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Industrialization and Environment in Thailand: A NIC at What Price?

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Thailand, traditionally an agricultural country and a major food exporter, is undergoing rapid rates of structural change and industrial growth. Industrial output has been growing at double-digit rates in recent years and is expected to continue to do so well into the twenty-first century. Already, industry's share of the Gross Domestic Product (GDP) is more than twice that of agriculture's, and Thailand is well on its way toward becoming a Newly Industrialized Country (NIC). However, both the rapid rate and the pattern of Thai industrialization are generating many environmental problems with which the country is ill-prepared to deal. Industry's heavy concentration in the Bangkok Metropolitan Region (BMR) and the surrounding coastal provinces is accelerating urbanization and compounding urban problems. Traffic congestion; water shortages; solid waste; and air, water and noise pollution problems have noticeably worsened during the last few years of rapid industrialization. Both environmental awareness and environmental legislation (setting of standards) have advanced considerably in recent years, but enforcement is lagging. In the meanwhile, very little is known about the environmental implications of the changing structure of Thai industry and of the government's industrial and trade policy, including industrial promotion.

The purpose of this TDRI study is to analyze the relationship between industrial growth, structural change and industrial policy to environmental problems and to propose policies that would both "minimize" and internalize the environmental cost of industrialization in an advanced developing country. The study also attempts to demonstrate that uncontrolled environmental problems generated by rapidly advancing and geographically concentrated industrialization ultimately become a constraint to industrial growth itself, apart from their impact on the quality of life.

Finally, the study will derive the implications of the analysis for industrial and environmental policies and examine the feasibility, cost and effectiveness of alternative policy instruments such as incentives to influence industrial location, effluent charges, pollution permits, environmental funds, bonds and audits. The present overview reports on some preliminary findings, with the focus on industrial trends and hazardous waste and waste water management.

TRENDS AND PATTERNS OF INDUSTRIAL POLLUTION

The Thai economy has grown at the rate of 7 percent during the 1970s, 6 percent during the early 1980s, and 10 percent during the late 1980s. If Thailand were an advanced industrialized country, pollution loads would have grown roughly proportionately, because of limited structural change in such an economy. Thailand, however, has undergone dramatic structural change during the last twenty years, with the share of agriculture falling from 27 percent in 1970 to 15 percent today, while the share of industry* rose from 26 percent to 35 percent during the same period. Therefore, the rate of economic growth understates the growth rate of industrial pollution, which follows the higher rate of industrial growth: 8 percent in the 1970s, 10 percent in the early 1980s, and 13 percent in the late 1980s. Furthermore, there has been a structural change within industry itself, which witnessed the share of the non-hazardous-waste-generating industry in industrial GDP reduced from 71 percent in 1979 to 42 percent over the period of 1979-1989 and that of the hazardous-waste-generating industry double, from 29 percent to 58 percent. This means that industrial pollution is becoming potentially more harmful and less assimilable by the environment.

The shift from import substitution industrialization in earlier years to export promotion more recently has meant more reliance on low-cost-1abor industries, which may also be less polluting per unit of value added. Second, the concentration of industry implies certain economies of scale in pollution control and treatment that may partially offset the loss of natural assimilative capacity by overloading. Third, the high profitability of much of Thai industry suggests a degree of affordability of pollution control expenditures without a significant loss of international competitiveness.

Given Thailand's relatively large size and the considerable assimilative capacity of its environment, the current level of industrialization and implied pollution load would not present a serious problem if it was evenly distributed throughout the country. While hazardous waste always presents a problem, most other pollutants—especially biodegradable wastes—could be assimilated if widely distributed. In Thailand, however, (unlike Taiwan, for example), industry is highly concentrated in the BMR and its surrounding provinces, whose landscape air and water bodies, particularly rivers, are receiving pollution levels far in excess of their assimilative capacity. Fifty-two percent of industries (76 percent in terms of GDP) are located in the BMR. This has two negative and two positive implications for the environment. On the negative side, the concentration of industrial waste in a limited space destroys the environment's natural assimilative capacity through overloading. The proximity to the country's larger urban centers increases the potential damage from industrial pollution as well the cost of treatment, due to the mixing of heavy metals from industry with biodegradable waste from households. On the positive side, the concentration of industry and hence industrial waste in and around Bangkok means economies of scale in pollution control and treatment, and that the rest of the country is virtually free of industrial pollution. The government's policy to decentralize industry into the rural areas, to reduce congestion, and to spread the benefits of industrialization should also take into account the environmental pros and cons of such a policy. The implication might be to promote a limited number of clusters of industry outside the BMR rather than throughout the countryside. Taiwan, for example, is now experiencing a backlash against its comprehensive rural industrialization.

PROJECTION OF INDUSTRIAL POLLUTANTS

We will focus on three main groups of industrial waste: hazardous waste, biodegradable waste, and air pollution. Hazardous waste is defined as, "any waste or combination of wastes which because of its quantity, concentration or physical, chemical or infectious characteristics, may (1) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or (2) pose a substantial present or potential hazard to human health or the environment when improperly treated stored, transported, or disposed of, or otherwise managed" (Engineering Science Inc. 1989).

Hazardous waste is classified into 16 groups (as shown in Table 1) because each group has a different risk factor and cost of treatment. Biodegradable waste is represented by biochemical oxygen demand (BOD) in industrial waste water. In terms of air pollution from industrial sources, the focus is on sulfur dioxide (SO_2), and nitrogen oxide (NO_x). Two other important air pollutants, carbon dioxide (CO_2) and lead (Pb), have more to do with energy generation and transportation than industry per se and are thus covered by TDRI's "Energy and Environment Study." This overview focuses on hazardous waste and, to a lesser extent, biodegradable waste. While part of the full study, air pollution is not covered by this overview.

Industrial Hazardous Waste

The manufacturing sector is by far the largest generator of hazardous waste—ranging from heavy metals to toxic chemicals and from solvents and acid waste to organic and inorganic sludge. In terms of volume, 90 percent of all hazardous waste is generated by manufacturing, four percent by hospitals and laboratories, and one percent by municipalities. In terms of risk and the likely impact on health, hospital waste is more significant than its small share suggests because of the far larger numbers of people who are exposed to it. However, what is particularly alarming about industrial hazardous waste is the projected rapid growth of such waste, both in quantity and hazard, as Thailand becomes further industrialized. In the absence of effective controls, what determines the volume of hazardous waste is the profitability of the hazardous-waste-producing industry vis-a-vis other industries. Since most industrialized countries require and enforce proper treatment and disposal of such waste, the industry tends to have a comparative advantage in flowing to countries with lax environmental regulations. As an export-oriented, rapidly industrializing country, Thailand is at risk of attracting "too much" of the "wrong" type of industry.

Hazardous waste from industrial sources stood at 1.1 million tons in 1986. Based on a very conservative assumption of 5 percent GDP growth during 1987-2001, Engineering Science Inc. (1989) has projected that the hazardous waste generated by the manufacturing sector will reach 1.9 million tons in 1991, and 5.7 million tons by 2010 (see Figure 1). Heavy metal sludge and solids is by far the largest group, accounting for 77 percent of the total. The largest generator of heavy metals is the basic metal industry, followed by fabricated products and electrical machinery. The main generators of oils are transport equipment, machinery, textiles and chemical products. Acid and alkaline waste is generated mainly by fabricated products and electrical machinery, which along with paper and furniture, are also the main generators of inorganic sludge. Solvents, the last major category of hazardous waste, is generated by the printing, rubber, machinery and chemical products industries. Thus, eleven out of the twenty TSIC industrial groups—comprised of 28,000 factories—are significant producers of hazardous waste.

With the notable exception of the pilot Bang Khun Thian treatment facility in Thon Buri, the bulk of hazardous waste is currently freely disposed of into rivers and land fills or is stored in drums on-site with little or no treatment. While no empirical assessment of the risks involved has yet been made, experience in other countries such as the United States suggests considerable risk to health and ground water supplies. A preliminary assessment by analog of environmental risk factors for Thailand is shown in Table 1. Public health statistics indicate that the incidence of occupational diseases, adjusted for population growth, has increased 4.4 times between 1978 and 1987 (Ministry of Public Health 1990).

Industrial Biodegradable Waste

It is estimated that 5.6 million tons of BOD load are currently generated by selected industries which are major generators of biodegradable waste (Figure 2). Sugar factories account for 63 percent of the BOD load, followed by pulp and paper (15 percent), and beverage factories (6 percent). The balance is contributed by tapioca mills, rubber industries, textile factories and slaughter houses, in that order. Preliminary medium-term projections indicate that the BOD load will rise to 9.5 million tons by 1996, with the share of sugar factories, tapioca mills and slaughter houses reduced and that of the pulp and paper industry and the beverages industry increased.

Most of this waste is discharged untreated in the form of industrial effluent into public water bodies. Industrial effluents combine with waste water from households to reduce the dissolved oxygen (DO) in rivers to levels below ambient standards. The Chao Phraya and Tachin rivers are already below the ambient standard set by the National Environment Board (NEB) and are at risk of becoming anaerobic in certain heavily polluted sections during part of the year. The monitoring data of the Department of Industrial Works (DIW) for 1986 (the year for which data are most complete) indicate that the total BOD load in fourteen rivers has reached 516,000 tons. Treatment at a 70 percent level of the modest cost of 6 baht per ton would cost between 1.0 and 2.3 billion baht, depending on the volume of waste water associated with the monitored BOD load (see Table 2). Treatment of 70 percent of projected BOD loads for 1990 as shown in Figure 2 (assuming an average concentration of BOD of 5,000 mg/liter) would cost as much as 4.7 billion baht, which is 2.6 percent of the 1990 GDP of the BOD-generating industries. This could be an overestimate, despite the use of conservative figures. First, proper pricing for water would reduce the amount of waste water discharge. Second, charging waste-generators for waste water treatment would induce efforts to minimize waste. Third, unlike hazardous waste, central water treatment is not always the lowest-cost approach to water pollution control.

REGULATING POLLUTION EXTERNALITIES

While industrial waste is an inevitable byproduct of industrialization, industrial pollution need not grow in proportion with industrial growth. First, a shift toward less heavily polluting industries would reduce the growth of industrial pollution below the rate of industrial growth. Second, a shift to more efficient industrial production and energy-generating technology would further reduce industrial pollution per unit of GDP. Third, a switch toward less polluting or less hazardous raw materials would also reduce industrial waste in both quantity and toxicity. Fourth, dispersion of polluting industries would reduce the ambient concentrations and increase the effective assimilative capacity of the receptors. (Except at very low levels of hazardous waste, concentration of hazardous-waste-generating industries may in fact reduce the problem by facilitating control, collection, treatment and disposal). Fifth, waste treatment reduces the quantity and toxicity of industrial waste, while proper disposal reduces the associated damage to both human health and the natural environment.

The waste- or damage-minimizing changes in production technology, plant location, or waste treatment and disposal will not be taken voluntarily by the individual firms that generate the waste for the following reasons:

1. Industrial pollution and its associated damage to other individuals, activities, or the environment is an externality or a spillover that does not perceptively affect the operations of the firms that generate it.
2. Waste reduction or treatment involves additional expenditures, which increase production costs and reduce competitiveness. Thus, in the absence of some form of regulation, free disposal of uncontrolled and untreated waste is the most "economic" and therefore preferred option of private industry.

With pollutants accumulating at an exponential rate of 12-15 percent a year and becoming increasingly hazardous, no piecemeal patching up of existing regulations will reverse the trend. Without an effective mechanism of industrial pollution control, Thailand is likely to acquire the dubious reputation as a "pollution haven," increasingly attracting heavily polluting industries spun off by other countries. The consequent structural change of Thai industry toward pollution-intensive industries, the projected continued rapid industrialization for the next two decades, and the declining assimilative capacity of an already overloaded environment will accelerate environmental degradation—leading to a reduction of the quality of life and ultimately constraining growth itself. One risk is the discouragement of foreign investors in the long run; another is damage to the thriving tourist industry; and a third is retaliatory tariffs for unfair trading from countries with higher effective environmental controls.

POLICY ALTERNATIVES: THE FIVE PRINCIPLES

In designing effective policy instruments for industrial pollution control, the following five principles need to be observed:

1. **The Ambient Quality Target:** The aim should be the achievement of a desired environmental quality (ambient standard), not a uniform effluent or emission standard or level of waste treatment. This is because ambient quality is the ultimate objective, and it can be achieved through various means; uniform effluent standards is only one, and rarely the most efficient, instrument. The target ambient quality standard should be specific, monitorable and verifiable.
2. **The Minimum Cost Principle:** The desired ambient quality standard must be attained through the most cost-effective means that is at the lowest possible cost to the economy—including cost to the regulatory agency, such as monitoring and enforcement cost; and cost to the industry, such as a reduction in output and an increase in the pollution control cost. This implies that the chosen policy instrument must be enforceable in the Thai context, at a relatively low cost, and with a minimal leakage.
3. **The Polluter Pays Principle:** The chosen policy instrument must be self-financed, and perceived to be equitable. The polluter pays principle is now widely accepted around the world. While the payment is collected from the industrial producer, the ultimate burden (incidence of the pollution charge) is shared between the producer and the consumer in a proportion determined by the elasticity of demand for the product in question. In the case of an exported commodity sold in competitive world markets (and therefore facing infinitely elastic demand), the full burden is assumed by the producer;

therefore, his competitive position may be affected. Hence, the following two principles should be considered:

4. **The Competitiveness Imperative:** The policy instrument chosen should not significantly reduce the overall competitiveness of Thai industry, although it would unavoidably change the industrial mix in the medium to long run, if it is effective at all. Maintaining competitiveness while controlling pollution implies the existence of inefficiencies that the chosen instrument should seek to reduce.
5. **Policy Transition:** Changing the industrial mix from high- to low-polluting industries is one of the desirable outcomes of an effective pollution control instrument. However, structural change takes time, since investments have already been made under "pollution haven" conditions that will take time to depreciate. Therefore, for both fairness and efficiency, allowance for adjustment during the transition period must be made. The new policy is also likely to be more acceptable to the industry if it is gradually phased in over an appropriate period. The stability and predictability of the policy is critical if industrial investment is to be gradually shifted from high- to low-polluting industries.

In choosing an appropriate pollution control instrument that fulfills all these conditions, consideration must be given to the type of industrial waste and to the scale and geographic distribution of industry. A central treatment facility is likely to be suitable for hazardous-waste-producing industries because hazardous waste cannot be assimilated by the environment and is harmful even in small quantities. To ensure that such waste is properly treated and safely disposed of, as well as to benefit from economies of scale in treatment, a central treatment facility can best fulfill the stipulated conditions, provided it is appropriatedly financed and operated as discussed below. Another case where a central treatment facility might be suitable is for small-scale industries concentrated in a given location, which affords economies of scale in joint waste treatment. A case in point is the Bang Khun Thian hazardous treatment center in Thon Buri.

ENVIRONMENTAL FUND INITIATIVE FOR HAZARDOUS WASTE MANAGEMENT

Building on the Bang Khun Thian central treatment experiment, we propose the establishment of an Environmental Fund for the centralized treatment of hazardous waste throughout Thailand. In an earlier section, hazardous waste was projected to reach 1.9 million tons by 1991. However, not all hazardous waste can be cost-effectively managed through central treatment facilities. In the following we exclude metal smelting—the single largest producer of heavy metals—because smelter generated hazardous wastes are relatively stable and can usually be kept on site by appropriate containment measures (Engineering Science Inc. 1989). Even with the exclusion of metal smelting, heavy metals from other industrial processes present the greatest environmental risk, because of both their large quantities and their high relative risk factor (see Table 1). Infectious waste is second in terms of environmental risk, but it will also be excluded since the focus of the study is on manufacturing waste. This leaves 595,000 tons of industrial hazardous waste (1991) that require proper collection, treatment and disposal. This must be done at the minimum possible cost. In terms of cost effectiveness (i.e., risk reduction per million baht of expenditure), the priority for collection, treatment and disposal should go to heavy metals, photo wastes, alkaline wastes, and acid wastes (see Table 1). Not only should the generated waste be traced, recovered, treated and disposed of at the minimum possible cost without sacrificing safety standards, but also the generation of waste itself must be minimized. Therefore, an ideal hazardous waste management system should provide generators of waste with the incentive to both minimize waste and to fully declare it.

The proposed Environmental Fund aims not only to fund treatment and proper disposal of waste but also to encourage minimization of waste. The Fund would be financed from charges on hazardous waste generators in proportion to their type and quantity of waste and its distance from the treatment facility. The charge should be set at the cleaning up cost, which is about twice the treatment and disposal cost. The latter was estimated to average 1,000 baht per ton, including transport, treatment and disposal costs. In actual implementation, the charge would vary according to type and quantity of waste and the distance involved (see Table 1). At the level of the projected 1991 industrial hazardous waste of 600,000 tons, a 2,000-baht-a-ton charge would raise 2.4 billion baht. Fifty percent of this amount would constitute the Environmental Fund for Hazardous Waste; the rest would be deposited in an Escrow Account earning interest on behalf of hazardous waste generators. Once the contracted waste delivery for treatment is made in full, the funds and interest in escrow would be returned to the waste generator concerned. The

Fund would be used to treat and properly dispose of hazardous waste, while the Escrow Account would act as a bond to ensure delivery of waste and additional funds for cleaning up any waste that is disposed of untreated by generators which fail to deliver it for treatment. Implementation of the proposed scheme would help arrest the exponential growth of hazardous waste and the even faster growth of the cost of treatment (see Figure 1) due to the increasingly refractory waste being generated.

Two related problems arise. First, how is the hazardous waste generated by each factory to be determined, since there is clearly an incentive here to under-report? There are a number of options that can be used either individually or in combination. Fairly accurate parameters for hazardous waste generation by type, production process and output capacity do exist (see for example Engineering Science Inc. 1989). The deliverable waste can be set based on these parameters or at the average for the industrial group as a whole, based on the previous year's statistics and/or monitoring results. This raises the second issue: how to detect a factory that produces more waste than the industry average and disposes of the excess quantity illegally to avoid additional payments. At the other extreme, a firm may argue convincingly that it is more efficient than the average firm in the industry and therefore generates less waste. After all, a good system should encourage waste minimization. To deal with these two issues an environmental auditing system, to be detailed in the full study, is proposed. This system, combined with random inspection of the production process, should both minimize unreported waste and verify claims of reduced waste generation that would qualify generators for rebates and lower waste coefficients for subsequent years.

The implementation of the proposed system is consistent with and will be facilitated by the introduction of the value added tax system. The contribution of the industry to the Environmental Fund through the hazardous waste charge amounts to about 0.2 percent of the industry's valued added, or one percent of its profits assuming a conservative 20 percent profit rate. The more efficient the industry is in its production process, the less waste it generates and the less it has to pay for waste treatment and disposal. The industry thus has the incentive to reduce waste, and this should further reduce its expenditure on hazardous waste management. With charge-induced waste minimization, the development of business opportunities in hazardous waste management and induced structural changes toward less polluting industry, the impact on the economy would be minimal. The industry, at a minimum cost to itself and the economy, would thus make a tremendous contribution to its own image and to the quality of life of the Thai people, while preserving its competitiveness in world markets.

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The complete report, "Industry and Environment," will be presented at the 1990 Year-End Conference.