GULF OF THAILAND[3]

Sources	BOD load reaching Inner Gulf (tons BOD/day)		
	Sanitary wastes	Industrial wastes	Total
Chao Phrya River	50.8	10.3	61.1
Mae Klong River	2.5	47.4	49.9
Tha Chin River	4.5	4.5	9.0
Bang Pakong River	1.2	0.5	1.7
Petchburi River	0.2	4.8	5.0
Coastline	18.6	157.7	176.3
Total	77.8	225.2	303.0

The estimated total BOD load of 303.0 tons/day represents the estimated maximum daily load discharged into the Inner Gulf. This load includes the discharge of 62.7 tons BOD/day created by the 27 sugar mills in the region during the cane sugar processing season (December—April). During the off season (May—November) the estimated BOD load discharged into the Inner Gulf will be 235.8 tons/day or about 78 percent of the maximum load.

Significant effects of industrial wastewater and sanitary sewage on water quality include (a) increasing BOD, (b) decreasing DO, and (c) increasing coliform concentrations. Several surveys on the quality of water in the river and canals in Bangkok showed that the BOD ranged between 5–70 mg/l and the DO many times dropped to 0 mg/l[4]. The number of pathogenic organisms such as *Salmonella* and viruses is expected to be very high, since the main sources of pollution are human waste and refuse. Only the proper treatment of the water supply and such extra precaution as boiling water before drinking can protect those consuming water from such health hazards. Some factories also discharge waste containg heavy metals and compounds which are toxic to aquatic life. Table II lists some substances which may be encountered in Thailand and which are toxic to fish.

TABLE II: SOME SUBSTANCES TOXIC TO FISH[5, 6]

Substances	Nature or source	Approx. lethal concentration to fish (mg/l)
Aldrin	Insecticide	0.02
Alkyl benzene-sulphonate	Synthetic detergent (sewage)	3–12
Chloramine	Chlorinated effluent	0.6
Copper sulphate	Algicide, metal processing	0.03
Cyanide	Plating	0.04–0.1 (CN)
DDT	Insecticide	0.01
Mercuric chloride	Pesticide	0.01 (Hg)
Methyl mercaptan	Oil refining, wood pulp waste	1.0
Parathion	Insecticide	0.2
Phenol	Chemical wastes	1–10
Silver nitrate	Photographic wastes	0.004 (Ag)
Zinc	Galvanizing	0.01

The National Research Council[7] recently reported a study of the physical, chemical and biological characteristics of the Gulf of Thailand. Mercury and lead concentrations in sea water throughout the Gulf of Thailand were found to be much higher than the average found in most seas. The highest concentration of mercury, 4 ppb, was found near Phai Island. However, no deleterious effects caused by mercury have been reported within this region. Other heavy metals concentrations, including silver, cadmium, cobalt, copper and zinc were within the average for the world's sea waters.

Institutional Responsibility

Since 1970 there has been growing concern of the government for these pollution problems. Several investigations have been carried out to detect the nature and degree of environmental pollution. For examples, the Ministry of Public Health has been regularly monitoring the general quality of surface waters. At the Asian

Institute of Technology (AIT), the Environmental Engineering laboratory is actively engaged in a number of projects concerned with water pollution problems. The Institute for Environmental Research of Chulalongkorn University, is responsible for a number of studies of environmental pollution. To obtain data on the extent of pollution and its impact on the marine resources, a programme of field study and investigation has been underway as a cooperative venture of the national Research Council, the Thai Navy's Division of Ocaenography, the Department of Marine Science of Chulalongkorn University, the Department of Fisheries of the Royal Thai Government and some other governmental agencies since 1973.

In 1975, the National Assembly passed an Act entitled "Enhancement and Conservation of National Environment Quality Act", which established a National Environmental Board with responsibilities among other things for water pollution control.

Quite a number of workshops, seminars and symposia have been held. Laws, regulations, and standards in relation to environmental pollution are being prepared. These activities show that the Government of Thailand is concerned with the control of environmental pollution.

The responsibilities for water qualities vary considerably from country to country. In Thailand the primary responsibility is shared between the Ministry of Public Health, the Ministry of Industry and the National Environmental Board, directly under the Prime Minister's Office.

Control Measures

The authorities have taken some measures in dealing with the grossly-polluting domestic wastes resulting from the concentration of population in the Bangkok metropolitan area. Not only will the consulting engineers be concerned with designing works for the collection of waste waters but also with selection of the method. The extent of treatment will be based upon the results of a pollution survey of the rivers and canals. This survey has already been initiated through the combined efforts of a number of governmental departments described above. When sufficient data have been collected, it will be possible to assess the effects on the receiving waters of discharging all the city's wastes from one outfall. Consideration can then be given to the kind and extent of treatment necessary to minimize these effects.

Generally, the treatment of domestic sewage raised no difficult technical problems; however, the area where the need for technological competence will be most pronounced is in dealing with industrial wastes. As governmental policy is to attract industry, it would be difficult to impose prohibitive limitations on industrial development but, in the long-term view, it would be unwise to allow continuation of the free discharge of untreated wastes. Responsible industries are normally willing to cooperate in pollution control programmes but have no internal expertise to handle their wastewater problems. It is essential that sufficient time be given to industry to evaluate their wastes in terms of quantity and quality and to test their

sublethal effects of waste materials on aquatic biota requires extensive study. Monitoring of stream water quality and biota will provide useful data on a river system which can be used in the future to warn of increasing pollution or indicate recovery of a rehabilitated stream.

Conclusions and Recommendations

There is no difficulty in disposing of wastes resulting from man's activities; they may be released to the nearest water course or the sea, or discharged on land. However, there are few instances in which this may be done without causing physical, economical, or other damages. Normally it will be necessary to minimize the wastes whenever possible, to collect those that are inevitable, and to treat them in such a way, and to such a degree, that they will produce no damaging effects.

In Thailand the uncontrolled discharge of wastes into surface waters impose serious limitations on their use for water supply. The extent of pollution now reaching the Inner Gulf is estimated to average 303 tons BOD/day. Pollution problems in the five major rivers draining into the Inner Gulf should be prevented. Municipalities and sanitary districts along the river must cooperate in solving their domestic sewage problems. In addition, the authorities should conduct monitoring programmes in each river in different seasons of the year, to study the assimilative capacity of the rivers, particularly in the periods of low flows. Major downstream water uses must be determined and their quality requirements established. Finally, in-depth analysis is critically needed for assessing the impact of pollution on the receiving waters. As this study proceeds, the evolving results can then be used to evaluate alternative regional pollution control systems and to select the best plan.

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