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Photo on front cover: *One of the many oil trucks that travel daily into and out of Bangkok. Photograph by Juliette Lamont*

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Oil Transportation in Thailand*

Tienchai Chongpeerapien

THE OIL DISTRIBUTION SYSTEM

Oil product consumption in Thailand was about 13,040 million liters (excluding LPG), 74 percent of which (9,640 million liters) was produced by domestic refineries. Most of the oil trade in Thailand has been controlled by the country's four largest oil companies: namely, PTT, Shell, Esso and Caltex. Altogether, these four companies control about 94 percent of the total market share. The rest of the market is held by small, independent oil companies, most of which are 100 percent Thai-owned.

About 43 percent of this oil is consumed in Bangkok (5,761 million liters), followed by 11 per cent in the East and South, and about 7-8 percent in the remaining regions (see Table 1).

Approximately 78 percent of the oil – either produced domestically or imported from Singapore – is shipped to primary oil installations in Bangkok. This includes most of the oil produced by the two refineries in Sriracha (which is shipped to Bangkok by barge), and by the Bangchak refinery. From these main installations, the oil products are further distributed to consumers in Bangkok and in the Central, North, Northeast, and Western regions. There are two modes of oil transportation from the installations in Bangkok. First, the oil is sent directly by tanker trucks of varying sizes to end users in Bangkok (including Don Muang Airport), and in most other parts of the country. Of the 9,225 million liters of oil sent from the Bangkok installations, 7,745 million liters (84 percent) were transported by truck (see Table 2).

Table 1 Oil Product Sales by Region

Million liters

	Total	Four Major Companies
Bangkok	5,761	5,471
Central	981	854
North	1,170	1,125
Northeast	1,169	1,103
East	1,471	1,358
West	1,027	989
South	1,460	1,419
Total	13,039	12,318

Second, a relatively small amount of oil – 16 percent of the total – is transported by rail tankers to consumers in the North and Northeast. Furthermore, rail oil transportation service is available from Bangkok installations only. Despite continuously rising oil consumption in all parts of the country, the volume of rail oil product transportation has been declining. The volume fell from 1,618 million liters in 1982 to 1,462 million liters in 1988.

As for the other regions, oil products are being shipped to consumers in the South by barge from Sriracha refineries, and also by barge from Singapore. Consumers in the West receive oil products partly by barge from Sriracha but mostly by truck from Bangkok. Consumers in the East are serviced directly by trucks from Sriracha refineries.

Because of the relatively heavy reliance on tanker trucks, the amount of oil truck traffic in the Bangkok metropolitan area is very high. It is estimated that about 1,100 trucks transport oil from Bangkok oil installations each day. These trucks play a significant role in the city's traffic problems, particularly in the Bangkok Port areas and in some key outbound highways.

COMPARATIVE COSTS OF OIL TRANSPORTATION

One of the reasons why trucking has become the primary oil transportation mode in Thailand is because it affords the lowest economic and financial costs for

* *This is a summary of the "Oil Transportation System in Thailand" study. TDRI was hired to conduct the study jointly with the Oil Transportation Policy Working Group, Chaired by Dr. Phisit Pakkasem of the NESDB.*

Table 2 Oil Transportation From Bangkok Installations

Million liters

	Truck	Rail	Total
Bangkok	4,783	-	4,783
Central	647	140	787
North	451	678	1,129
Northeast	485	650	1,135
West	772	1	773
Other	608	11	619
Total	7,745	1,480	9,225

inland oil transportation. Compared to railways, oil transports by truck – especially those having a 30,000-liter capacity – is significantly less costly both in the short run (in which investment costs are excluded) and in the long run. For example, this study has found that the short-run financial cost of oil transportation from Bangkok to Khon Kaen by 30,000-liter truck is 18 satang per liter, compared to 28 satang per liter by rail. Since the government's allowed transportation markup to Khon Kaen is 32 satang per liter, proprietors transporting oil by truck make a 14-satang-per-liter transportation "gain," giving them a competitive edge in upcountry sales. Thus, proprietors have had a strong incentive to transport oil by truck in recent years.

In the long run – when investment costs are considered – truck transportation to Khon Kaen will cost 23 satang per liter, while long-run rail transportation costs will be 47 satang per liter. Furthermore, economic cost calculations also consistently indicate lower oil transportation costs for trucks compared to railways. Thus, a 30,000-liter truck is more efficient than are railways for oil transportation in Thailand.

It has been found that rail transportation has a high double handling cost in addition to its high operating cost. Oil transported by rail needs to be stored at upcountry oil depots first before final deliveries to end users are made by truck. A large number of these depots have been underutilized because of the increasing popularity of the tanker truck, which has compounded the problems of high rail system unit costs.

On the other hand, because barge transportation has lower costs than transport by tanker truck, barges have become the main transportation mode for the Southern provinces. Barges have very low operating costs and are able to compete with trucks despite the double handling costs involved.

In summary, the current oil transportation system in Thailand consists mainly of truck transport for inland destinations and barge transport for the Southern provinces.

THE IMPACT OF FUTURE OIL CONSUMPTION ON OIL TRANSPORTATION

The National Energy Policy Office has projected that oil consumption in Thailand will grow from 14,834 million liters in 1988 to 36,550 million liters by the year 2000. The demand will grow between 10-14 percent annually during the Sixth Plan period, and will gradually decelerate afterward. Regionally, high demand will come from Bangkok and its nearby provinces, and from provinces in the East.

Given its high future demand, a large quantity of oil will pass through Bangkok oil installations. Under the scenario of the existing oil transportation system, Bangkok installations will be handling 28,640 million liters of oil by the year 2000, compared to 9,225 million liters handled in 1987. If the shares of transportation held by the various modes remain unchanged from today's, the number of oil truck trips from Bangkok installations will increase from 1,100 in 1987 to over 3,000 by the year 2000. Such a large number of truck trips will certainly compound the ever-worsening Bangkok traffic problems in the future.

MEASURES FOR IMPROVING THE FUTURE OIL TRANSPORTATION SYSTEM.

This study has proposed a number of measures that would improve the efficiency of the country's oil transportation system. They include the construction of a major oil product pipeline, the sharing of oil depots by oil companies, and others. These measures are summarized as follows:

- **Sriracha Oil Product Pipeline Construction** The PTT's proposed Sriracha-Saraburi oil product pipeline should be built. The study has found that the 185 km, 18-inch pipeline has lower financial and economic costs compared to all other inland transport modes, including the 30,000-liter truck. For example, the long-term financial costs for carrying oil from Sriracha to Don Muang Airport are 6, 11 and 28 satang per liter for pipeline, 30,000-litre truck and rail transport, respectively. The pipeline should be developed as a public/private joint venture project having PTT as the coordinator and major shareholder. The pipeline's primary purpose is to carry oil products to a new common terminal in Saraburi, which will supply consumers in the Central, North and Northeast regions. Small terminals along the pipeline route will supply parts of Bangkok, and a branch line to Don Muang Airport should also be built.

- **BAFS Pipeline** Should the Bangkok Aviation Fuel Services (BAFS) decide to build the Bangchak-Don

Muang jet fuel pipeline, the pipeline should be a multi-product line in order to increase the project's economic viability. The study has found that the Sriracha-Saraburi pipeline could transport oil to Don Muang at a lower cost than could the proposed BAFS line. Thus, consideration should be given to constructing the BAFS line as a supplementary pipeline connected to the Sriracha line in order to increase the supply security for Don Muang Airport.

- **Bangkok Oil Installations** The role of Bangkok oil installations should be reduced from that of a nationwide supplier to that of serving Bangkok area consumers only. In addition, the Bangchak refinery should become a common supplier, providing oil to all licensed oil traders for distribution in the Bangkok metropolitan area. In this way, the oil distribution system in Bangkok will become more efficient, and oil truck traffic in the city will be minimized.

- **Western Oil Depots** To further reduce oil truck traffic in Bangkok, oil companies should be encouraged to build oil depots on the upper west coast of the Gulf of Thailand to receive supplies directly by barge from Sriracha. The depots will serve consumers in the Western Region.

- **Rail Transportation** The rail transportation system should be streamlined in order to improve efficiency and to reduce operating costs. The rail transportation tariff must be substantially reduced in order for railways to become competitive with other transportation modes.

- **Joint Depot Utilization** One way to cut rail transportation costs is by increasing the utilization of upcountry oil depots, particularly those in the North and Northeast. Joint usage of some depots – for example, in Ubon and Udon provinces – will help reduce the high unit operating costs of these depots.

- **Inland Waterways Transportation** The study has found that transporting oil by river barge to Nakhon Sawan is relatively costly compared to truck transport. It also incurs high risk because of uncertainty about the water level, especially during the dry season. A fully loaded barge requires a 2.8-meter draft, whereas the water level in some parts of the river will be as low as 1.7 meters during the dry season period.

- **Upcountry Transportation Allowance** Bangkok has been the point of origin for Thailand's oil supply for decades, and the government has established its upcountry oil transportation allowance based on the distance from Bangkok. Thus, oil dealers in the provinces come to Bangkok to pick up their oil because in this way, they make the largest transportation "gain." However, since most of the country's refining capacity is in Sriracha, it will be appropriate to establish Sriracha as oil supply point of origin as far as the transportation cost markup is concerned. Provincial oil traders will thus have an incentive to pick up their oil from Sriracha. They could also take advantage of the new highways linking Sriracha with the North and Northeast, bypassing Bangkok. In this way, oil truck traffic in the capital city will be further reduced.

Constraints to Technology Development in a Rapidly Growing Economy: The Case of Thailand*

Chatri Sripaipan

INTRODUCTION

This paper's aim is to first describe the constraints to technology development in Thailand, then to apply these contraints to other fast-growing economies in general, so that some common lessons may be learned. We shall begin by presenting the case of Thailand.

The Thai economy has experienced very rapid growth in the past few years. In 1987, 1988 and 1989, GDP growth rates in real terms were 8.47, 11.0 and 10.5 percent, respectively. Moreover, the figure for 1988 was recently revised by the National Economic and Social Development Board (NESDB) to 13.2 percent – which is the fastest growth rate in 30 years. Growth rates for 1990, 1991 and 1992 are also predicted to be high – 9.9, 9.2 and 9.0 percent, respectively (TDRI 1989).

Other macroeconomic indicators also appear favorable, at least for the near future. Trade deficit as a percentage of GDP is predicted to be on a downward trend, from 7.1 percent in 1990 to 6 percent in 1992. The current account deficit is expected to decrease from 2.9 percent of GDP in 1990 to only 2.0 percent in 1992. The only concern is a possible high inflation rate, which will generally accompany high economic growth. The yearly increase in consumer prices is predicted to peak in 1990 at 6.5 percent and to decline to 4.1 percent in 1992 (TDRI 1989).

However, despite the optimistic position suggested by the macroeconomic indicators up to the early 1990s, there are many concerns about the sustainability of Thai economic growth in the longer term. As we are now facing infrastructure constraints, a shortage of human resources, worsening income disparity, a deteriorating environment and rising land and food prices, a number of questions need to be addressed: Have we been on the right path of social and economic development? How can we cope with the unstable and rapidly changing world economy? What sort of balance should we strike between economic growth, income distribution, and the environment?

On the question of the sustainability of Thai development, Dapice and Flatters (1989) examined eight major perils in the world economy: world-wide depression, protectionism, commodity price instability, technological change, labor-cost competition, foreign capital inflows, exchange rate volatility and environmental issues. They concluded that:

> *External shocks will be the major constraints facing Thailand in the near- to medium-term future. Of crucial importance, however, will be economic policies that anticipate and present the development of internal bottlenecks and barriers to economic growth; ...Possibly the greatest policy problems facing Thailand at the moment are the inadequate attention to infrastructure, and, most importantly, formal education and training.*

While agreeing with the above statement, we would like to more closely examine the problems of constraints to technology development and to present some recommendations for overcoming them.

STATUS OF TECHNOLOGY DEVELOPMENT IN INDUSTRY

Industry can be divided into resource-intensive, labor-intensive, scale-intensive, differentiated, and science-based (see Annex A). Between 1970 and 1987, there was a marked shift from resource-intensive industries to labor-intensive ones. In production, the share of resource-intensive industries as a percentage of GDP fell from 54.3 percent to 39.7 percent, while the labor-intensive industries increased from 23.3 percent to

* *Summary of a paper presented at the International Symposium on Asia's West Pacific Development and Cooperation on Technology and Economy, May 22-24, 1990, Beijing, China.*

38.7 percent. Other sectors of the industry neither increased nor decreased in importance. As for exports, the shift from resource-intensive to labor-intensive industries for the same period was even more pronounced. Resource-intensive industries decreased from 86.8 percent to 37.4 percent, and labor-intensive industries increased from 10.7 percent to 39.0 percent; the scale-intensive, differentiated and science-based industries, though small, all made very substantial gains (Dahlman et al. 1990).

Examples of labor-intensive industries that made substantial contributions to Thai exports include gems and jewelry, textiles and garments, footwear, toys, and furniture. The increase of differentiated goods for export was due mainly to electronics parts and components, especially integrated circuits.

Recently, TDRI conducted a study on the technological capability of Thai industry (Kritayakirana et al. 1989). Altogether, 116 firms in the three areas of biotechnology, materials and electronics were surveyed (Annex B). The biotechnology-based industries are mostly in Sector 31 of resource-intensive industries. The material-based industries can be found in the sectors of labor-intensive, scale-intensive, and differentiated goods. The electronics industries are mainly included in Sector 383 of differentiated goods. These industries were graded on four capabilities: namely, acquisitive, operative, adaptive and innovative. Acquisitive capability refers to the firm's ability to search, assess, negotiate and procure relevant technologies as well as to install and start up production facilities. Operational capability includes the efficient operation of process and machinery, including its maintenance. Adaptive capability comprises knowledge acquisition, technology digestion, and minor product and process modifications. Finally, innovative capability involves carrying out research and development activities and making radical or major product and process modifications.

It was found that the operative capability had the highest score in all industries. The acquisitive and the adaptive capabilities scored slightly lower, and the innovative capability was very low. This shows that Thai industry still concentrates its efforts on production. It has not sufficiently mastered the core technology to make further developments other than minor adaptations. Statistical analysis of the scores yields some interesting findings, such as:

- Large companies have a better operative capability than do small ones, but they still lack effective technological strategies.
- Small companies cannot efficiently operate the existing equipment and processes.
- Some multinationals appear to be better able to transfer technology than do others.
- BOI-promoted companies do not take sufficient advantage of their privileged status to import more technology.
- Surprisingly, export companies have only average operative capabilities, and their technological strategies can be characterized as being passive or reactive rather than active or aggressive.

These findings – particularly the last one – raise questions regarding the ability of Thai exporters to seize opportunities in areas of potential dynamic comparative advantage. The lack of effective technological strategies even by large companies and export companies may dim the prospect of self-sustaining industrial development.

CONSTRAINTS TO TECHNOLOGY DEVELOPMENT: LESSONS FROM THAILAND

In trying to explain why the technological capability of Thai industry is not as high as we would like, we should look at both the demand for and the supply of technology.

Demand

Technological capabilities reside in productive sectors. Therefore, the demand must come from them. Dahlman et al. (1990) suggest various reasons why privately-owned enterprises invest so little in R&D. First, R&D has not been viewed as necessary because most companies are still producing traditional standardized products. Second, the environment is not sufficiently competitive for stimulating innovation. Third, existing government incentives are inadequate. Fourth, more complex technology is imported as turnkey packages. In addition, foreign and joint-venture companies do not contribute toward creating an innovative environment, because they rely on technology from the parent company; small local firms cannot afford to invest in R&D and Thai firms tend to be short-term and commercially oriented.

All of these factors are true to varying degrees. Sripaipan et al. (1990) proposed that the economic and policy factors are perhaps the most important in creating demand. They concluded that:

- Because the manufacturing companies are rapidly expanding their production capacity to meet increased demand, they do not experience external pressures to innovate, nor do they have the spare resources to develop new or differentiated products.
- The industrial environment, which still has high import protection and/or restrictive entry of new companies to some sectors, does not put sufficient pressure on firms to innovate.

- Production machinery, R&D equipment, and measuring instruments face high import tariffs, discouraging extensive use, especiallv for small-scale industries.
- There are no fiscal incentives for R&D – such as credits, deferred profits and accelerated depreciation of equipment – to encourage firms to undertake R&D, as in other countries. However, a withholding tax is levied on royalties and license fees for foreign technology to discourage their use.

Supply

For a developing country like Thailand, it is natural to expect that the S&T infrastructure in the country is insufficient to meet the needs of the industry. We shall consider the S&T infrastructure under S&T institutions and human resources.

S&T institutions that are needed to help companies effectively use technology are:

1. Technical consultancy services for realizing the full potential of the equipment and processes bought.
2. Testing services to qualify products to meet national and international industrial standards.
3. Calibration services for measuring instruments.
4. Information services to source technical supplies, products and services.

For companies that perform technology development activities, there are further needs to access the information of current S&T activities both domestically and abroad in order to seek collaboration.

The inadequacy of these services limits a firm's access to technology. The problem is particularly severe for small firms with limited human resources and connections.

As for human resources, the present economic boom has caused a severe shortage of technical workers for production. This situation is likely to remain for some years. Although the demand for R&D personnel is presently not high, neither is the supply. If circumstances foster a greater need for company R&D in the future, as anticipated by many top executives, the shortage of R&D personnel will hamper the efforts of industry to upgrade itself into more technology-intensive and higher value-added areas. The shortage of personnel at the level of secondary school graduates is another danger. Thailand presently graduates less than 300,000 secondary education students a year. This is extremely low in relation to its population of 55 million. As industry requires an increasingly higher level of education for workers to operate more sophisticated machinery, the class of workers could be depleted in a not-too-distant future. This is another factor that can limit the move up the technology ladder.

RECOMMENDATIONS

In this section, some suggestions are made for remedying constraints for technology development, possibly with cooperation from the West-Pacific countries.

Demand

One of the most potent tools for stimulating technology demand is industrial competition. However, competition cannot be so high as to discourage participation or so low as to encourage complacency. Import tariffs will need to be lowered and barriers to entry removed, with full awareness of the vulnerability of infant industries, which need to be protected in their initial stages.

To provide incentives for technology activities, the scheme should be designed to reach a large portion of the industry, thus raising overall technological capability. Lowering import duties on capital equipment will certainly have far-reaching effects. It will lessen the cost of companies acquiring modern technologies. Tariff protection for local capital equipment manufacturing is not needed due to its inherent high profit margin and high value-added. On the other hand, fiscal incentives such as tax rebates should be introduced only at an appropriate stage of development – when the tax base generated from R&D related activities is sufficiently large, and there are measures to prevent non-R&D performers from exploiting such incentives.

Supply

Dahlman et al. (1990) suggested that by acquiring foreign technologies and effectively using and diffusing them, one can go a long way before experiencing the need to develop one's own technologies. While we do not dispute the validity of the suggestions, we still believe that government ought to be more active in building up both the S&T infrastructure and human resources.

If Thailand continues to maintain a high rate of economic growth in the next decade, it will soon become a Newly Industrialized Economy (NIE). We will need a large number of high-quality personnel to operate the country. The personnel required are not limited to science and technology. We need economists who can guide us in the rapidly changing world economy, lawyers who can negotiate technology deals and intellectual property right agreements, as well as sociologists who can analyze the effect of social transformation. Can

the present educational system produce these people? The answer is that the system will need major changes in concept, outlook and incentives. Teaching should be made an envied profession in both social and economic status. Secondary education should not serve simply as a bridge between primary and tertiary education but should have its own objective of providing the students with some specific skills. There should be a proper mix of S&T graduates in proportion to those in the social sciences and humanities. Finally, it should be understood that a lot more investment in people is needed and that both the government and the private sector are responsible for such investment.

As for the S&T infrastructure, the emphasis should be on small industries, which comprise the majority of industrial enterprises, in order to enable them to reach high standards, to specialize in a particular technology, or to grow. They should be provided with services that improve access to and utilization of modern technology. Here, the technology consultancy service is extremely important in providing information and technical assistance. However, an enterprise also needs management and marketing expertise as well as financial resources in order to survive. It would also be very beneficial if the technical consultancy service can provide such services in an integrated package. Management and marketing expertise can be obtained through training or in association with a business partner. Financing of small-scale industries will need a dedicated financial institution for small-scale industries.

CONCLUSION

A fast-growing economy can be caught in a dilemma. Although the importance of indigenous technological capability is recognized for sustained development, the demand for R&D has not been high in Thailand despite rapid economic growth. This is due to a number of restrictive policies that limit competition and discourage R&D. At the same time, there is a scarcity of qualified personnel and an inadequate S&T infrastructure.

It is important that such a malady be diagnosed and remedied by revising related policies and devising new ones to create an environment that is conducive to technology development. To accommodate the transformation, investment for educating a new generation of personnel must be made. Small enterprises should be encouraged to serve as engines of growth and innovation.

As the political and economic complexion of the world has changed from "bipolar" to "multipolar," regional cooperation is becoming even more significant. Countries of the Western Pacific should cooperate in trade, industry and technology, and Thailand could play an active role in such a cooperation.

COOPERATION: A POSTSCRIPT

For cooperation to be long lasting, it is essential that there are mutual benefits for all concerned parties. Countries of the Western Pacific must get to know each other well before areas of cooperation can be identified. One way of accelerating the process is to provide each other with information. The problem is, which information is required? It is difficult to ask people to provide you with information that they do not possess or in which they are not interested. I personally am interested in science and technology development and policy in other countries, and I am willing to share imformation about Thailand with you. What I am suggesting is a network based on personal interest, which can be created immediately without cost. If the interchanges continue, then it can be institutionalized.

The second suggestion for cooperation is "strategic alliance" (as opposed to "complimentarity"). The word "strategic alliance" has been used to describe the cooperation between competitors in some specific areas. It shows that cooperation and competition can coexist. "Complimentarity" means assigning each partner to a specific task which compliments the others'. An example is the ASEAN auto parts project, which was designed to encourage each member to manufacture parts that would be assembled into an ASEAN car. The talks went on for decades without results, because the members have conflicting interests and they do not own either the technology or the market. Recently, however, this "complimentarity" project was implemented by a transnational corporation (TNC) of the ASEAN countries by establishing manufacturing plants of diesel engines and electrical equipment in Thailand; steering gears and electrical equipment in Malaysia; transmissions in the Philippines; and gasoline engines in Indonesia.

Countries of the Western Pacific region may be trading competitors in a number of commodities – such as rice, rubber, palm oil, and others – but there are certainly areas in which cooperation in these commodities can be mutually beneficial. Each producing country has certain indigenous technological capabilities. There is no reason why we cannot join forces in research to improve product quality and spcifications. An example here might be collaborative programs in biotechnology research to fully exploit the comparative advantage of biodiversity in the natural resources of this region. Some countries may be further ahead than others in a specific area, and the whole group can thus benefit. Each country still has to adapt the technique to local conditions and will compete with the others on the world market. In this way, intraregional cooperation can be encouraged while fostering local competition, which is necessary for healthy and vigorous growth.

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Annex A

Classification of Manufacturing Industries

Following are the five categories of manufacturing industries with their respective ISIC classification of the covered sectors.

1. Resource-Intensive Industries

31	Manufacturing of food, beverages and tobacco
323	Manufacturing of leather, except footwear and wearing apparel
331	Manufacturing of wood, wood and cork products, except furniture
3411	Manufacturing of pulp, paper and paperboard
353	Petroleum refineries
354	Miscellaneous products of petroleum and coal
369	Other non-metallic mineral products
372	Non-ferrous metal basic industries

2. Labor-Intensive Industries

321/322/324	Textile, wearing apparel and footwear industries
332	Manufacturing of furniture and fixtures,except primarily metal
380/381	Metal scrap from manufactures of fabricated metal products and fabricated metal products, excluding machinery and equipment
39	Other manufacturing industries

3. Scale-Intensive Industries

34	Manufacture of paper, paper products, printing, publishing, except 3411
351	Manufacture of industrial chemicals
355	Rubber products
356	Plastic products not elsewhere classified
361/362	Manufacture of pottery, china earthenware, glass and glass products
371	Iron and steel basic industries
384	Transport equipment excluding 3845

4. Differentiated Goods

3821	Engines and turbines
3822	Agricultural machinery and equipment
3823	Metal and woodworking machinery
3824	Special industrial machinery and equipment excluding 3823
3829	Machinery and equipment except electric not elsewhere classified
383	Electrical machinery, apparatus, appliances and supplies
3852/3	Photographic and optical goods, watches and clocks

5. Science-Based Industries

352	Manufacture of other products
3825	Office, computing and accounting machinery
3851	Professional, scientific, measuring and controlling equipment
3845	Aircraft

Annex B

Technological Capability Rating of Producing Firms

Industry	No. of Firms	Acquisitive Capability	Operative Capability	Adaptive Capability	Innovative Capability	Average Capability
Aquaculture	4	4.54	4.15	4.13	3.25	4.02
Feed	4	4.21	3.75	3.94	2.95	3.71
Seed	3	3.46	3.70	3.69	2.80	3.41
Dairy	3	3.61	3.20	3.08	2.20	3.02
Flower	4	3.08	3.25	3.00	2.40	2.93
Organic Acid	4	2.79	3.55	3.63	1.55	2.88
Alcohol	4	3.25	2.80	2.75	2.05	2.71
Health	6	2.92	3.50	2.63	1.37	2.61
Biotechnology Based Avg.		3.44	3.49	3.32	2.25	3.13
Foundry	6	3.57	3.03	3.30	2.23	3.03
Heat Treatment	2	3.40	4.40	4.05	2.50	3.59
Machining	3	4.10	4.33	4.03	1.67	3.53
Ind'Machinery	8	3.93	3.68	3.50	1.98	3.27
Engine Parts	2	4.25	4.70	4.65	1.40	3.75
Forging	2	2.95	2.60	3.65	0.90	2.53
Die/Sheet	6	3.63	3.77	3.85	1.50	3.19
Resin	4	2.65	3.75	2.90	1.45	2.69
Plastics	3	3.10	2.53	1.87	0.80	2.08
Rubber	5	3.24	2.80	3.18	1.84	2.77
Latex Product	1	2.50	4.80	3.50	1.40	3.05
Compound Clay	1	3.20	2.80	2.30	2.00	2.58
Refractory	4	3.05	3.05	3.58	1.90	2.90
Tableware	1	2.80	3.40	3.30	2.00	2.88
Sanitaryware	3	3.23	4.27	4.60	3.03	3.78
Tiles	3	3.17	3.67	3.93	1.13	2.98
Insulator	1	2.80	2.80	3.30	2.20	2.78
Material Based Avg.		3.40	3.51	3.51	1.78	3.05
E.Component	10	2.68	3.86	2.13	0.53	2.30
Consumer E.	8	2.54	2.78	2.25	0.41	2.00
Communication	3	3.17	3.20	2.56	0.83	2.44
Industrial E.	4	2.67	2.35	3.00	1.31	2.33
Comp. H/W	4	2.83	2.90	2.42	1.00	2.29
Comp. S/W	3	3.28	3.20	3.67	2.25	3.10
Electronics Industry Avg.		2.76	3.16	2.49	0.85	2.32

Source: Kritayakirana et al. (1989)

Rating: Ratings were assigned on the scale of 1 to 5.

5 Best performance compared to leading firms in developed countries
4 Very good compared to average capability in industrialized countries
3 Above average performance among Thai firms
2 About average among Thai firms
1 Below average among Thai firms

Water Resources: Shortage Amidst Abundance

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It is somewhat paradoxical that Thailand, a country with plentiful freshwater resources (180 cu. km) and adequate rainfall (over 1,500 mm per year), is suffering from increasing shortages of water for both domestic and industrial use. Of the 3,900 cubic meters of annual renewable water resources per capita, 18 percent, or 600 cubic meters per capita, is withdrawn annually. Of this, 90 percent is used for agriculture, 6 percent for industry, and 4 percent for domestic use. Yet, water shortages are widespread and are increasing rapidly, both in frequency and severity. In the tourist city of Pattaya, for example, water scarcity has given rise to a thriving industry and a new form of land use – "strip mining" and trucking water to hotels and restaurants. In the industrial province of Samut Prakan and other areas of the Bangkok Metropolitan Region, excessive ground water pumping has led to land subsidence of 5-10 centimeters per year, affecting an area of 4,550 square kilometers and contributing to flood damages equal to billions of baht. Despite considerable expansion of its distribution system, the Metropolitan Waterworks Authority (MWA) is able to supply only 43 percent of the area and 66 percent of the population under its responsibility. In Chiang Mai, the Provincial Waterworks Authority (PWA) pumps 600,000 cubic meters of water a month from the Mae Teng canal to satisfy only 65 percent of household demand; the rest needs to be met by ground water – at a rate of about 200,000 cubic meters a day, compared to a recharge rate of under 150,000 cubic meters.

Concurrently, the water demand for domestic, commercial and industrial use is growing rapidly, due to the accelerating economic growth and structural change of the economy. The economy is experiencing its third year of double-digit growth and is expected to continue to grow at annual rates of 6-8 percent for the next ten to twenty years. Assuming an intermediate growth rate of 7 percent and proportional water use, the demand for water should double in ten years and more than triple in sixteen years – outpacing a supply which faces limited raw water allocation, water pollution, and rising supply costs. Without a mechanism to register growing scarcities and to balance growing demands and dwindling supplies, water shortages are likely to increasingly emerge as a binding constraint on economic growth.

The objective of this TDRI study (which is part of a larger research project on "Industrialization and the Environment") is to answer the following set of questions and policy issues arising from the growing strain on Thailand's water resources posed by the Thai economy's rapid growth and industrialization:

1. Given the demographics, income growth, and structural change projections and the current trends in water consumption, what is the projected demand for water by different sectors over the next ten to twenty years? How does the projected demand for water compare with available and planned supplies?
2. What is the potential role of water pricing in both demand management (efficient water use) and supply expansion? Should the Cabinet continue to set uniform water rates for the entire country, or should the relevant Waterworks Authority be allowed to set its own rates, based on the marginal cost of supply? What are the implications of charging different rates for industry, tourism, urban centers and rural areas? What is the potential role of the private sector in water supply? How can the constraint on water pricing imposed by ground water pumping (and the consequent land subsidence and saline water intrusion) be resolved? Can a waste-water charge be added to the water supply charge? Should it be flat or progressive?

The present overview reports on some preliminary findings and emerging policy options, with the focus on industrial and urban water use in and around Bangkok.

WATER PROJECTIONS TO THE YEAR 2010 FOR GREATER BANGKOK

The Metropolitan Waterworks Authority (MWA) is responsible for pipe water supplies in Bangkok and its surrounding towns. During the past decade (1980-89) the demand for MWA water grew at a compound rate of 8 percent per annum – from 286 million cubic meters in 1980 to 628 million cubic meters in 1989 (see Table 1). If it continues to grow at this rate over the next two decades, the projected annual demand for water will reach 1,464 million cubic meters by the year 2000. Assuming that leakage stabilizes at 30 percent of production, the demand for raw water will be 2.1 billion cubic meters in the year 2000. This is a conservative estimate. While the growth of the economy during 1980-89 averaged 6-7 percent per year, it is expected to grow at an average annual rate of 8 percent during the 1990s. Due to this faster growth rate during the 1990s and the structural changes that are certain to favor the Bangkok Region under the MWA's responsibility, the demand for pipe water from the MWA is likely to grow faster than 8 percent per year during the 1990s.

The demand for domestic, commercial and industrial water in general is likely to grow faster than the economy as a whole. This is because of rapid structural change, which is projected to increase the industrial sector's share from 35 percent today to 40 percent by the year 2000 and the percentage of urban population from 23 percent today to over 30 percent by the year 2000. Since agriculture is by far the largest user of water, structural changes that reduce the share of agriculture should theoretically save much larger quantities of water than that needed to supply the growing urban and non-agricultural sectors. Unfortunately, this is not the case, because migration tends to originate from rain-fed rather than from irrigated areas. More farmers continue to use water wastefully regardless of its growing scarcity, since it is provided free of charge. Therefore, non-agricultural demands for water will actually rise without a corresponding decline in agricultural water use.

In fact, the demand for irrigation water is likely to increase in the foreseeable future, as farmers seek to substitute agricultural intensification for land expansion, which is no longer available, and shift to higher-value crops such as fruits, fish and vegetables, all of which are water intensive. Only a reduction in rice cultivation due to low rice prices might substantially reduce the quantities of water used by the agricultural sector. Flood irrigation of paddies at zero cost to the farmer is at the margin the lowest value use of water in the country. Even if more raw water were to be made available for urban and industrial use, there are substantial costs involved in conveyance, treatment and distribution, which translate into a rising supply curve for pipe water to urban and industrial centers.

Another source of demand growth beyond the economy's growth rate will come from the gradual depletion of the ground water aquifer in and around Bangkok and the growing unsuitability of surface water (rivers) for domestic and industrial use, due to pollution from domestic and industrial wastes – which are freely disposed of in public water bodies. A shift from ground water to pipe water is likely to occur with the depletion of the aquifer and an increase in the pumping cost. If we assume that the sustainable withdrawal from the aquifer is 50 percent of the 1987 uptake of 415 million cubic

Table 1 Water Pricing and Water Use in Metropolitan Waterworks Authority Area

Year	Nominal Effective Rate (฿/m)	Real Effective Rate (฿/m)	Minimum Rate (฿/m)	Maximum Rate (฿/m)	Nominal Prod. Cost ฿/cu.m	USERS Thousands	USERS Growth %	MWA Water Production (Million cu.m)	Water Sales (Million cu.m)
1976	1.449	3.295	0.50	2.50	n.a.	317	n.a.	431	n.a.
1977	1.487	3.223	0.50	2.50	n.a.	329	3.7	430	234
1978	1.494	2.987	0.50	2.50	n.a.	341	3.7	460	240
1979	1.534	2.819	0.50	2.50	2.29	356	4.3	485	252
1980	1.597	2.661	0.50	2.50	4.56	387	8.9	575	286
1981	2.198	3.055	0.50	2.50	5.01	423	9.2	625	327
1982	3.029	3.712	1.50	5.50	5.40	445	5.2	630	342
1983	3.059	3.557	1.50	5.50	4.97	468	5.1	627	370
1984	3.190	3.587	1.50	5.50	4.63	519	11.1	731	423
1985	4.926	5.501	4.10	8.75	5.64	602	15.9	802	477
1986	6.142	6.646	4.10	8.75	5.63	660	9.5	821	485
1987	6.092	6.482	4.05	8.70	5.64	721	9.4	841	523
1988	6.102	6.328	4.00	8.70	5.65	790	9.5	860	570
1989	6.118	6.118	4.00	8.70	5.35	867	9.7	934	628

Source: MWA Annual Report, various issues.

meters, 200 million cubic meters would be added to the present demand for MWA water; it would increase by 500 million cubic meters by the year 2000, and by 1,080 by the year 2010.

At the same time, as surface water becomes unfit for use due to urban and industrial pollution, an increasing number of households and industries, which now depend on such sources, will have to switch to pipe water. Because it is difficult to estimate this source of demand growth and because we wish to remain on the conservative side, we will ignore it. Our best estimate is that the demand for water will grow at the annual rate of 10 percent, reaching 1,792 million cubic meters by the year 2000; and that it will grow at an annual rate of 8.5 percent during the second decade, to exceed 4,052 million cubic meters in the year 2010. The corresponding demand for raw water would be 2.6 billion cubic meters and 5.8 billion cubic meters.

These preliminary demand projections are significantly higher than those of the MWA, which projects a doubling of water demand in thirty years, reaching 2.26 billion cubic meters per annum by the year 2017 (Dhamasiri 1989). MWA's projections imply a 3.4 percent increase in water demand per year. This is low, both by comparison to the growth of demand during the past decade and to the projected growth of the economy during the next two decades.

The MWA further projects that with the phasing out of its ground water pumping operations, its demand for surface raw water will triple by the year 2017, requiring 7.78 million cubic meters per day, compared to the maximum of 5.18 million cubic meters per day allocated by the Royal Irrigation Department (RID) from the Chao Phraya irrigation system. (Despite its low demand projections, the MWA expects to reach the RID limit by the year 1997). To meet the projected long-term excess demand, the MWA is planning the transfer of 2.6 million cubic meters per day (or 949 million cubic meters per year) from the Mae Klong river basin through a 100-kilometer-long canal. The MWA estimates that the scheme will cost US$60 million in capital investment and US$1.4 million in operational and maintenance costs. The cost of transferred raw water is estimated at 1.7 cents (or 0.44 baht) per cubic meter. This is probably a gross underestimate, since these calculations are based on government-assessed land prices, which are far below the actual market prices. Furthermore, the MWA is considering constructing its own surface water storage in the North or in the West in order to ensure an adequate water supply for 15 million people (Dhamasiri 1989).

INDUSTRIAL GROWTH, GROUND WATER USE, AND LAND SUBSIDENCE

Industry uses water for a variety of purposes, ranging from washing raw materials and equipment to cooling and condensation. Water is also used as a factor of production incorporated in the final product and as a means of conveying other production inputs. Industry is a relatively small user of water compared to agriculture, which uses about 30 times the amount of water per unit of GDP that industry does.

Industrial Growth and Water Use

Yet, industrial water use is significant for a number of reasons:

- The industrial sector has been and is projected to continue to grow at double-digit growth rates, while the growth of the agricultural sector is leveling off. Because of the geographic concentration of industry, water demand is concentrated in a limited area while agricultural demand, being geographically dispersed, can be met from a variety of sources.
- Because of the proximity of industry to the country's largest urban area, the urban demand for water is added into that of industry. Concurrently, the availability of suitable raw water diminishes as a result of urban pollution, and the cost of treatment rises.
- While there are economies of scale and savings from the concentration of users in water distribution, the conveyance cost of raw water from distant places may outweigh such economies.
- Industry, by its own very concentration and waste mismanagement, reduces the availability of acceptable-quality water not only to itself but also to other sectors.

Based on the average water use per factory and per employee of Samut Prakan factories, it is estimated that Thai manufacturing withdraws about 2.1 billion cubic meters of water a year (1989 estimates). Since over 50 percent of the factories are located in the Bangkok Metropolitan Region (BMR), the annual demand for water for industrial use is currently at least one billion cubic meters. In fact, since BMR-based industries tend to be larger in size than those outside the BMR – accounting for 72 percent of the industrial GDP – their demand for water should be at least two-thirds of the total industrial demand, or 1.3 billion cubic meters annually (3.6 million cubic meters per day).

While the lion's share in industrial output comes from the Greater Bangkok Region, most of which is under the MWA's responsibility, industry is a negligibly small user of pipe water from the MWA. In Samut Prakan, for example, of the 52,895 cubic meters of water used daily by 59 sampled factories, only 215 cubic meters a day (less than 0.5%) was pipe water purchased from the MWA (JICA 1989). The rest was obtained from ground water pumping (95%) and from other sources such as rivers and canals (4.5%). It is estimated that

Table 2 Ground Water Consumption of the BMR (cu.m/day, 1978-1989)

Thousand cu.m/day

	Private Sector							
Year	Bangkok	Nontha-buri	Samut Prakan	Pathum Thani	Samut Sakhon	Total	MWA	Total
1978	339	26	228	60	28	682	n.a.	n.a
1979	363	29	245	61	29	727	n.a.	n.a
1980	418	34	264	75	35	828	464	1,292
1981	465	42	285	77	39	909	450	1,359
1982	499	45	316	84	52	996	430	1,426
1983	522	53	319	99	58	1,052	375	1,427
1984	543	56	353	114	61	1,127	340	1,467
1985	500	52	343	110	39	1,043	281	1,324
1986	477	46	364	118	79	1,084	171	1,255
1987	485	57	382	126	87	1,137	183	1,320
1988	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	170	n.a.
1989	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	120	n.a.

Source: Ramnarong and Buapheng 1989
Note: Use of ground water in Nakhon Prathom is not included, partly because it is not within the announced critical areas and partly due to the lack of data.

about 1.2-1.4 million cubic meters per day of well water is pumped from ground water aquifers in the Bangkok Metropolitan Region. Of this amount, 80-90 percent is extracted and used by the private sector, mainly factories and housing estates. The rest is pumped by the MWA itself to supplement its surface water supply.

There is a large discrepancy between our estimate of industrial water use (3.6 million cu. m/day) and the reported ground water pumping of 1.14 million cubic meters per day (see Table 2). Even if we assume that 80 percent of the 300 million cubic meters of pipe water purchased from the MWA by "Business, State Enterprises and Government Agencies" was used by the manufacturing sector, we can account for at most another 0.66 million cubic meters per day. This brings the total to 1.8 million cubic meters per day, which is only half the estimated total use. The balance must have been withdrawn either from other (surface) water sources or from unreported deep wells. Industrial water use from non-ground water, non-MWA sources in Samut Prakan was estimated to be only 5 percent of the total water use. This can account for at most 0.2 million cubic meters per day, leaving 1.6 million unaccounted cubic meters to be attributed to unreported ground water pumping. This finding is supported by the fact that industrial output grew by 67 percent during 1985-89, while MWA water sales grew by only 32 percent during the same period (see Figure 1). Since there is no reason to suggest that water use per unit of industrial output was reduced by half, ground water pumping must have accelerated in order to meet the growing water demand from industry. This is corroborated by independent estimates of industrial waste water discharge.

Ground Water Preference

Three reasons are often given for the industrial sector's heavy reliance on ground water: (1) lack of access to pipe water, (2) the unreliability or insufficiency of the pipe water supply, and (3) the lower cost of ground water compared to the cost of pipe water. While it is true that the MWA is servicing only about half of the area and only about two-thirds of the population under its responsibility, there is evidence to suggest that even if access were ensured, ground water pumping would continue. Of the 2,126 operating wells inspected by the MWA in 1988, 1,871 wells (or 88%) were within the MWA's distribution system; of these, 1,345 wells (or 72%) belong to the MWA's customers. This suggests that factors other than lack of access are responsible for the widespread preference of ground water to the public water supply. Quality is not a problem, since the two sources are comparable, with the possible exception of higher electrical conductivity of MWA water, which may present a problem for certain industries (JICA 1989). The unreliability and/or insufficiency of the supply might be a problem in some areas (such as Pattaya under the

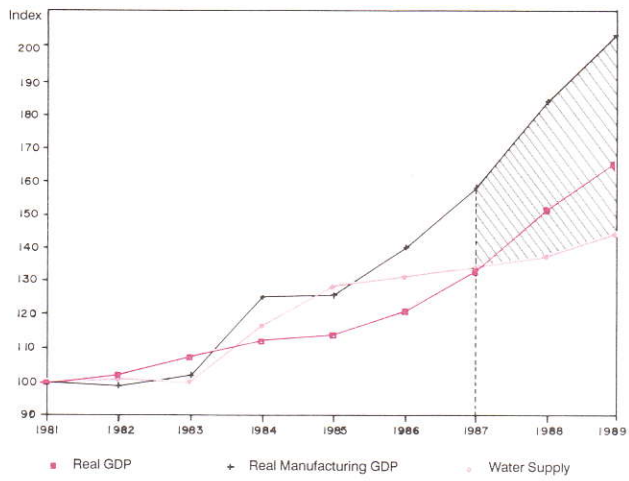


Figure 1 A comparison of Indices of GDP, manufactuing output and water supply suggests the emergence of a water deficit, especially for industrial use, which is presumably satistied through both legal and illegal ground water pumping.

PWA), but considerable improvements have been made in recent years. The paramount reason for the ground water preference appears to be cost consideration. The private cost of ground water pumping (including both capital and operating cost) is one to two baht per cubic meter, while the average rate of pipe water is about 6 baht per cubic meter. Because of the generally high quality of ground water, which obviates costly treatment, ground water emerges as by far the least costly source of water – less costly than even local surface sources such as rivers and canals, because the latter require costly treatment.

Social Costs of Land Subsidence

Ground water pumping, however, has additional social costs that are not considered by the private sector, notably: user cost due to accelerated depletion of the aquifer, which is only partially renewable; and the environmental cost of land subsidence due to overpumping in excess of replenishment. These social costs are significant. The average land subsidence in the eastern part of the BMR was 5-10 centimeters per year (Sodarathit 1989), and part of the area is below the mean sea level. Flood losses and damages to property have been estimated at billions of baht, with record losses of 6.6 billion baht in 1983. It is difficult to determine how much of the annual flood damage is due to land subsidence. However, flood damage accounts for only a part of the social costs of land subsidence. Other costs include damage to property and structures from the subsidence itself and the cost of prevention and mitigation measures taken by both individuals and the city. The government determined that these costs were sufficiently high to warrant phasing-out ground water pumping by 1998 through the following measures:

- Increase the supply of raw water to the MWA from surface sources (mainly, the Chao Phraya).
- Phasing-out the MWA's ground water pumping by 1987.
- Acceleration of the MWA's pipe water development in critical areas.
- Restriction of the private sector's growth of ground water pumping to 5 percent per year until 1987, with a reduction by 5 percent during 1988-92, by 10 percent during 1992- 97, and abandonment by 1998.
- Adjustment of the ground water charge in order to bring it closer to pipe water rates.

The results of the subsidence mitigation plan have been less than satisfactory. The MWA reduced its ground water pumping from 464,000 cubic meters per day in 1980 to 171,000 cubic meters in 1986. However, in 1987, when ground water pumping was supposed to stop, it was actually increased to 183,000 cubic meters per day. While progress has been made in the past two years, the MWA was still extracting 120,000 cubic meters per day in 1989. The supply of pipe water to the critical subsidence area has increased, but this has not reversed the rising trend of *reported* ground water pumping by the private sector – which reached 1.14 million cubic meters in 1987, the last year for which data are available. (As shown earlier, the actual ground water pumping could be twice as high). This is not surprising, considering that ground water remains by far the least costly water source, despite the introduction in 1977 of a one-baht-per-cubic-meter ground water charge that was instituted to account for the social cost of ground water pumping. Not only is this charge too low (equal to only 0.50 baht in 1977 prices) to bridge the 4-5-baht-per-cubic-meter difference between ground water and pipe water, but also the collection of this fee is rather inefficient and erratic. The Department of Mineral Resources, which oversees the utilization of ground water, lacks the manpower and infrastructure to collect the fees and to ensure compliance with the Ground Water Act of 1977, which requires a permit for ground water pumping; and the Deep Well Notification No. 7 of 1985, which requires installation of a flow meter on *all* wells more than 15 meters in depth.

BALANCING SUPPLY AND DEMAND MANAGEMENT

The response to the emerging water shortages has always been via efforts to increase the supply by developing untapped water resources through new water resource development. This invariably led to the construction of new dams and reservoirs by the Royal Irriga-

tion Department (RID) and the Electricity Generating Authority of Thailand (EGAT). However, the most suitable sites for reservoirs have already been used up, and further expansion faces a steeply rising supply curve in terms of both construction and environmental costs. The most cost-effective approach for dealing with shortages of raw water today is undoubtedly improved maintenance and efficient management of existing systems through rehabilitation and protection of watersheds, dredging of sedimented reservoirs, and efficient allocation of water among competing uses. The latter requires pricing of raw water according to its scarcity value and supply cost for all users – including agriculture, electricity generation and the public water supply – to limit waste and induce efficient use and conservation.

The Metropolitan and the Provincial Waterworks Authorities (MWA and PWA) are also dealing with emerging shortages through supply expansion, despite the constraints they face on securing new raw water sources. The MWA's latest scheme for diversion of water from the Mae Klong River to Bangkok is a case in point. Similarly, costly water supply schemes to increase the water supply to Pattaya from reservoirs designed for the exclusive use of the Eastern Seaboard are being carried out by the PWA.

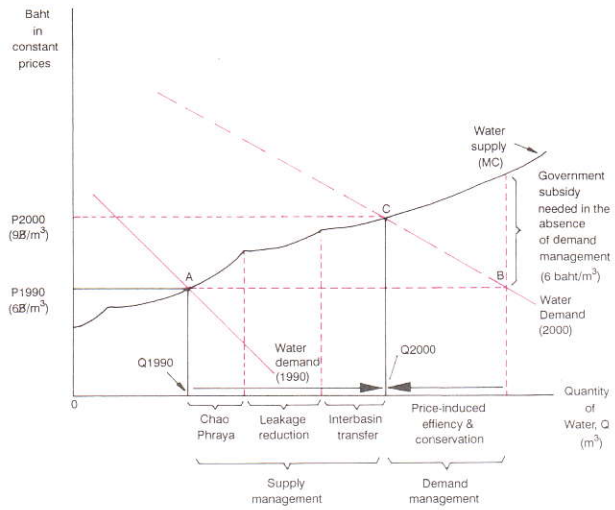
Demand management has not been practiced in Thailand despite the tremendous growth in demand in recent years and the apparent wasteful use of water. The real price of pipe water is lower today than it was in 1986 (see Table 1), even though the marginal cost of supply has increased in light of the need for interbasin transfer. Raw water continues to be a free good, both to the farmer and to the public utilities (MWA, PWA and EGAT). This is due to many reasons, including the perception that water is still an abundant, virtually inexhaustible resource, a perception which is reinforced by the annual flooding; the perception that water is a "gift of nature" which should not be priced and a basic need from which no one should be deprived; and the belief that the dêmand for water is not responsive to price even if the price is allowed to increase substantially. These perceptions and beliefs find their expression in the supply of raw water to farmers and utilities free of charge, and the supply of water to domestic, commercial and industrial uses at "low" prices fixed in nominal terms by the Cabinet, and hence declining in real terms. Ostensibly, the objective is to help poor farmers, to protect poor urban consumers, and to promote industrialization. The result is that large farmers, wealthy urban consumers, large industrial establishments, luxury hotels and foreign tourists enjoy a generous water subsidy, which lies at the root of the emerging water shortages. The social welfare and equity concerns are legitimate and can easily be met by controlling the lowest block of the water tariff, leaving the rest to the forces of supply and demand.

THE CRITICAL ROLE OF WATER PRICING

Water pricing is critical for meeting water shortages and managing growing demands for several reasons: it helps determine the optimal sectoral allocation of water (e.g., among agricultural, industrial and domestic uses); it encourages reduction of waste and promotes efficient water use, thereby limiting demand; and it recovers the costs of supply, thereby making funds available for expanding the supply. Shielding the users from the rising supply price of water guarantees either growing water shortages, growing water subsidies, or a combination of the two (see Figure 2).

The critical question in the case of water shortages is this: What are the alternative sources of supply, and what is the supply cost of each alternative? The MWA, for example, faces the following options: an additional supply from Chao Phraya River; diversion from the Mekong River; a reduction of water leakage; ground water pumping; and a reduction in demand through higher water rates, which would increase both water use efficiency and water recycling. Each of these alternative "supply" sources involves different scarcity, production and environmental costs, which vary with the level of supply. For example, while the production cost of ground water is relatively low (1-2 baht/cu. m), its environmental cost is very high, due to land subsidence resulting from overpumping. In contrast, beyond a certain level, reduction of leakage is costly, but has minimal or no environmental impacts. Tracing the lowest cost alternative of each level of supply defines the long-term water supply curve, which interacts with the demand curve to determine the optimum price of water (see Figure 2). The most critical parameter for water demand management is the price elasticity of the demand for water, which reflects the scope for controlling demand through pricing.

Preliminary estimates of the demand function for water in Bangkok suggest a price elasticity of -0.36, which means that a 10 percent increase in the effective price of water would result in a 3.6 percent reduction in the quantity demanded. At the 1989 level of MWA sales of 628 million cubic meters, an increase in the effective price from 6.12 baht per cubic meter to 9.0 baht per cubic meter would result in a reduction in demand of 17 percent, or 107 million cubic meters. This represents a less than 50 percent increase in nominal terms and a 15 percent increase in real terms over the 1986 price. This price increase, which roughly reflects the opportunity cost of raw water, would generate revenues of 846 million baht. These revenues can finance the supply of an additional 158 million cubic meters at the current operating cost of 5.35 baht per cubic meter, or 160 million cubic meters at the full cost of 9 baht per cubic meter.



Q: Water quantity
P: Water price
A: Demand and supply balance 1990 (P = 6.12 baht/m^3)
B: Demand and supply balance 2000 (P = 6.12 baht/m^3)
C: Demand and supply balance 2000 (P = 9.00 baht/m^3)

Figure 2 Meeting Fututre Water Shortages Through a Combination of Supply and Demand Management (a hypothetical example)

Our projections suggest that the MWA will reach the RID limit of 1,890 million cubic meters of raw water from the Chao Phraya River by 1996, and that by the year 2010, an additional one million tons of raw water will be needed. Under the no-demand-management scenario, the demand for raw water in the MWA area will surge to 5,800 million cubic meters per year. If demand management is practiced by raising the price of water to 9 baht per cubic meter and keeping it constant in real prices, the RID limit will not be reached until 1999. Moreover, the demand for water in the year 2010 would be one billion cubic meters lower, which at 9 baht a cubic meter saves 9 billion baht.*

However, raising the price of pipe water to account for the rising cost of supply and to induce efficient use and conservation will further increase the cost advantage of ground water. This would lead to increased ground water pumping, further land subsidence, and frustration of government efforts to phase out ground water pumping altogether. To foreclose the substitution of pipe water with ground water following a price rise, the cost of ground water must be made comparable to that of the pipe water. This would be accomplished by raising the ground water fee to a level equal to the price of pipe water minus the pumping cost, currently estimated at 1-2 baht. However, an increase in the ground water fee – specially a large one – is likely to lead to increased illegal ground water pumping, as well as collection and monitoring difficulties for the Department of Mineral Resources (DMR).

CONCLUSIONS AND RECOMMENDATIONS

To effectively deal with these problems, the following options should be considered. First, the responsibility for collecting and monitoring ground water use could be transferred to the MWA, which has the necessary manpower, infrastructure and vested interests to collect the fees and to monitor ground water use. This could be done at a minimum additional cost, since the majority (over 70%) of ground water users are MWA customers. Second, the increase in the ground water fee should be implemented gradually. Third, factories should be required to account for their water use at a level corresponding to their production capacity and type of industry. Factories reporting water use per unit of output less than 80 percent of the average use of their industrial group as a whole would be charged the average unless they can document superior efficiency, which will be confirmed by an independent environmental audit. Firms will be free to use either ground or pipe water or any combination of the two. Both sources would be metered and monitored by the MWA. The price of the two would be comparable: the ground water fee plus the pumping cost should equal the average tariff for the pipe water.

Currently, the industrial water tariff is progressive through small increments up to 2,000 cubic meters per month and regressive thereafter. The justification for this is not evident. To simplify matters, a three-step progressive rate is proposed:

- 0-100 cubic meters, 8 baht per cubic meter
- 101-2,000 cubic meters, 9 baht per cubic meter
- over 2,000 cubic meters, 10 baht per cubic meter

This rate should be indexed and automatically increased to maintain its real value. If a more gradual progression is warranted, it should apply jointly to both pipe and ground water to prevent multiple sourcing as a means of reducing the effective tariff rate. We believe that in the long run, such a system will limit ground water pumping to two groups of industries: (1) industries for

* *These are gross savings. To obtain net savings, the lost consumer and producer surplus from lower water consumption at higher prices must be deducted. Preliminary estimates suggest that net savings are substantial.*

which reliability of supply is critical, thus warranting a backup system to pipe water, and (2) industries outside the MWA's effective distribution system. In the short-to-medium run it is necessary to allow for a smooth transition and adjustment to the new system by implementing parity between pipe and ground water rates in stages. An increase of the ground water fee by one baht (in real terms) each year will achieve parity by 1998, when ground water pumping is scheduled to terminate. Termination by ban or prohibition is not necessary, since bans rarely work, and since ground water pumping has a contribution to make to the water supply—which if kept at the rate of replenishment, will not result in land subsidence. Proper pricing would ensure that the scarce ground water is put to its most efficient and sustainable use at minimal or no environmental cost.

Thus, to reestablish the balance between the demand and the supply of water in the Bangkok Metropolitan Region and to forestall future shortages and environmental impacts arising from rapid urban and industrial growth, it is recommended that:

1. The Metropolitan Waterworks Authority (MWA) is given more authority and freedom in setting water rates in line with the marginal costs of supply; the Cabinet need only maintain control over the lowest block rate to protect poor consumers and very small businesses.
2. The MWA is also given the authority for setting and collecting ground water, while the DMR continues to have authority over the exploration and monitoring of ground water resources.
3. The average effective price of MWA water is raised to a level that fully reflects the opportunity cost of water, the production cost (both fixed and operating cost), and the environmental cost involved. The price should be indexed and authomatically adjusted through a formula that takes into account both inflation and the rising scarcity and supply cost of water.
4. The ground water fee is raised to a level that achieves a full parity with pipe water when pumping costs are added. This is necessary not only for reducing overpumping and associated land subsidence, but also for ensuring that the limited sustainable replenishment of ground water is put to its most efficient use (e.g., where MWA water is not available, or where water quality and reliability are critical). The revenues from the ground water fee should be divided among the MWA, BMA and DMR to be used respectively for addtional pipe water development, for flood prevention in subsidence-affected areas, and for ground water resource exploration and monitoring.

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

Theodore Panayotou

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Krerkpong Charnpratheep

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 industrial sector here includes manufacturing, mining, construction and power. In later parts of the paper, industry is used in the more narrow sense of manufacturing.*

The shift from import substitution industrialization in earlier years to export promotion more recently has meant more reliance on low-cost-labor 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 polutants – especially biodegradable wastes – could be assimilated if widely distributed. In Thailand, however, (unlike Taiwan, for example), industry is highly concentrated in the Bangkok Metropolitan region (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% 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 signficantly 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

Table 1 Hazardous Waste, Environmental Risk Factors and Cost Effectiveness of Treatment.

Hazardous Waste Type	Waste Tons (1)	Relative Risk Factor	Exposed Population Million (2)	Environmental Risk Factor (3)	Cost of Treatment Baht Per Ton	Cost of Treatment 1000 Baht	Risk Reduction Per Mill of Baht	Risk Reduction Rank
Oils	219,467	1	57	13,000	637	139,822	100	9
Liquid Organic Residues NH	21	1	17	0	577	12	0	11
Liquid Organic Residues H	290	1,000	17	5,000	8,343	2,419	2,100	6
Organic Sludges - NH	1,563	1	16	0	577	902	0	11
Organic Solids NH	1,759	1	16	0	8,343	14,675	0	11
Organic Sludges and solids H	3,352	1,000	16	54,000	8,343	27,966	2,000	7
Inorganic Sludges and solids	19,254	1	42	1,000	146	2,811	500	8
Heavy Metal Sludges & Solids	136,810	10,000	13	17,785,000	158	21,616	823,000	1
Solvents - H	6,806	100	41	28,000	1,976	13,449	2,100	6
Solvents - NH	29,357	10	41	12,000	3,195	93,796	100	10
Acid Waste	125,428	100	32	401,000	257	32,235	12,500	4
Alkaline Waste	34,235	100	33	112,000	77	2,636	42,800	3
Off Spec Products	25	1	7	0	2,907	73	0	11
PCB	247	10,000	11	27,000	*	*	*	*
Aquecus Organic Residues	242	100	10	0	146	35	0	11
Photo Wastes	16,345	100	52	85,000	54	883	96,300	2
Municipal Wastes	11,757	1	57	1,000	2,410	28,334	10	10
Infectious Wastes	76,075	100	57	434,000	577	43,895	9,900	5
Total	683,003	-	-	-	626	427,620	-	

* Thailand has stopped importing PCB since 1985. PCB waste from past imports is currently send aboard for treatment
H = halogenated
NH = non-halogenated
(1) Estimated quantities in 1991
(2) 1991 population in provinces where specific waste type is being generated
(3) Waste quantity x relative risk factor x exposed population/1000 rounded off to nearest 1000

Source: Based on Engineering Science Inc. 1989

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 Khuntien 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 biochemical oxygen demand (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 %), and beverage factories (6%). 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.

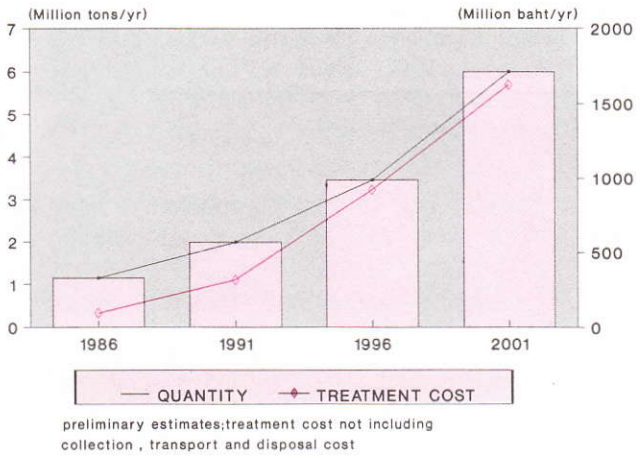

Figure 1 Projected Hazardous Waste Quantities and Treatment Cost

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 disolved 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,"

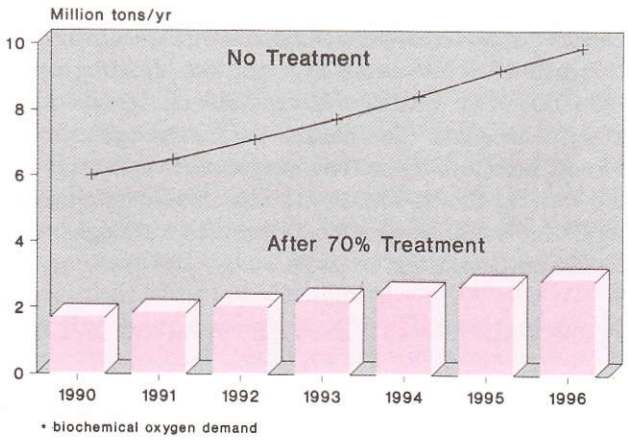

Figure 2 Industrial B.O.D.* - Loading Projection (Preliminary Estimates)

Table 2 Preliminary Estimate of BOD Load to Major Rivers in Thailand (1986)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No.	River Name	DO of River mg/L	Std. DO mg/L	No. of Factory	Flow 1000 cu.m. per yr	BOD Load tons/yr	70% Cost of Treatment million B	Treatment Residual BOD tons/yr	Cost of Treatment million B
1	Bangpakong	4		135	13,997	86,761	58.8	26,028	173.3
2	Chao Phraya	0.3	2	351	53,224	81,426	223.5	24,428	162.7
3	East Coast Gulf			123	16,345	80,427	68.6	24,128	160.7
4	Mun	3		84	7,350	75,867	30.9	22,760	151.6
5	Thachin	<2	2	376	166,757	56,033	700.4	16,810	112.0
6	Maeklong	>4		22	47,741	48,910	200.5	14,673	97.7
7	Ping			17	125,087	30,254	525.4	9,076	60.4
8	Nan			19	101,866	21,819	427.8	6,546	43.6
9	Chi			82	18,015	19,106	75.7	5,732	38.2
10	Khong			55	1,532	7,091	6.4	2,127	14.2
11	Prachinburi			27	281	4,618	1.2	1,385	9.2
12	Wang			13	1,517	3,719	6.4	1,116	7.4
13	Yom			5	102	296	0.4	89	0.6
14	Kok			2	18	55	0.1	16	0.1
SUM				1,311	553,833	516,381	2,326.1	154,914	1,031.7

Source: Department of Industrial Works; ONEB (1986); Department of Health (1986)
Note: (3) This amount of load covers only factories under motoring scheme of DIW
(6) Assuming cost of treatment = 6 baht/cu.m
(8) Assuming average BOD concentration = 3,000 mg/L and cost of treatment = 6 baht/cu.m.

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 Khutien hazardous treatment center in Thon Buri.

ENVIRONMENTAL FUND INITIATIVE FOR HAZARDOUS WASTE MANAGEMENT

Building on the Bang Khuntien 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 1.2 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 consistant 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.

NEWSBRIEF

DR. AMMAR SIAMWALLA IS APPOINTED PRESIDENT OF TDRI

Dr. Snoh Unakul, Chairman of the Board and Council of TDRI, has announced the confirmation of Dr. Ammar Siamwalla as the Institute's President, effective September 1, 1990. Dr. Ammar succeeds Dr. Phaichitr Unavikul, who submitted his resignation as President of the Institute in July.

Dr. Ammar, who had been TDRI's Director of Agriculture and Rural Development since 1984, is one of the country's best-known economists. He holds a degree in economics from the London School of Economics and a Doctorate in Economics from Harvard University. Prior to his tenure at the Institute, Dr. Ammar was on the Faculty of Economics at Thammasat University; served as a research staff economist at Yale University; and was a visiting professor at the Food Research Institute, Stanford University. He also served as Research Fellow with the International Food Policy Research Institute, Washington, D.C., from 1978-1984.

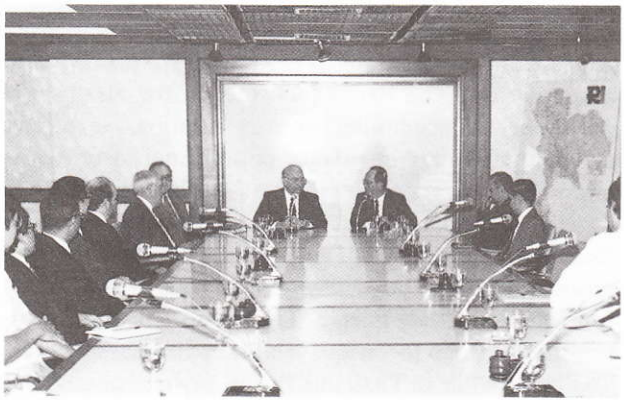
Dr. Snoh also announced that Dr. Narongchai Akrasanee has submitted his resignation as Executive Vice President of TDRI, but that he will continue to work as an advisor to the Institute and to participate in the Institute's development as a member of the Board of Directors.

Dr. Ammar Siamwalla

Moreover, Dr. Virabongsa Ramangkura, TDRI's Director of the Macroeconomic Policy Program, has resigned from the Institute in order to assume his post as the country's Minister of Finance.

U.S. SECRETARY OF AGRICULTURE VISITS TDRI

Dr. Clayton K. Yeutter, Secretary of Agriculture of the United States, visited the Institute on August 14 and led a round-table discussion on "The GATT and Its 1990 Farm Bill." The meeting was attended by TDRI Board and Council Chairman Dr. Snoh Unakul; Dr. Ammar Siamwalla, the Institute's President; senior staff members of the Institute; and 30 other participants, including government officials and leading businessmen and academics.



Profile of Dr. Clayton K. Yeutter

When U.S. President George Bush announced his selection of former U.S. Trade Representative Clayton Yeutter for the post of Secretary of Agriculture, he described Dr. Yeutter as a strong free-trade advocate with an extensive background in agriculture.

The President emphasized that Dr. Yeutter's nomination "will send a significant message to our trading partners abroad." Free trade and expanded U.S. farm exports, the President said, "will have no greater spokesman, no greater advocate."

Dr. Yeutter has strongly promoted U.S. agricultural interests in international markets and has extensive support among farm-state politicians. He first joined the Department of Agriculture in 1970 as a consumer and marketing service administrator. In 1973 he became Assistant Secretary for Marketing and Consumer Services, and a year later he became the Assistant Secretary for International Affairs and Commodity Programs.

From 1975 to 1977, Dr. Yeutter served as Deputy Special Trade Representative, negotiating an end to

several trade disputes, including what was known as the "cheese war," in which European nations withdrew subsidies to cheese makers. After leaving government, Dr. Yeutter became Chief Executive Officer of the Chicago Mercantile Exchange, America's top trading market for foreign currencies.

In 1985, President Ronald Reagan appointed Dr. Yeutter U.S. Trade Representative.

Mr. H. J. Van Wersch of the World Bank Visits the Institute

Mr. H.J. Van Wersch of the World Bank visited TDRI on July 27 and held talks with Dr. Twatchai Yongkittikul concerning the Institute's goals and its functions, including organizational and administrative issues. Mr. Van Wersch is on a fact-finding mission to assist the Nepalese government in establishing a national research institute to serve as a think tank for Nepal. He also explored the possibility of establishing an institutional relationship between TDRI and the Nepalese institute after its establishment.

1990 Year-End Conference to be Co-organized by the Chai Pattana Foundation and TDRI

Last December, His Majesty, the King addressed the Thai people about the crucial issue of environmental degradation. His Majesty's address has galvanized government, private sector, and public concern about Thailand's rich, yet fragile natural resources and the country's accelerating industrialization, with its resultant strains on the nation's land and mineral resources, water and air quality, infrastructure, and human resources.

Thus, The Chai Pattana Foundation and the Thailand Development Research Institute have organized this important conference to serve as a major forum to thoroughly examine all the issues involved in addressing this dilemma...

- What are the major developmental scenarios that Thailand must confront and consider?
- How will the globalization of environmental issues affect Thailand's economic growth?
- What are technocrats' analyses of Thailand's economic/environmental situation during the next two decades?
- How have environmental management issues influenced the government's formulation of the upcoming Seventh Plan?
- What is the private sector's perceived role in cleaning up Thailand and conserving its environment?
- How will environmental issues affect the business sector in the future?

The 1990 Year-End Conference, "Industrializing Thailand and Its Impact on the Environment," will be held on December 8-9 at the Ambassador City Jomtien, Chon Buri. More than 600 participants from both the public and private sectors will be attending. For further details and registration information, please contact Khun Prasith Chantrdee or Khun Niti Nakbunbs at TDRI (tel: 258-9012).

SEMINARS ATTENDED AND PAPERS PRESENTED ELSEWHERE

IN-HOUSE SEMINARS

TDRI organized a seminar on AIDS, attended by about 20 persons who are knowledgeable of and are involved in the AIDS prevention campaign in Thailand. The purpose of this seminar was to exchange information and to identify critical areas of intervention by the government. July 19.

P&D

Dr. Twatchai Yongkittikul attend the Conference on "The Political Economy of Tax Reforms and their Implications for Interdependence" jointly organized by the Korea Development Institute and the National Bureau of Economic Research, Seoul, June 14-16.

Dr. Twatchai Yongkittikul was invited as guest speaker to a group of University of Hawaii students on a study tour in Thailand. The group consists of 24 graduate students in the Master of International Business Program. July 12, Shangri-La Hotel, Bangkok.

Dr. Twatchai Yongkittikul attended the Conference on "Subsidies and Fees of Private Education Institutes." The Conference was attended by about 60 participants representing administrators and teachers of private secondary schools, government officials, and academicians. The issues focussed on the role of the government in promoting private educational institutes, and the potentials of private educational institutes in improving educational quality and equity. August 9-11.

Dr. Twatchai Yongkittikul, spoke on "The Thai Economy in the 1990's: Problems and Prospects," to a group of Japanese businessmen who are members of the Inter-Futures Study Forum. The group was on an overseas training trip to various countries in Asia including Thailand. While in Thailand, the group held discussions with government officials, local businessmen and

economists, and also visited industrial and business centers in Chiang Mai and the Eastern Seaboard Project. Shangri-La Hotel, August 7.

ARD PROGRAM

Dr. Ammar Siamwalla attended and presented a paper on "Agricultural Trade Reform, Price Stability and Impact on Developing Countries" at a policy seminar on "The GATT Negotiations on Agriculture and Developing Countries" sponsored by International Food Policy Research Institute, held in Montreaux, Switzerland on May 31 - June 1.

Dr. Ammar Siamwalla gave a lecture on the Thai economy in the public seminar on Southeast Asia, held by Kyoto University in Kyoto, Japan from July 9-15.

Dr. Ammar Siamwalla and Dr. Suthad Setboonsarng attended and presented a paper on "The Response of Thai Agriculture to the World Economy" at the International Agricultural Trade Research Consortum Symposium, "Agriculture and Trade in the Pacific: Towards the 21st Century" held in Honolulu, Hawaii on August 1-2.

Dr. Ammar Siamwalla participated in the Vietnam Workshop organized by FAO in Hanoi, Vietnam between August 15-25.

ITR PROGRAM

Dr. Paitoon Wiboonchutikula participated in and presented a paper on "Trade and Industrial Development in Thailand: Past Policies and Future Issues." at the Workshop on Comparative Analysis of Development Policies in China, Japan, Korea, and Thailand, sponsored by the Korea Development Institute, East-West Center, and the Asia-Pacific Institute in Seoul, Korea, on May 16-20.

Dr. Paitoon Wiboonchutikula participated in the USIS Economic Seminar on "Financial Globalization and Thai-U.S. Investment Relations," held at the Hotel Sofitel Central, Hua Hin, on June 22-24.

MEP PROGRAM

Dr. Virabongsa Ramangkura and Dr. Bhanupong Nidhiprabha presented "The Macroeconomics of the Public Sector Deficit" at the World Bank, Washington, D.C., USA., July 12-13.

Dr. Damkirng Sawamiphakdi attended the First Thailand-China Symposium on Thailand-China Relations in Commemoration of the Fifteenth Anniversary of the Establishment of the Diplomatic Relations between Thailand and the People's Republic of China, organized by the International Studies Centre and the Chinese People's Institute of Foreign Affairs. He also presented a paper entitled "Current Economic Trends in Thailand" co-authored with Dr.Teerana Bhongmakapat, Khun Prasert Chakepaichayon, and Khun Nipat Somjitt. Beijing, China, July 12-13.

Dr. Virabongsa Ramangkura attended the seminar on "Senior Policy Seminar" held by the World Bank. He also presented a paper entitled "Investment Recovery and Financing: Thailand" co-authored with Dr. Pakorn Vichyanond. Caracas, Venezuela, July 19-22.

Dr. Damkirng Sawamiphakdi attended the "Comparison of East Asian Data and Model Structure" held by the International Center for the Study of East Asian Development (ICSEAD). He also presented a paper entitled "Thailand's Macroeconomic Linkages and International Adjustments" co-authored with Dr. Bhanupong Nidhiprabha and Khun Chanin Kamheangpatiyooth. Kitakyushu, Japan, July 31 - August 2.

EIU PROGRAM

The EIU program, together with officials from the National Energy Policy and the Electric Utilities, held meetings with officials in various provinces in the Upper South, East and South. The meetings are a part of the 1991 load forecast exercise that aims to improve forecasting methodology for all upcountry regions of the country.

NRE PROGRAM

Dr. Dhira Phantumvanit of NRE appeared as a Panel Discussant at the Third International Conference on Practical Applications for Environmental and Energy Efficiency Management. His presentation focused on energy and environmental perspectives in Thailand, emphasizing interactions between the two sectors, and strategies for future conservation efforts. The conference, organized by the Energy Conservation Center of Thailand and the International Institute for Energy Conservation, was attended by over 140 participants from the government, academic, and private sectors.Central Plaza Hotel, Bangkok, 17-18 July.

Khun Krekpong Charnprateep presented the paper, "National Hazardous Waste Management Action Plan," at a hazardous waste management conference held at the Ambassador Hotel in Pattaya, from 5-7 August, 1990. The paper outlined potential strategies for the proper treatment and disposal of hazardous wastes in Thailand, while developing an overall framework with which to address this increasingly severe environmental concern.

Dr. Dhira Phantumvanit is serving as chairman of the Subcommittee on Industry and Environment, which is under the National Environment Committee. Work is currently focused on formulating Thailand's position regarding long-term global environmental issues, with particular emphasis on industry, environmental quality, and private sector participation in environmental

management.

Dr. Duangjai Intarapravich participanted in a seminar on Natural Resource Management Planning, by NESDB and USAID, 29 June-1 July, Ambassador City, Pattaya.

Dr. Duangjai Intarapravich participanted in a Round Table Discussion on "Progress on and Problems of the Mineral Industry" by the Mining Council. July 6, Indra Hotel, Bangkok.

Dr. Duangjai Intarapravich participanted in a workshop on Natural Resource Management Planning, by the NESDB and USAID, 13-15 August, J.B. Hotel, Songkla.

Dr. Chartchai Parasuk participanted in a seminar on Rural Resource Management Planning, 16-17 July, Chiang Mai.

Dr. Chartchai Parasuk pariticipanted in a seminar on the Forestry Development Master Plan for National Development, 1 August, Bangkok.

STD PROGRAM

Dr. Chatri Sripaipan attended as a resource person the Symposium on Transnational Technology Towards the Year 2000 in the ESCAP Region, ESCAP Conference Room, Bangkok, April 23-26 1990. The Symposium was organized by the Economic and Social Commission for Asia and the Pacific (ESCAP) in collaboration with the United Nations Centre on Transnational Corporations (UNCTC) and was attended by experts, government officials and private sector representatives from China, Hong Kong, India, Indonesia, Japan, Malaysia, Pakistan, Philippines, Republic of Korea, Sweden, United States and Viet Nam, including participants from the Asian and Pacific Centre for Transfer of Technology (APCTT) and the United Nations Department of International Economic and Social Affairs.

Dr. Chatri Sripaipan spoke at a seminar on Demand for Human Resources in Industrial Development, which was organized by Rajamangala Institute of Technology, Bangkok Campus, on April 24.

Dr. Chatri Sripaipan presented a paper on "Constraints to Technology Development in a Rapidly Growing Economy: The Case of Thailand," at the International Symposium on Asia's West Pacific Development and Cooperation on Technology and Economy, which was organized by International Technology and Economy Institute, Beijing, China, May 22- 24.

Dr. Chatri Sripaipan presented a paper on "Prospects for Cooperation in Industrial Technology Between Thailand and the European Community" at the Workshop on the Science and Technology Development in ASEAN Countries: Problems, Prospects, Scope for Cooperation with the European Community, which is an EC sponsored workshop, at the Asian Institute of Technology (AIT), Bangkok, June 7-8.

Dr. Chatri Sripaipan travelled to Japan from June 25 - July 6 at the invitation of National Institute for Research Advancement (NIRA) to discuss the content and methods of the cooperative research with NIRA and to visit Japanese public institutions and private companies.

HRS PROGRAM

Dr. Orapin Sopchokchai attended a workshop on "Women's Organizing Abilities." The workshop was hosted by the Friedrich Ebert Foundation and the Organizing for Development An International Institute (ODII). Upperville, Virginia, June 17-20.

RESEARCH PROJECTS COMPLETED/NEW CONTRACTS

EIU

The EIU program has recently completed two books on the "Deregulation of the Oil Price in Thailand" and the "Oil Transportation System in Thailand." The books have been published and have been submitted to concerned government agencies and energy policy consultants for consideration.

NRE

The Geographic Information Systems (GIS) group of NRE completed its cooperative project with the Thai-Australia Highland Agriculture and Social Development Project (TA-HASD) which established a GIS-based management information system to be used for land use planning and other tasks associated with TA-HASD's opium-crop substitution project areas in Northern Thailand. The project confirmed the strong potential for use of GIS as a practical tool for application to land use planning in Thailand. Based on TDRI's input, TA-HASD has decided to re-structure its own planning tools to incorporate GIS into its system.

Dr. Dhira Phantumvanit and Juliet Lamont completed a project report examining the potential for the establishment of a regional policy research network on natural resources and the environment. The report was submitted to the project sponsor, the Rockefeller Brothers Foundation, and will subsequently be distributed to select policy research institutions in the Pacific Rim region, and in North America. Portions of the report were excerpted for use in ESCAP's strategy

development sessions for the upcoming Ministerial Level meeting on Sustainable Development, scheduled to be held in October, in Bangkok.

STD

On May 15, 1990, an agreement was signed between SEAMICO and TDRI, to carry out a project entitled, "Four Investment Opportunity Research Studies." The four sector studies to be carried out under this project include: Electronics; Automotive Parts; Metal Working; and Machine Tools. The objectives of this project are: to provide an in-depth understanding of the development of the respective sectors, the role of the major players, the sector's current status in Thailand, and the present government policy framework; to indicate areas in which there is significant scope for future investment within the respective sectors (detailing Thailand's comparative advantages in the sector); and to prepare information and analyses that support the production of materials designed to enhance the BOI's investment promotion activities both inside and outside Thailand. This project is funded by the Office of the Board of Investment (BOI).

ITR

1. An agreement was signed in July between the International Development Center of Japan (IDCJ) and TDRI, for TDRI to conduct a research project on "Transformation of the Thai Economy: The Balancing of Agricultural Development and Industrialization," which was funded by IDCJ. The objectives of this project are to identify the impact of the changing linkages between the agricultural and the industrial sectors on sustainable growth and social stability and to recommend policy measures that will not create lopsided development patterns and social instability.

2. In August, an agreement was signed between the International Center for Economic Growth (ICEG) and TDRI to carry out a research project on "Industrial Structural Transformation and Technological Development in Thailand." The objectives of the project are to identify technological development as a source of rapid structural change and sustainable growth of industries and to examine the comparative roles of government, and foreign and local firms in technology transfer, technological development, and assisting in the structural change of Thai industries.

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