

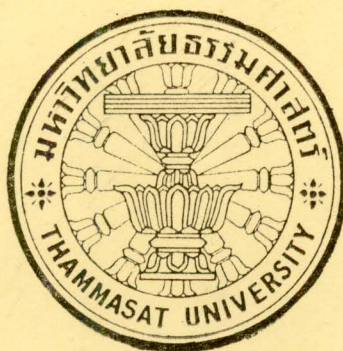
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DISCUSSION PAPER SERIES

Number 81

The Theory of Transactions Costs : An
Application to the Case of Water Pollution
Control in Mae Klong, Thailand

by

Somluckrat Wattanavitukul



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TABLE OF CONTENTS

	<u>Page</u>
I INTRODUCTION	1
A. Externality: A Traditional Approach	3
B. The Concept of Transactions Costs as an Explanation for the Existence of Externa- lities	11
C. Water Pollution Abatement in Thailand as in 1975	14
II PRE-POLLUTION CONTROL LAWS IN WATER USE AND THEIR IMPLICATIONS	16
A. Interpretation of the Law	17
B. Judiciary Interpretations and their Economic Implications	23
III WATER POLLUTION CONTROL AND ITS IMPACTS ON WATER RIGHT ENFORCEMENT IN THE MAE KLONG AREA	33
A. The Water Pollution Control Interpreted	35
B. Water Pollution Control and its Implications on Judicial Resource Allocation	43
IV GOVERNMENT DISCRETION OR PRIVATE PROPERTY RIGHT: A CONCLUSION	51
A. General Consideration	52
B. Government Discretion	54
C. Private Property Rights	61
Appendix I: Government Enterprises and the Percentage of Share held by Government	70
Appendix II: Minimum Standards for Industrial Wastes	78
Appendix III: Document 1: Regulations by the Department of Industrial Factories for the Sugar Factories in Mae Klong Area to Correct and Improve their Waste Treatment System, Produc- tion Season 1974/75	79

	<u>Page</u>
Appendix IV: Document 2: The Five-Year Plan for Water Quality Control and Reclamation in the Chao Phraya, Mae Klong and Tachin Rivers	81
Appendix V : Improvement and Conservation of National Environment Quality Act B.E. 2518	83

THE THEORY OF TRANSACTIONS COSTS: AN APPLICATION TO THE CASE
OF WATER POLLUTION CONTROL IN MAE KLONG, THAILAND*

I INTRODUCTION

The alleged necessity for a statutory intervention in water pollution has been uncritically accepted by many economists concerned with public issues and natural resources. Natural resources, in the broadest context, can be divided into those which are renewable and nonrenewable. Water resource, by nature, is renewable, unless its natural assimilative capacity has been completely destroyed. Natural resources which once developed are "irreversible" deserve separate treatment which may or may not yield the same set of rules for optimal allocation proven to be applicable to the reversible resources. However, due to limitation of time and lack of information at hand, the issue will not be discussed here.

A divergence between private and social costs emerges when when a factory located upstream releases waste into a public stream and thus reduces the "quality" of the water for other users; the cost of such action is the reduction in income of all other people

* This paper represents part of the author's dissertation under the same title written at the University of Washington, Seattle, Washington in 1976.

adversely affected. An externality is said to exist. In Thailand, government action is invariably recommended to resolve such externality problem. Although one may hypothesize corrective government actions capable of improving the situation, their practicality remains to be investigated. The question is whether regulations will or will not replace or improve upon private contracting.

As commonly used in economics, the term externality suggests misallocation of resources stemming from deficient private contracting. However, the presence of "externalities" such as water pollution does not necessarily imply economic inefficiency. The absence of contract stipulating the use of water among users may result from high transaction costs, from existing legal arrangements, from the costs of information, or simply from a lack of foresight. Therefore, instead of proceeding to recommend remedy for the water pollution, this paper addresses itself to questions on: (1) why water pollution exists, (2) whether the assignment of water right to the polluting or the polluted party yields different result on the solution to resource allocation and thus the pollution problem, and (3) whether the present implementation of government policies in the area implies a less costly action than what would have been otherwise through private negotiations.

This analysis seeks to explain water pollution in light of the costs of making transaction of water use right. One conclusion reached is that the divergence between private and social costs found in the Mae Klong area is consistent with wealth maximization. Given the costs in enforcing water laws, as identified, this study also conclude that present government intervention implies a social cost greater than social gain.

A. Externality: A Traditional Approach

That the concept of externality originated from Pigou's analysis of the divergence between social and private net products has been well documented.¹ Externality in the case of water pollution refers to a situation where residual from a production process becomes undesirable to or damaging for the production or consumption of subsequent users. They impose higher costs on users "external" to the waste discharger. These cost, however are not considered in the initial production decision and output is consequently expanded beyond the socially optimal level.

This traditional line of argument is based on Pigou's analysis where, "owing to the technical difficulty of enforcing compensation for incidental disservices, marginal trade net product is greater than marginal social net product."² The concept is summarized in Figure 1 where A is a producer who pays

the marginal factor cost (MFC_A) for the use of the input and receives the marginal product (MP_A). Production by A creates a harmful effect on other individuals such as B; the marginal damage incurred by B is measured along MD_B schedule. Pigou's marginal trade net product ($MTNP$) is defined as the value of the marginal product to A minus the marginal factor cost. The marginal social net product ($MSNP$) is then the $MTNP_A$ minus the marginal damage to B. In this traditional approach, "divergence" is measured by the vertical distance between the $MTNP_A$ and the $MSNP$ schedules.

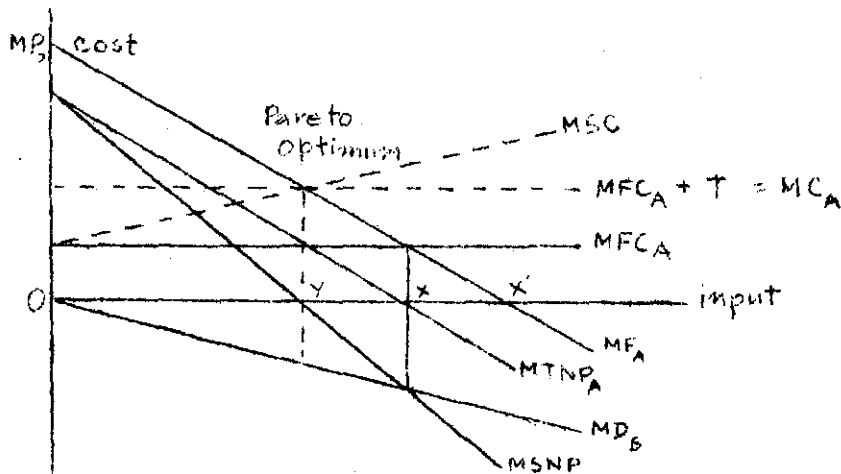


Figure 1 Pigou's Divergence between Marginal Trade Net Product and Marginal Social Net Product

When a production activity does not have any harmful effect on outside parties, an input use at a level equal to x (x' in the case of public water resource where the price of water as an input is zero) is consistent with the Pareto condition. When a harmful effect exists, the marginal trade net product to A exceeds the marginal social net product incurred by society in an amount measured by the vertical distance between the $MTNP_A$ and the $MSNP$ curves at every level of input. The divergence area between the two curves is equal to the total value of what Pigou terms "uncharged disservices." Such divergence is solely attributable to the absence of contractual arrangement, we may call it the "uncontracted effect." The allegation is generally that market fails to achieve "efficiency;" and government intervention is usually called for, in the form of a tax against the producers of the harmful effect.

In later analysis the absolute value of the marginal uncharged disservices is added on to the marginal factor cost to reflect the full marginal cost to the society for the use of input whereby a harmful effect is produced. (See Figure 2.) The vertical distance between the MSC and the MFC curves thus measures the divergence between private and social costs. To eliminate such divergence, a unit tax on input equal to the marginal value of the uncharged disservice at input level y would equate the marginal cost paid by A with the marginal social cost which is also equal to

the value of marginal product received by A. "Efficiency" is attained and welfare is at its maximum. However, government action is not costless nor has it been confirmed to be always less costly than its market counterpart; but the consequences of taxation and the spending of the proceeds have hardly been systematically assessed in this type of welfare proposal.

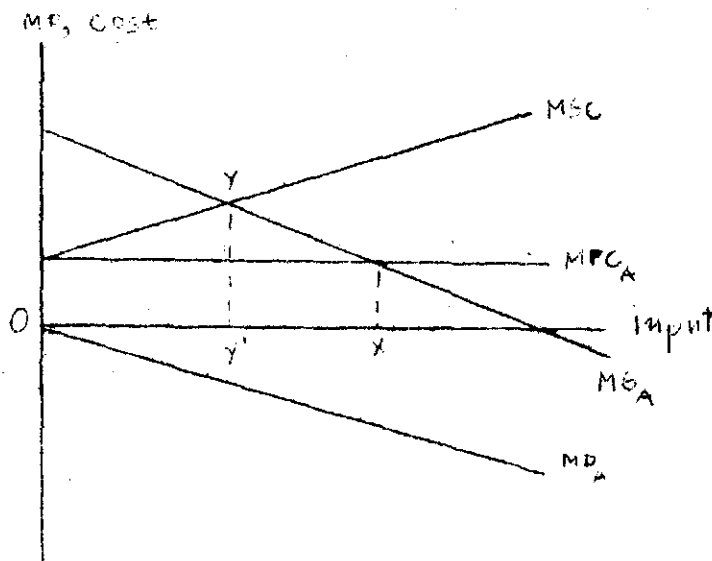


Figure 2 Divergence between Private and Social Cost

Water resources, particularly when flowing streams are involved, has always been treated as a special case among commodity and service markets because of its fugitive nature. As a corollary, any attempt by some users to improve water quality will make other users beneficiaries of an unpaid for benefit. As a result, all

water users tend to withhold treatment hoping someone else will "clean up" the water. Over time, with increases in population and in production, the opportunity cost for certain uses of water such as the disposal of waste has also increased. Remedy proposed has been in the form of making the polluters fully liable for this harmful effect, or by placing a tax on their production, or by allowing certain industries to operate within "zone." Essentially, government action is seen as the only solution.³ Advocates for the Pigouvian tax-subsidy program, to name a few, are Baumol, Brown, and Wender.⁴ A combination of government action and market mechanism has also been recommended. For example, Larry E. Ruff suggests that a government agency "...should put a price on pollution...set to approximate the marginal social cost of pollution."⁵ Such a price, once set, will be taken into the cost consideration of the firms and thereby an optimum level of pollution will be achieved.

A question arises immediately is on the measurement of the marginal social cost. Water quality has a multidimensional property: It can be measured in terms of its temperatures, value of dissolved oxygen, biochemical oxygen demand, acidity, alkalinity, etc. The variety of water uses implies a different degree in "water purity" for each use.⁶ This, in turn, implies that varying levels of marginal damage (part of the marginal social cost) can be caused by a single activity such as the manufacturing of sugar in the Mae Klong area.

Any measurement of marginal social cost is further complicated by the fact that organic degradation, up to a certain point, increases the level of food for fish and thus reduces the cost or increases the output in the fishery industry. The marginal uncontracted effect on the fishery industry thus starts with a beneficial effect, diminishes to zero, becomes negative, then turn zero again once the water becomes anaerobic and the whole fish population is killed. Therefore, the question is: What is the relevant margin in setting the "price on pollution" as suggested ?

In practice, the measurement of benefits and costs has hardly been unique. Water users include household as well as industrial and agricultural producers. How should one integrate and balance health effects or aesthetic value against monetary and physical cost ? What are the appropriate discount rate, if at all, one should adopt ? These questions rest outside the province of this paper. Nonetheless, they must be answered to justify the "price on pollution" if efficiency is truly the purpose of the pricing program. In the case where production is taking place at an input level such that the uncontracted effect is beneficial to a third party, then, by the traditional approach, a subsidy is in order.

Other recommendations for government intervention include Allen V. Kneese's effluent charge per unit of waste,

Table 1: Suggested Stream Standard for Developing Countries

Controlling Water Use	Stream Standard	
	Quality Parameter	Suggested Level
Potable Water Supply	Most probable number of Coliforms (MPN) pH Dissolved Oxygen (DO) Arsenic Chromium (hexavalent) Cyanide Lead	90% of samples examined throughout any year < 10/100 ml., no sample > 20/100 ml. 6.5 - 8.5 > 2 mg/l < 0.2 mg/l < 0.05 mg/l < 0.01 mg/l < 0.1 mg/l
Irrigation	Total Dissolved Solids (TDS) Electrical Conductivity (EC) Sodium - adsorption - ratio (SAR) Boron	< 400 mg/l - poor drainage < 1000 mg/l - good drainage < 750 micromhos per cm - poor drainage < 2250 micromhos per cm - good drainage & low SAR < 10 - high mineral content or poor drainage < 18 - low mineral content or good drainage < 1.25 mg/l - sensitive crops < 3.75 mg/l - tolerant crops
Fishing	Dissolved Oxygen (DO) Pesticides: DDT Endrin DHC Methyl Parathion Malathion Carbon Dioxide (CO ₂) pH Ammoniacal Nitrogen (NH ₃ - N) Cyanide Arsenic Chromium	> 2 mg/l < 0.002 mg/l < 0.0004 mg/l < 0.21 mg/l < 0.10 mg/l < 0.15 mg/l < 12 mg/l 6.5 - 8.2 < 1.2 mg/l < 0.01 mg/l < 1.0 mg/l < 0.05 mg/l
Waste Disposal	Dissolved Oxygen (DO)	> 0 mg/l

Problem of Social Cost" in 1960 that the analysis of the issue, once again, departed from the traditional approach. Coase views a situation where a harmful uncontracted effect by A is inflicted upon B as a problem involving a reciprocal nature: To avoid the harm to B would inflict harm on A. Therefore, there is no divergence between private and social costs to start with. The argument is summarized in Figure 3 where the curves are the same as depicted in Figure 2.

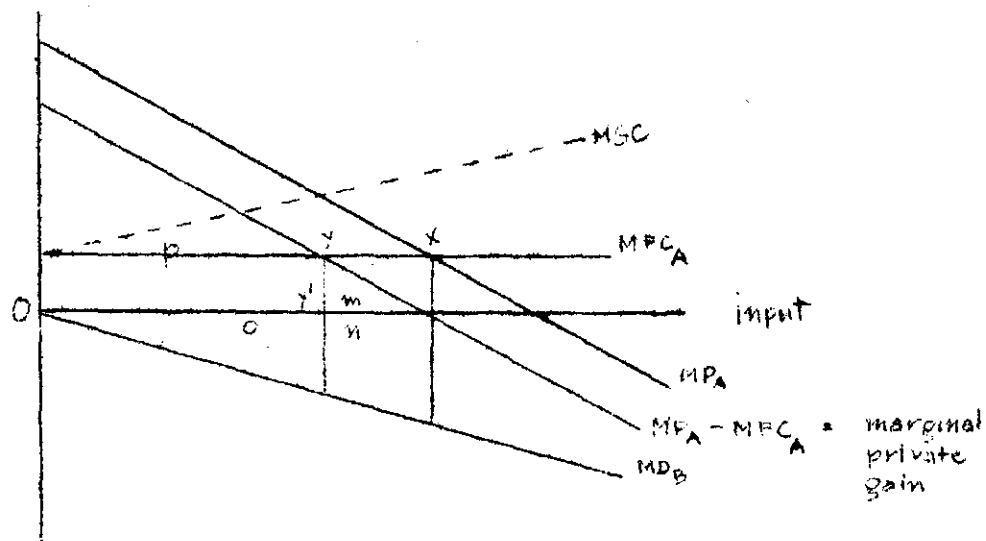


Figure 3 Marginal Gain and Marginal Damage of an External Effect

In Figure 3, if A employs an input at a level x , without contracting or any regulation, marginal damage incurred by B is measured along the MD_B curve. By inducing A to produce at a level

John H. Dales' effluent charge in exchange for a "pollution rights."⁷ Where taxation is adopted and its adjustment is unavoidable, direct control of certain activities during the inversion period while tax adjustment is carried out and responses to such change are at work may be needed in an integrate program of environment management.⁸

Although the suggestions may seem to differ in concept, they have not advanced much from where Pigou left off in 1920 when he wrote:

It is, however, possible for the State, if it so chooses, to remove the divergence in any field by "extraordinary encouragement" or "extraordinary restraints" upon investment in that field. The most obvious forms... are, of course, those of bounties and taxes.⁹

This leaves much to be desired. Very few empirical studies exist, especially in the developing countries. We thus maintain that unless any corrective action by government is confirmed to be less costly than its competitive counterpart, its implementation is inconsistent with the basic wealth maximization and must be discouraged.

B. The Concept of Transactions Costs as an Explanation
for the Existence of Externalities

Although Frank H. Knight pointed in 1924 that the "doctrine of external economies (or diseconomies) rests upon a misconception,"¹⁰ it was not until Coase's article, "The

less than A, some damage to B is avoided. However, A is now experiencing damage in the form of a reduction in the net gain. In the case of water pollution and B has the right to receive clean water, i.e., to exclude A from discharging waste into the stream, the maximum amount A is willing to pay for the right to discharge waste up to y' is equal to area p . If area o , representing the minimum amount B is willing to accept, is smaller than p , transaction will take place. If the cost for such a transaction is zero, then "society" will experience a net gain equal to the difference between areas o and p . How such net gain will be distributed between the two contracting parties depends on their relative bargaining positions.

If A has the right to pollute, B will pay an amount equal to or less than n for A to reduce waste discharge to the level y' where marginal gain to A is equal to marginal damage to B. A in this case is willing to accept a minimum amount equal to area m . Again transaction of the right will take place, and if the transaction cost is zero the net gain to "society" equals the difference between areas m and n . The Pareto condition is implied with an input use at level y' with its associated level of pollution (this is the same level yielding a Pareto optimal use of input in Figure 1).

We now relax the assumption on zero transaction cost. Suppose, instead, it is positive and greater than $(n-m)$ but

smaller than $(p-o)$. If B has the right to exclude A from discharging waste, contracting will take place. If, however, A is given the right to pollute, no attempt will be made on B's part to bring the level of waste discharge from x to y' . Thus, with positive transaction costs, the arbitrary assignment of rights no longer produces an invariant result with respect to resource use and the gain to society.

We further suppose that the transaction cost is larger than either $(n-m)$ or $(p-o)$, i.e., the transaction becomes "prohibitively" costly. If the exclusive right to pollute is assigned to A, the wealth maximizing postulate and a transaction cost greater than the net gain, $(n-m)$, dictates that B will not act to reduce the pollution from the level associated with an input x . If B is given the right before A has started his production, with a transaction cost greater than $(p-o)$ the result will be a zero input used by A and he will produce nothing. If the right is assigned to B after A is already producing, however, the result will be an input level of x being used whereby B absorbs all of the uncontracted effect.

This last case, i.e., the presence of water pollution under this circumstance is a market solution constrained by the legal system and the existence of high transaction costs. The absence of private contracting thus by no means implies a market

failure. Furthermore, B here is maximizing his wealth by taking no action against A, given the high transaction costs which he will incur.

It is in this last category that we believe the pollution in the Mae Klong River falls. A general interpretation of the law that every person is entitled to the use of clean water was not common knowledge, particularly before 1969, and since waste disposal in general had not yet become a problem the public had very little incentive to seek out a determination of its rights, which were then construed primarily in judicial decision. The threat of water pollution was first officially recognized in 1969. Since then a growing awareness of environment quality has led to an amendment of the Factory Act in such a way that factories producing harmful effect are explicitly held liable for damage they have caused. Writing by prominent legal experts urging people to exercise their right has also begun to make an impact during this period.¹¹ The result has been a reduction of information cost which in turn has induced observable changes in the reaction of damage parties. This development is discussed in Section III.

C. Water Pollution Abatement in Thailand as in 1975

All concerned with mitigating the pollution of Mae Klong area have centered their suggestions on ways to prevent the dumping of wastes from industrial factories, and in every report we have

studies, action by central government is recommended. Agricultural contamination, on the other hand, from the runoff of fertilizers and insecticides, though recognized has not raised an outcry for precautionary requirement. On a broader horizon than Thailand alone, a general observation relating to the allotment of water rights has been increasingly toward more central regulation and relatively limited roles of private decision-making and the market processes.¹² Representative suggestions in Thailand include, "setting up a new agency or restructuring an established one with authority through national law..."¹³ or strengthening the power of the Division of Industrial Factory Control in closing a factory.¹⁴ A study by a mission acquired through the United Nations Environment Programme recommends that,

...the Government of Thailand should formulate, adopt, announce and implement a comprehensive Environment Protection and Management Policy which incorporates two main elements; namely

(i) Strengthening the powers and responsibilities of individual Ministries and existing agencies of government to control pollution, dispose of waste and improve the environment; and

(ii) Integrating this traditional method with a completely new approach based on the "total environment" concept, through a new powerful agency so as to make a comprehensive coordinated attack on pollution, waste and environmental problems.¹⁵

Major actions taken since 1969 to abate water pollution in the Mae Klong area and to control the environmental quality in general can be summarized as the following.

(1) Minimum standards for wastes and waste water to be released into any public waterway have been imposed on all industries.

(2) A Central treatment plant especially designed to treat the waste water released by eleven sugar factories was constructed and placed in operation in 1974 in the Mae Klong area.

(3) Issuance of regulations requiring the existing eleven sugar factories in the Mae Klong area to construct their own cooling tower to recycle their cooling water, none of which is allowed to be discharged into the river. Sugar factories licensed after 1974 are required to have their own complete system for all types of waste water, since the waste treatment capacity of the central plant was based on the waste load produced by the eleven factories in operation before 1974.

II PRE-POLLUTION CONTROL LAWS IN WATER USE AND THEIR IMPLICATIONS

The statutory regulation of waste discharges into public streams in Thailand can be divided into two periods. The first covers the era prior to 1969, over a time when domestic waste was the major source of water contamination. General prohibition of water contamination and the setting of penalties for violation can be traced back to the 1902 Klong Control Act (amended in 1940). Chapter IV of the 1941 Public Health Act and the Factory Act of

1939 (amended in 1960) also dealt with water use. Any conflicts of interest in water use involving compensation for damage were customarily resolved through judiciary interpretation of the Thai Civil Code. Throughout this pre-pollution control period, all industrial factories were subject to the same set of regulations that governed domestic waste.

The enactment of the Factory Act of 1969 (repealing the Factory Act of 1960) marks the beginning of the second period. Industrial waste is distinguished from domestic waste and for the first time recognized as the major source of public stream pollution. This period has seen a proliferation of committees, of studies, and of recommendations all concerned with environmental protection and management. Vigorous and direct action by the government against the industrial water users, particularly in the sugar factories in the Mae Klong area since 1969, also serve to separate recent policy on pollution control from the earlier period.

A. Interpretation of the Law

Three major implications can be drawn from the laws and the Thai Civil Code existing prior to 1969, (1) rights in water resource are limited to the use right which is nonexclusive; (2) every person is equally entitled to the use right; and (3) transferability of such right is explicitly prohibited by law

(which is redundant, since the absence of the right of contract or to transfer is already implied by the nonexclusivity of the use right). Although the laws and regulations regarding water use were not assembled under one single heading of "water law," they encompassed the problems of water contamination originating from almost all source.¹⁶

However, although the statutory development toward the later part of this period clearly indicates a movement toward a more explicit and direct responsibility for damage against the industrial factories, not all controls imposed by the government were uniform. All state-owned factories or what the Thai law has defined as state enterprises,¹⁷ up to 1975, were exempted from all requirements.¹⁸

Since state enterprise in Thailand accounts for a large percentage of the industrial sector, this exemption has a vital bearing on the whole question of pollution abatement. Information in Appendix I clearly indicates the wide horizon of government activities in the industrial sector. An expansion of the state enterprise over time is apparent both in terms of its diversity of products and an increasing percentage of share held by the government in the existing activities. More importantly, many of these state-owned enterprises are among the major producers of harmful effects, e.g., pulp and paper mills, distilleries,

slaughterhouses, battery manufacturing plants, etc. It is somewhat ironical that production of these commodities by the government has been intended to avoid excessive harmful effects which would have been induced by the "profit motive" of the private sector to begin with--another example where the actual result of public policy departs from its stated intention.

Rights in Water Use. Water use rights in Thailand are usufructuary. Owners of land bordering a stream have a right to take water for use on the land. This right to use water exists solely because of the relation of the land to the water and is included in the ownership of the land. However, substantial or excessive withdrawal from the stream or reduction of the natural flow is a violation of the rights of other users (Supreme Court 280/2498).¹⁹ It is in this context that any use that reduces the quality of stream water is considered a violation of the rights of successive users.

Legally, stream pollution is classified as a "nuisance."²⁰ When nuisance is likely to become or has become a threat to "the health, safety, or right and liberty of the public," the burden of curing the nuisance rests almost entirely on government officials.²¹

The water use right is also confirmed by the requirement for factories to maintain their surroundings and give "reasonable" care before releasing their waste water.²² No penalty, however,

was mentioned in cases of violation. Only in the 1960 Factory Act has it become compulsory that

...the factory owner must construct, with durable materials proper drainage which is connected to the public drainage system or to a pond specially constructed to receive the waste water. Such drainage system and the discharge of waste water must be designed such that they will not cause any problem to water users who rely upon waterways in the neighborhood. 23

The Notion of Equal Right. The course of action in modifying laws and finally in making the factories explicitly responsible for damage caused by water pollution from industrial waste has enhanced the water use right in general. However, no user can legally exclude others from using any particular stream since water resource is one of the "common properties of the kingdom," defined as

...all types of property owned by the kingdom for common use by the public or for conservation for future public use, such as...waterways, highways, lakes.... 24

Everybody is entitled to an equal right in water use as long as the exercise of such right does not violate other person's right.

Thus, we find such cases as the following.

... the defendant is allowed to keep his edible morning glory in the canal which is a common property of the kingdom before the plaintiff receives the licence for commercial fishery in that same canal. The defendant, by failing to confine his vegetable bed within the front of his house, has obstructed the plaintiff's fishing activity and thereby has violated the plaintiff's right. (Supreme Court 949/2508).

The notion of equal right is also implied by Section 228 of the Thai Penal Code which reads:

Whoever, by any means whatever, causes a flood or an obstructing to the supply of water, which is a public utility, shall, if such act is likely to endanger any other person or a thing belonging to any other person, be punished with imprisonment not exceeding five years or fine not exceeding ten thousand baht, or both. ²⁵

This is equivalent to saying that every person is equally entitled to the use of water in its natural form in terms of quantity as well as in quality. Thus, any activity reducing the quality of water to such extent that remedial treatment by subsequent users is necessary is held liable for damage in the strict sense of the law. ²⁶ The argument usually follows that waste discharge from the factories along the Mae Klong has caused damages to property downstream; and since the factories have never been granted the right to discharge their waste into the river, either at the time their licences were issued or in the Ministerial Regulations issued under the Factory Act, they are liable for such damage. Two questions, however, arise. First: Do all damaged parties have the right to seek compensation? Second: What is the possibility that an eligible damaged party will actually taken a legal action against the polluter?

The answer to the first question is apparently that the right to seek compensation is confined to landowners along the

stream who incurred "special damages." Section 1337 of the Thai Civil Code reads:

When any person, in exercising his own rights, causes damage or nuisance to any owner of immovable property to an extent beyond a reasonable level or expected level under normal circumstances taking into account the condition and the location of such property, the owner of such property has the right to take necessary action to eliminate the cause of the damage or nuisance. This, however, does not eliminate the right of the property owner to claim compensation for damage already incurred.

However, note that such right to seek compensation is vested only in the landowners. Those who lease or otherwise obtain the right to use the land are not protected, i.e., they are not eligible to claim compensation.

To answer the second question, the relevant costs associated with a legal suit must be identified and then compared with the expected amount of benefits. This will be investigated in detail later.

Nontransferability of Water Use Rights. Transferability of water use right is explicitly prohibited by law as long as water is classified as common property which is,

...not subject to ownership by private individuals through ordinary means of market transferability. Transferability is possible only through implementation of special law or by the Royal Decree. 27

The nontransferability of water use right thus not only is implied by the nonexclusivity of the right but also is confirmed by law.

Although the physical attributes of a stream would have occasioned a relatively high cost of policing any private investment inputs committed, such cost would certainly be lower for an exclusively owned stream than for a nonexclusive one. Since the choice of product, among other things, is also constrained by this policing cost, a product which entails relatively lower cost of policing will be chosen in the absence of exclusive rights. In the case of the sugar factories, we can say that the product chosen in association with non-exclusive right in water use is pollution, i.e. waste discharge, which turns out to be a "bad" instead of a "good" in that it yields a negative use value. With exclusive right, a product with a value higher than waste discharge would be produced.

B. Judiciary Interpretations and Their Economic Implications

Two broad theories govern the adjudication of private property rights in disputes regarding stream pollution: Namely the natural flow theory and the reasonable use theory.²⁸ Under the natural flow theory, each property owner along a stream has the right to have the stream come down to him in essentially its natural condition; pollution by upstream parties incure liability for damage and the threat of an injunction against future discharge. Under the reasonable use theory, each property owner can make a "reasonable" use of the water without incurring liability; "unreasonable or excessive" use, on the other hand, do incur liability for

damage and a potential injunction against future waste discharge. In comparison, it has been found that the use of judicial resources implied by the natural flow theory is relatively less extensive than that implied by the reasonable use theory. Since the natural flow theory also encourages negotiations among private parties it thus allows a wealth maximizing "solution" over water disputes

In Thailand, the notion of equal right in water use implies a recognition of the natural flow theory. In practice, judicial decisions in the twenty-five years between 1944 to 1969 have shown a systematic pattern that also implies the use of the natural concept. A total of thirteen cases relating to water use throughout Thailand, none from the Mae Klong area, were brought to the Supreme Court ²⁹ within that period. All decisions were consistently in favor of the damaged parties. ³⁰ However, as noted earlier, agricultural uses of water are under preferential treatment even in the later period after 1969 when water pollution has become an issue central to almost all concerns. Also exempted from the waste treatment requirement are domestic uses of water, the state owned factories as well as the municipal sewage systems.

It appears that when a case of water dispute is brought to court and the damage is confirmed to be greater than would be "reasonable" under what the court considers "normal and reasonable circumstance," the result is predictable that the plaintiff's

claim for compensation will be granted. Therefore, an industrial waste discharger faces almost a certainty of losing any case brought against him, once his action is confirmed to have caused the damage. It follows that the polluters have an incentive to seek out-of-court settlements which invariably cost less than a judgment against them-- particularly, if an injunction against future discharge were to be granted, they would face an additional cost of installing a pollution control device.

At this point, one is tempted to conclude that the predictability of a court decision implies a large number of out-of-court settlements, which in turn would explain the small number of cases brought to court in the past. However, predictability is only one of the two major determinants of a legal action. The second, which we believe to be more important, is the transaction cost involved in seeking compensation for damage. Such transaction cost may be so great as to explain not only the small number of cases brought to court but also a small number of out-of-court settlements, although no total of these can be substantiated. Once certain costs are identified as crucial in determining a given type of transaction, however, it is possible to establish that the higher the costs the fewer transactions will take place. When the existence of water pollution is explained by high transaction cost, it then follows that making contractual stipulation

more complete, i.e., equating the apparent marginal inequalities, would be a costly procedure. In that case, unless the transaction costs can be correctly reduced, any indiscriminating attempt to "solve" the water pollution problem through legislation may result in net social costs greater than net social benefits.

The Cost of a Legal Action. For a waste-producing firm, let us assume that (1) the firm is liable for pollution damage, and (2) some damage has already occurred.

Suppose a downstream party has filed for compensation for damage; whether the waste-producing firm will fight the case depends upon such factors as its possibility of winning (losing) the case, the amount of compensation being claimed for, the legal fees, other monetary and nonmonetary costs of transaction. The expected expenditures facing him may be summarized as:

$$E(D) = (1-p) (D_p) + p [- (D + L + I)] -T$$

where p is the probability of losing the case and $(1-p)$ the probability of winning. The Thai legal system imposes on the loser all legal fees (L) including those paid to the lawyers of both parties as well as to the court. D stands for the present value of the past damage while I stands for the cost involved in avoiding future damage in case an injunction is granted; and D_p stands for the future damage for which the firm will not have to

compensate. T , denoting other costs of transaction, is not a single item but a function of information costs, bribery, personal safety, etc. (The "safety" item may seem irrelevant at the moment; justification for including it as a cost factor will be provided later.) T is thus what each party has to pay regardless of the court decision.

When the probability of losing, p , is equal to unity which is implied by the predictability of the court decision, the expected expenditures by this waste producing firm is reduced to

$$E(E) = -(D + L + I) - T$$

Although if he wins the case, his expected expenditure is only $-T$ (the minus sign indicates what he has to pay, while a plus sign indicates what he will receive), the probability of his winning under the circumstances implied by the law is zero. Therefore, he has a strong incentive either to pay the downstream party to withdraw the case or to bribe the officials assigned to investigate the alleged pollution. In either case, the expenditure will be less than undergoing the trial. Generally, it would be in the interest of the waste producer to wait until the case reaches the court before he starts making an offer because if the plaintiff agrees to compromise and accept a payment in the presence or with the knowledge of the court, he is not allowed to sue again

as long as the pollution by this same operation is of essentially the same quality and quantity as at the time he receives the payment.

In bringing the case to court, the expected expenditure facing the damaged party may be summarized as:

$$E(E) = p(D) + (1-p) [- (+ L + F)] - T$$

where p is the probability of winning and $(1-p)$ the probability of losing the case. If the winning probability, p , equal zero, the expected expenditure to him is the sum of the present value of the past damage (D), the legal fee (L), and the present value of future damage or the cost in avoiding future damage (F) and all other transaction costs (T). When his probability of winning equals one, his expected expenditure is reduced to $(D-T)$. The question to be considered is whether the net value of this expression will be positive.

Some elements in T are basically of the same nature whether the potential plaintiff is an industry or a nonindustrial individual. Other elements, however, differ significantly and should be considered separately.

An Industrial Factory as a Potential Plaintiff. When the damaged party is another industrial factory which owns both the land and the plant, it can, according to law, file for a com-

compensation;³¹ but such a move has never been taken. The notion of equal right to all water users explains partly the reluctance of industrial factories to take action against their polluter. The main reason is the fear that whatever the result (which is likely to be unfavorable to the polluter), it would in practice prove as applicable to the damage party as to the damaging party. The reason for this seeming paradox is that each factory along the river is, at one and the same time, a damaged and a damaging party as long as it has to dispose of any waste from its own production process, and it may soon be subjected to the same charges by factories located further downstream.

If the damaged party does not own the land, but leases, the land on which the plant is located (a widespread practice), then he is not even entitled to claim compensation for damage.³² For a factory owner to bring in the landowner as co-plaintiff, two conditions must be satisfied: (1) the gain from the cooperation must exceed the cost, and (2) the distribution of this net gain must be acceptable to both parties. Such cooperation can be seen as a very costly process. On the one hand, the factory can provide all the technical details to prove the extent of damage; but he is not legally entitled to claim compensation. On the other hand, the landowner lawfully has the right for such claim. This situation is almost analogous to the case of bilateral monopoly where no "optimal" solution can be reached.

Moreover, the maximum allowable period for the land lease contract (thirty years) may prevent the landowner from proving that his income from the property has been lessened. Finally, the factory owner also faces the apprehension common to all that a court decision favorable to him may later be turned against him by other downstream parties.

This fear of the "boomerang effect" may appear insignificant since nothing guarantees that if a factory owner refrains from suing his upstream polluters, then his downstream neighbors will not sue him. However, two special characteristics of the sugar factories along the Mae Klong river makes the boomerang effect a major deterrent to filing legal suits: (1) all fifteen sugar factories are owned by only five families, and (2) their location makes the argument on the boomerang effect a reasonable and significant point. The location of the factories along the river can be summarized as follows:

Upstream 1 2 2 1 1 2 1 1 3 3 4 4 2 2 5 Downstream

where the same number indicates the same owners. (Among these families, some are related by marriage.)

We observe these factories drawing water from the river during the daily high tide period, storing their waste during operation, and then discharging during the second daily high tide

period, usually at night, or during a recess in production. The behavior represents a tacit, mutually agreed-upon, contract among the factories in response to a potential liability for damage implicit in the legal system. "Externality" within this stretch of river has thus been internalized when the interest in so doing is common to these factories.

A Nonindustrial Party as a Potential Plaintiff.

Nonindustrial party refers to any activity except an industrial factory. Given the probability of winning a legal case as unity, the expected expenditure facing this potential plaintiff is the same as that facing an industrial factory, i.e., $(D-T)$. Again, it is the net result of this expression that will determine whether legal action should be taken. Since farmers and household water users are subject to preferential treatment under the Thai law, they are not threatened by the boomerange effect of a court decision. It would appear strange, then, that only thirteen such cases have reached the supreme court during a period of twenty-five years. Either a large number of out-of-court settlements must have taken place, or some costs must be present that make both in-court and out-of-court settlements virtually impossible.

For an out-of-court arrangement to work it is essential that the equal rights in water use be common knowledge. However,

there is reason to believe otherwise, particularly, since such rights are based primarily on the judicial interpretation of the law as discussed earlier. More importantly, the costs of seeking out and enforcing the rights tend to be high. Under a well functioning and uncorrupted system, a group of individuals applying for relief from water pollution would be informed of their rights and directed to the appropriate offices. In practice, in Thailand, most such petitions are ignored, while the petitioners are subjected to harassment of all sorts both from the officials and from hired hands of the damaging party. Threats to the lives of complainants and their families are not uncommon. Unfortunately, this statement cannot be documented. But readers familiar with the social and political environment of remote agrarian areas in a small southeast Asian country will agree that this is truly what happens. Therefore, unless a sufficiently large and vocal group can assembled fast enough to attract attention from the public at large, or reach a highly placed official who happens to have no personal interest involved with the polluter, the cost in exercising one's right is prohibitively high indeed (i.e., the industry virtually owns the river) !

Hence, the small number of cases to reach the court does not imply that most compensation has been paid outside the court. In point of fact, actions against water polluters in the past, either in court or out-of-court, have been very few because

of the high transaction costs involved. Subsequent government interventions in an attempt to control the water pollution problem, have, perhaps unintentionally, reduced certain components of these transaction costs. As a result, we observe a changing pattern of contracting behavior among individuals regarding water use rights. This is the main subject of discussion of the following section.

III WATER POLLUTION CONTROL AND ITS IMPACTS ON WATER RIGHT ENFORCEMENT IN THE MAE KLONG AREA

Water pollution control in Thailand began in 1969 when the most recent Factory Act was passed. Since then, a series of supportive government actions have taken place; they include (1) an imposition of a set of minimum standards of waste water allowed in public waterways,³³ (2) specific waste treatment requirements for the sugar industry in the Mae Klong area,³⁴ (3) a central waste treatment plant operated by the government in the area, and (4) a one - man mission, through the United Nations Environment Programme, "...to assist government of Thailand lay down policies and plans which go forward on continuing basis; advise generally regarding measures on pollution problem particularly of Mae Klong and Chao Phraya rivers...."³⁵ The government's concern on the issue is plain in the Prime Minister's address to the Thai people:

...we realize the importance of conserving and maintaining the environment of the world in its good quality forever...pollution is a matter of survival for the planet--earth. 36

Environmental quality is, of course, a matter of degree, and to maintain the good quality forever is dubious rhetoric. Maintaining environmental quality would certainly conflict with the growth objective of Thailand's National Economic and Social Development Plan which has induced an increase not only in manufacturing production but also in waste by-products among various industries. As growing awareness of environmental values compete with the increasing industrialization, the sugar factories have come under close public scrutiny. One view, presented by the news media and certain government officials, is that the location of these factories is "wrong" and should be relocated.

In retrospect, however, if the existing sites have been chosen as the least private-cost location for sugar production, an attempt to relocate may incur more cost than gain to society. A study by Suchada Suwannapirom has confirmed that the present sites of the sugar factories are indeed the least cost location.³⁷ Factors affecting the location decision taken into consideration are (a) sources of water, (b) transportation facilities, (c) sources of sugar cane, and (d) administrative advantage.

A. The Water Pollution Control Interpreted

Any legislative amendment, if effectively enforced, constitutes an alteration in constraints which in turn leads to alterations in behavior. A redistribution of resource allocation is implied. However, the intended effects and the actual effects of legislation often differ. In this section we will show the following:

(1) The series of actions taken by the government has had little effect in reducing water pollution in the Mae Klong river.

(2) The minimum standards for waste water, though serving to single out the industrial source of water pollution, have also in the process reduced the predictability of the outcome for any potential legal challenge.

(3) Certain exceptions to the minimum standards requirement have brought forward the application of the reasonable use concept, which leads to greater recourse to judicial evaluation of the gains and costs of a legal action.

We also see that the equal right in water use, although apparently still unenforceable, and nontransferable, transferability, of a sort, of water use right has been awarded on a piecemeal basis through court order in the form of compensation for damage (granted

or withheld). We now turn to examine the effectiveness of the new wave of government regulations governing the management of industrial waste.

Government Regulations and their Effects on Pollution

Abatement. Although official survey conducted after the initiation of the 1969 Factory Act seems to suggest an "improvement" in water quality (see Table 2), economic indicators imply differently.

Since the properties of water samples to be tested are listed on a standard form, the fact that certain properties are not recorded for some periods raises a simple question. Are the properties omitted because they do not support the purposes of the investigators, or have they been abruptly deemed unimportant? One may well wonder what story the "not reported" values would tell. This type of report is certainly not reliable enough to undergird a conclusion, especially when the economic indicators imply otherwise.

Persistence of Water Pollution as Seen Through Rela-

tive Land Value. The basic assumption here is that within any region where industrialization takes place, the land value necessarily increases relative to a nonindustrialized area. Within an industrial region which locates along a flowing stream where pollution persists, however, the relative value of downstream land will be lower in proportion to the degree of pollution.

Table 2

Tested Properties of Water Samples from Mae Klong
(Average values)

	Nov. 1972		Feb. 1972		April 1973		Feb. 1974	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
Dissolved Oxygen (mg/l)	7.4	7.1	7.0	3.5	7.0	3.3	6.2	5.3
Temperature (F)	81.3	77.0	80.7	85.0	90.0	90.0	84.0	85.0
pH	7.0	7.2	7.0	7.0	7.0	7.4	n.r.	n.r.
Turbidity (units)	25-75	25	n.r.	n.r.	n.r.	67	n.r.	n.r.
Color (units)	12.6	35	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Hardness (mg/l)	112	108	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Conductivity (micro mhos/cm)	245	226	n.r.	n.r.	n.r.	196	n.r.	n.r.
Confirmed coliform (MPN/100 mg)	19×10^3	19×10^3	n.r.	n.r.	24×10^3	35×10^3	24×10^3	14×10^3
BOD	n.r.	0.5	1.5	4.1	n.r.	n.r.	n.r.	n.r.
Total Solid (mb/l)	n.r.	238	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
COD (mg/l)	n.r.	n.r.	44	38	n.r.	59	n.r.	n.r.
Suspended solid (mg/l)	n.r.	197	22	22	12	78	n.r.	n.r.
Alkalinity (mg/l)	n.r.	164	162	159	n.r.	n.r.	n.r.	n.r.
Acidity (mg/l)	n.r.	3.5	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.

Note: n.r. means not reported.

Source: Kasemsan Suwannarat, A Data on General Quality of Surface Waters in Thailand, Department of Health, item 5.1

[sic]

In 1974, three new sugar factories were constructed along the Mae Klong river. Information on land cost is available on only two of them, the Prachuab mill at the beginning of the "sugar zone" and the New Mitpol mill almost at the end of that zone. The land cost incurred by both firms can be summarized as:

Table 3
Comparison of Land Costs for Sugar Factories
For Upstream and Downstream
(Value in US Dollar)

<u>Prachuab (Upstream)</u>		<u>New Mitpol (Downstream)</u>	
Land area	92 acres	Land area	200 acres
Value/acre	\$15,625.-	Value/acre	\$1,250.-
Land Value	\$1,437,500.-	Land Value (1)	\$250,000.-
		Ground Water Facilities (2)	\$100,000.-
		Private Road (3)	\$50,000.-
Total Land Cost	\$1,437,500.-	Total Land Cost	(1) + (2) + (3)

Source: Suchada Suwannapirom, "Location and Distribution of sugar Mill in Thailand: A Comparative Study of the Eastern and Western Regions," master's thesis, Faculty of Economics, Thammasat University, 1975, p. 95.

Note : Conversion rate at US\$1: 20 baht.

Many believe that the location of the New Mitpol about two kilometers from the river indicates a new trend in the choice of factory location, and is a result of the movement to abate water pollution. The argument usually goes like this Since 1969, waste treatment has become compulsory. In the sugar industry, the treatment generally involves a simple method of aerobic pond or oxidation pond which requires a large land area and since land price along the river has increased significantly due to industrialization, it is natural for new plants to seek a cheaper location. Although this line of argument seems plausible, it is weakened by three major flaws.

First, government regulations regarding waste treatment have not been effective in relation to the sugar factories---the implementation of a central treatment plant and other additional efforts by government confirm our point here. The government has always had difficulty in enforcing any law against the industry. Officials at the Ministry of Industry revealed that whenever a sugar factory is warned of the impending closure for failure to meet the specific water quality standard, the owners in collusion

threaten a complete halt in operation. Given the highly perishable nature of cane, the small number of joint owners of the factories, and the fact that these factories together produce more than 60 percent of the nation's sugar, the threat cannot be taken lightly. Usually it puts an end to the attempt to enforce the law.

Second, eight sugar factories have been constructed since the control was imposed in 1969. Of this total seven are located along the river and of these, six are in a relatively upstream position. Thus the decision by the New Mitpol hardly represented a "trend" of location choice.

Third, the location of the New Mitpol is right in the heart of the industrial region yet its per unit value of land is lower by a factor of over twelve-fold than that of the Prachuab mill, for which the far more expensive land is virtually outside the actively industrialized area. The difference in land value would apparently be attributable to the status of pollution; only one sugar factory stands between the Prachuab mill and the headwaters of the river.

Therefore, by elimination, there is only one major reason to account for the difference in land values--the quality of river water. Contrary to official reports, the fact that pollution is greater as one continues down stream is implied by

the lower land values. The following government actions support this theory.

Government Action Interpreted. After 1969, with a set of minimum standard requirement in effect, the situation in the Mae Klong continued to deteriorate. The government then budgeted 20 million baht in May 1973 for the construction of a central treatment plant. In addition, regulations have been issued.³⁸ A Five-Year Plan in water quality control and reclamation has been outlined.³⁹

The very existence of the central treatment plant confirms the failure in enforcing waste standards and other regulations. Furthermore, waste still finds its way into the river due to inadequate capacity of the central plant. From an economic point of view, this is no surprise. Since the treatment fee is based on the quantity of sugar cane processed, it will reduced sugar production in the same manner an increase in the price of cane does, assuming sugar cane is a normal factor of production. Theoretically, water is available at a zero price both before and after a treatment is imposed. Basic economic theory predicts that given a zero price for any normal input, an "indefinitely" large amount will be demanded, i.e., each additional unit will be used, eventually, until its marginal product becomes zero. Therefore, a treatment fee imposed per unit of cane processed will not reduce the volume of water use and released.

Water pollution in Mae Klong is, in fact, highly seasonal. The annual sugar production season extends from November to mid-May, coinciding with the dry season when the water flow in the river is at its minimum, sometime as low as 27 cubic metres (CMS), compared with its peak of 2,500-2,800 CMS. The seasonal nature of sugar production dictates that the processing be done just when the risk of pollution is the greatest. This was true prior to the pollution control. After numerous government regulations and a central plant later, discharges of treated waste already satisfied the legal minimum standard will yet cause enough degradation to result in pollution.

In response to this situation, the sugar factories were required to construct additional storage to hold all their waste by-product throughout the production season and until the river regains a flow as high as 2,000 cms. In fact, the factories had already been doing that very thing before the government intervention. The action has simply made statutory a practice which was previously voluntary at a time of their own judgment, usually during high tide when the assimilative ability of the river is relatively high. Now the stored waste can be discharged only on order by the authority. Whether the government can react as spontaneously as the independent factories once did in response to the changing nature of the river is not hard to imagine.

Alternative Measure. The purpose to reduce the total volume of waste water as well as the level of waste concentration in the used water can be achieved through a price on the river water and a treatment fee based on waste concentration. A metering system such as those in the public water supply service would measure the use of water. Measurement of the waste concentration as a base for the treatment fee is entirely feasible. Indeed, government officials at the central plant presently have to check the property of waste water received in order to advise on appropriate pretreatment steps at the factories.

So far we have looked at the implications of the water pollution control with respect to resource allocation by the sugar factories. We now turn to examine the implications on the transactions costs in enforcing one's right in water.

B. Water Pollution Control and its Implications
on Judicial Resource Allocation

The nature of the right to water use in Thailand before the control movement has been established as being: (1) everyone is entitled to its use, (2) the right is equal for all individuals, and (3) the right is not transferable. We have also determined that whether a legal action against a pollution will take place depends on (4) the predictability of the court decision,

and (5) the transaction costs involved in such an action. An investigation of statutory development since 1969 indicates that (1) through (3) remain unchanged. The predictability and the transaction cost, however, have changed. The changes, in turn have caused certain observable adjustment in behavior which will be discussed in this section.

The Predictability of a Court Decision. Under the natural flow concept implied by judicial interpretation, a court decision can be predicted with certainty. However, such concept in general has been weakened by the power for the Ministry of Industry to "...determine that any factory...is exempted totally from complying with this Act (the Factory Act 1969). Furthermore, the requirement on the standards of industrial waste is subject to exceptions. ⁴⁰

The new regulations thus allow the court as well as the officials to judge the "appropriateness" of water use. Under such circumstance, "substantial damage" which was a sufficient condition for liability under the natural flow theory has become a necessary condition. Once the Substantial damage is confirmed, it will have to outweigh the "importance" of the polluters' activities to ensure liability. This is essentially the idea of cost-benefit analysis. Apparently, the court is now responsible for considering the effects of alternative allocations of rights and seeks to grant the rights to the to the party whose use is, by the criteria of the court, more valuable to

Such criteria are not clearly stipulated and are bound to differ from court to court.

Expected Expenditure on a Legal Case with Uncertain Predictability. For a hypothetical waste-producing firm, we assume, again, that (1) the firm is legally liable for damage, and (2) some damage has already occurred. Based on the same notations as previously specified, the expected expenditure of the waste producing firm in fighting a legal action is expressed as

$$E(E) = (1-p) D_F + p [-(D + L + I)] -T$$

Since the predictability of losing the case now ranges from zero to unity, the amount this firm will pay decreases with a decrease in the probability of losing the case, that is

$$\frac{\partial E(E)}{\partial p} = -D_F - (D + L + I) < 0.$$

The opposite is true for the damaged party. If the probability of winning the case is p , the amount he will pay can be expressed as

$$p(D) + (1-p) [-(D + L + F)] -T$$

where

$$\frac{\partial E(E)}{\partial p} = D + D + L + F > 0.$$

As long as the exact value of p is unknown but each party has reason to believe it to be favorable to him, there is incentive to go through with the court procedure. However, although the regulations have served to confirm the responsibility of the industrial factories, such responsibility is not directed toward the damaged party.⁴¹ Compensation for damage still relies upon the Thai Civil Code.

The decreased predictability of the outcome of a legal case can be seen by reviewing the Samut Sakorn provincial court records since 1969. Compensation for damage has been granted through the Thai Civil Code in only one of a total of ten cases over waste discharge, where both parties finally agreed to settle out-of-court. The final payment received by the plaintiff amounted to 15 percent of the damage value originally claimed for. (Mrs Chavee Tasannaprida v. The Petkasem Textile Factory Partnership Limited, Samut Sakorn Court, red number case 76/1969).

In the other nine cases⁴² brought to court by the same lawyer-- a phenomenon which takes place after the water pollution control, an explanation for which will be provided later, the court decision indicates a departure from the implications of the natural flow concept embodied in court decision prior to 1969. Since accusations by all nine plaintiffs were the same and against one group of defendant (the sugar factories), except with different value of compensation requested, the cases were determined at one and the same time.

...the court believes the plaintiffs to be as responsible for the damage as the defendant by failing to inform the defendant of the possible damage and by failing to take necessary action to prevent or reduce the damages. As for the waste water discharged, the defendant has obtained an official permission from the Department of Factory Control and the district office for the action. Moreover, the permission was officially announced so that necessary actions could be taken by people in the area to avoid the potential damage by the waste water...

...the defendant only released his waste water on the days allowed by the government official... he is partly responsible... By virtue of Section 223 of the Thai Civil Code, the defendant will compensate each plaintiff 50 percent of the value of the damage.....⁴³

However, even with sign of deviation from the natural flow concept, if the probability in winning (losing) a legal suit can be determined, our assertion still holds that the lower the transaction costs the more expenditure will be devoted in bringing about a legal action. Therefore, we will now deal with (1) the implications of water pollution control on the costs of transactions, and (2) the way by which the predictability of a legal case is determined.

Water Pollution Control and its Implications on Transactions Costs.

The Factory Act of 1969 and the numerous regulations that follow have performed one major function in making public the liability of industrial waste producers for resultant damage. Since this knowledge was not common before, the legislation has in effect reduced the information cost. However, the reaction differs among various concerns. For our hypothetical waste producing firm, with a probability of losing, p , less than unity the value of compensation for future damage (D_p) becomes positive. Thus, this firm will fight the case, if the present value

of all D_p , given the probability, is greater than what he would have to pay on losing the case. By winning the case, he is essentially granted a nonexchangeable property right in water use as far as the present damaged party is concerned. With the probability to lose equal to unity the under natural flow concept parlier this alternative was simply not available to this firm.

An Industrial Factory as a Plaintiff. Since waste treatment has become compulsory for all industries, the boomerang effect is expected to disappear. A factory along the river can no longer avoid waste treatment by refraining from suing its upstream neighbors. Not only the treatment cost has become unavoidable but also it will increase with additional waste discharged by upstream parties. Each party now will have no qualms about seeking compensation or obtaining an injunction against future pollution damage. This disappearance of the boomerang effect thus implies an increase in legal action by industrial as well as nonindustrial water users provided that the transactions costs have decreased significantly.

The Transaction Costs for a Nonindustrial Plaintiff. We have established that one great deterrent to bringing a legal action was an overshadowing fear about the physical safety of the plaintiff. Prior to 1969, any such action usually began with a solitary individual filing a complaint at a district office where it was normally tabled and never reached the court. Then came the 1969 Factory Act, and with it a remarkable reverse of procedure. Because the Act serves to identify the liable party, the damaged party and his lawyer are

now provided with a clearly defined opponent without prohibitive costs of information. Now it is the lawyer who is in a position to initiate legal actions. Better informed on legalities, armed with a new set of statutes and regulations, a lawyer can approach whole groups of individuals who share a situation of property damage from industrial water pollution. Such a move works both ways. The lawyer with a collective plaintiff has a strong case for impressing the court with the magnitude of the damage. On the other hand, the plaintiffs who join in the action remain incognito until the time to testify in open court. At this time the case is known to the public and their personal hazard is greatly diminished.

Since it requires the initiative of the attorney to reduce the safety element of transaction costs in this way, it is perhaps not surprising that only two lawyers have handled the sixteen cases over waste water discharge which have reached the Samut Sakorn and Rajburi courts. Therefore, we can maintain that the transaction costs have been reduced as an indirect effect of the water pollution control. Since now the court decision may differ from case to case, predictability for each case must be determined separately. We now turn to the determination of this factor, predictability.

The Predictability of a Court Case. Under the alternative concept of reasonable use of water sometimes adopted by the judicial authority, each case stands on its own merits. When disagreement on the value of the probability of winning or losing arises, the case

will be brought to court.

The plaintiff usually file the complaint as a "poor man's case," a situation where he is simultaneously petitioning for an exemption from all officials fees. Under this circumstance, the court will call for hearings to establish two points: (1) whether there is enough legal ground to build a case, and (2) whether the plaintiff deserves the exemption he petitions for. Both parties are required to testify in court. After these pre-hearings have established legal grounds (a process sometimes taking as long as two years), the court may rule that the plaintiff does not deserve the exemption requested. He is then required to pay all official fees within fifteen days to file an official arraignment or the complaint will be dismissed. The court decision at this point has established the predictability of the case and there is no need to go through with the trial. An out-of-court settlement can now be arranged.

Of the six cases in Rajburi since 1969, two were withdrawn and four were dismissed.⁴⁴ In each case a payment out-of-court was recorded. Thus, the act of bringing a case to court is simply a handy way to determine the possible outcome of a legal suit. When the probability that the waste-producing firm will lose is equal to or closer to unity, the management settles for out-of-court payment.

We thus reached a concluding remark to this section: The judicial resources will be used more intensively, given (1) the present

legal system, and (2) the tendency that a court will follow the concept of reasonable use value. Unfortunately, at the time of this study, it was still too early to determine the effects of the law. However, it is definite that during the five years since its perception (1) water pollution in the Mae Klong area has not improved, and (2) the use of judicial resources has become relatively more intensive compared with the pre-control period.

IV GOVERNMENT DISCRETION OR PRIVATE PROPERTY RIGHT :

A CONCLUSION

The problem of water pollution in Thailand has become a controversy of the "rich and powerful" industries against the "poor and helpless" people in nonindustrial occupations. Thus, there is a good political reason for the government to initiate control over water resource use in an attempt to maximize the "welfare" of the society. However, both the government and the society whose welfare is being maximized are abstract entities. It is individuals who function in the bureaucracies as well as in society; and there is good reason to believe that they have the same general motivations as other people in regard to their own wealth maximization. Although the cost constraints facing them in defining, policing, negotiating, and enforcing resource rights and contractual arrangements may differ, they are definitely nonzero.

Since evidence confirms that the continuance of water pollution in the Mae Klong river is largely explained by the existence of high transaction costs, such cost must be reduced if the problem is to be solved.

Conflicts of interest in water resources use should and will receive increasing attention as water becomes relatively less abundant in comparison with other factors of production. The costs of maintaining surface water in potable quality are increasing, in terms of other goods and services forgone. This constitutes only part of the costs incurred by the government in moving toward a more centralized control in water resources for that purpose. In this section we discuss other costs associated directly with government intervention, as they relate to the feasibility of a centralized control in comparison with a system of private property rights. Centralized planning as a decision process is direct and obvious in its operation. The market mechanism, on the other hand, is more subtle in its workings.

A. General Consideration

The preceding discussion is critical of government activities for only one reason: The government has been the only active agency in the field of water resource allocation while the market mechanism has never been allowed to play its role. There is nothing objectionable in government decision or centralized planning per se, as long as the allocation and development of water use accord with the same principles

governing the use of other resources. Traditionally, water use has been treated as a special case due to its fugitive nature. We maintain that the physical attributes of the water resource must be taken into account in applying the economic theory. In addition, there are always difficulties in abating pollution by some individuals without simultaneously benefiting other water users. However, it does not follow that the physical attributes or the difficulties imply an invalidation of economic theory.

Several implications have been drawn from statutory development affecting the right to use water. These rights are not at all well defined; they are also nonexclusive and nontransferable. Although an equal right in water use can be derived, in principle, from the existing law, it has been virtually impossible to enforce. The result is the presence of water pollution such as the one in the Mae Klong river. Recent statutory changes and direct actions taken by the government consistently indicate a bushfire-fighting approach. They give us the impression of treating the symptoms rather than the disease. Although many regulations have been imposed on the industrial sources of pollution in an effort to stop their waste discharge into public stream, the main and central cause of water pollution--the high transaction costs in enforcing water rights--has perhaps been indirectly affected by some regulations but has never become a central or explicit concern of any proposed "cure" for the problem.

B. Government Discretion

Government intervention has always been looked upon as a corrective process where the market system has failed. It is also constantly equated with "social preference" by its advocates who argue that in the political sphere the principle is "one man, one vote," whereas it is "one dollar, one vote" in the market process. Therefore, decision by majority vote necessarily represents a preferable social outcome. However, it is not unknown to us that people with wealth can derive political power either indirectly, through command over the means of influencing voters, or directly through control over members of the political organizations; or where political stability has not been continual and the voting system has been displaced. As a consequence, policies adopted by the government can hardly be expected to correctly represent social preferences. Furthermore, granted that government intervention is in fact representative of such wide-spectrum preferences, the political allocation process still faces an obstacle: The demonstration of preferences through the political process is infrequent as compared with the continual adjustment of the market system.

In Thailand, government control is customary over common resources such as water. However, the administrative and monitoring powers of the government departments are not directly specified in the law. Instead, they stem from the more general powers given to

the Ministries of Agriculture, Industry, and Public Health. Each ministry then sets its own regulations for those activities directly related to its responsibilities. For example, the Ministry of Public Health is charged with detecting health hazard including water based diseases in public streams where surface water is used for domestic consumption. The ministry authority can evacuate or quarantine any "house" which is the source of contamination. It does not have the power, however, to evacuate an industrial factory or to demand that the factory stops the contaminating operation. The control over industrial factories is rested entirely within the domain of the Ministry of Industry.

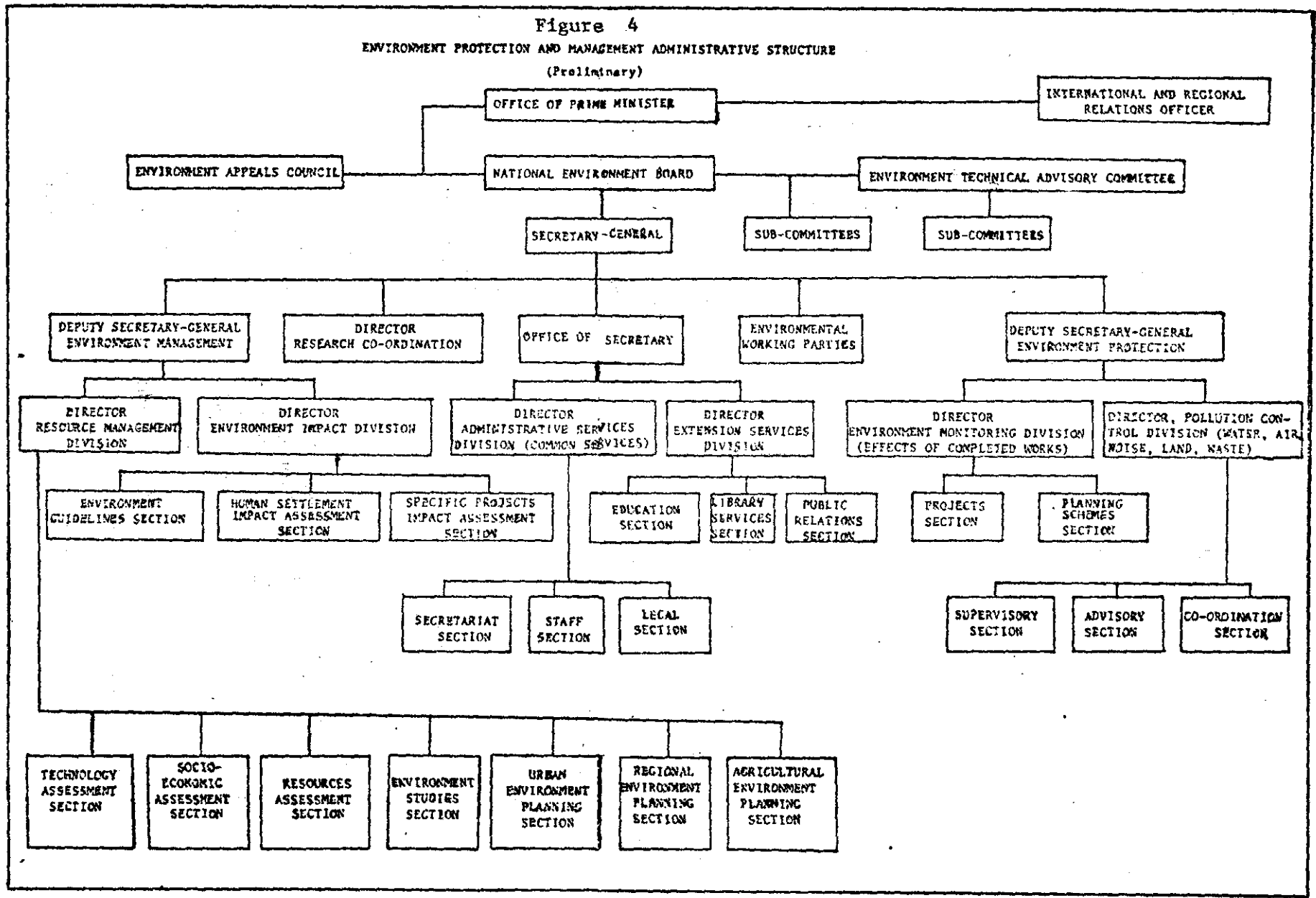
Municipalities, which are a separate branch of the government administration under the Ministry of Interior, are also authorized to control the use of water resource in regard to household sewage systems, and to public market garbage collection and disposal. The net result is that at least five departments under four ministries were working independently on the Mae Klong pollution problem without a clear definition of responsibilities and coordination among them.

Government involvement becomes wider still by adopting the recommendation put forth by the United Nations study in establishing a National Environment Committee which includes as its members, "...representatives from government agencies, academic institute, industry, rural activities, tourism and recreation and

local environment groups."⁴⁵ And for the committee to operate successfully, the mission also suggests "modern", comprehensive and realistic legislation...which must be coordinating, supervisory and advisory in character, and to cover the whole range of environmental problems."⁴⁶ The quest for such a full-scale environmental control will surely produce problems in administration as well as in the availability of essential technological and economic information.

Administrative Feasibility. Under a centralized planning system, a condition for wealth maximizing resource allocation will not automatically be brought about by competition among users bidding for scarce resources, as tends to be the case with the market system. Instead, wealth maximization must and should be consciously sought. The achievement depends as much on existing administrative resources as on future policies to be adopted. The government was in the process of implementing a "government Environment Protection and Management Policy and Programme" as suggested by the United Nations mission study and of a form outlined in Figure 4 at the time this study took place. Presently, a National Environment Board has been set up with its responsibilities as appear in Appendix V.

Figure 4
ENVIRONMENT PROTECTION AND MANAGEMENT ADMINISTRATIVE STRUCTURE
 (Preliminary)



By 1972, more than 11,000 factories throughout the country were engaged in production which releases waste or waste water. The administrative force in charge of industrial waste control under the Ministry of Industry then comprised only nine officials. Of this staff, three were engineers, one was a scientist, the others were technical vocational school graduates. The movement toward the recommended environment program means a tremendous expansion of manpower and an equally enlarged budget appropriation. This, in turn, raises a question regarding the financial feasibility of such program.

Major problems which will be encountered are best illustrated by a list of the present shortcomings of the government at the administrative level as summarized by this same mission. They are essentially as follows.

- (a) Lack of Environmental Assessment guidelines
- (b) Lack of Environmental Planning guidelines
- (c) Lack of comprehensive environmental background studies (inventory)
- (d) Lack of practical Planning Policy taking account of the environment in Human Settlement
- (e) Lack of a coordinated Resource Management Policy
- (f) Lack of Technology Assessment Policy
- (g) Lack of "Total Environment" or "Resource Management" approaches to the solution of specific problems
- (h) Lack of environment input in budgeting
- (i) Lack of effective public environmental education machinery
- (j) Lack of effective enforcement.⁴⁷

Moreover, the absolute size of the administrative staff is yet to be determined: The present circumstances give evidence of an overlapping of responsibilities (or lack of responsible authority

in certain areas) and a lack of communication among the government departments, sometimes purposely for the competition reason. Result: Too many agencies may be dealing with water resource use without a clear definition of their responsibilities and their coordination. On the contrary, if the power is assigned to one single national committee, the danger of misuse of power is amplified the wider the discretionary authority and the broader the scope of its activities. Important information may be overlooked.

The possibility of a misrepresented environmental program is also enhanced if, as suggested, the "...programme is evaluated and reviewed quarterly by an expert...."⁴⁸ What the expert decides to be "good" for the people may not be what they would have voted for. The defect in the political allocation of resources thus rests upon these individuals who function under the collective label of a "committee." They cannot be expected to be perfectly objective or detached from other voters at a time of decision making. Inevitably, they may develop interests in conflicts with those of the people they "serve and represent."

Information Cost. Information will be needed to learn the types of waste produced by each industry to determine the level of pollution abatement to be achieved, to choose the policy mechanism, to assign the right person to the right job and finally to enforce the regulation set forth. As an illustration, let us assume that

the government decides to "put a price on pollution." Such a price must be set equal to the marginal social costs of pollution. It is obvious that different prices must be charged to different industries. More important is the fact that one single action can impose a harmful/beneficial effect on a number of other activities. If the value of marginal damages can be measured or estimated with accuracy, then there seems to be no further problems: The vertical summation of all uncontracted marginal effects will indicate what the price of pollution should be for a particular level of pollution.

However, price determination here is subject to further complications. Not only must the exact magnitude and the position of each uncontracted marginal effect schedule be known; there is always more than one party operating along a public stream. So the question is: How can one separate the uncontracted effect caused by one sugar factory from that caused by another or from another type of industry? Only by setting different prices for each factory can the "inefficiency" in the traditional sense of an "externality" be resolved.

Granted that all this information can be obtained, one important condition remains to be satisfied: The information cost must be less than the present value of the difference between the integral of the value of marginal product and the value of the marginal damage.

The government has often ignored this basic principle for investment which requires that the present value of the gain be greater than that of its cost. Besides the popular use of a lower rate of discount for future gain, it is also common practice to underestimate the costs and overestimate the gain of a government project.⁴⁹ Therefore, unless the overall costs of a national environmental protection and management program, including the administrative as well as the information acquisition costs, are confirmed by systematic studies to be less than the overall probable benefits, the program should not be adopted.

C. Private Property Rights

As mentioned before, water rights in Thailand are not explicitly specified in but can be derived from the law. They are basically usufructuary. A water right is a real property subject to transaction in the market where such transaction are legally permitted, in which case the agreed price would represent the marginal use value of the right being transferred. Only when water rights are legally transferable will the water be put to its "best" use. When water rights are nonexclusive and nontransferable as in Thailand, the cost of policing private investment in the public stream increases and the value of water right as a property is greatly reduced. Production with the least policing cost such as waste disposal is thus chosen.

The voluntary exchange of private property rights as a means to solve the externality problem in water resource is in fact feasible within the Thai judiciary system. The basic obstacles for market exchange are: (1) the unavailability of information about water rights, and (2) the nonexclusive and nontransferable nature of the rights, which give rise to (3) the indefinite cost in enforcing the rights. Obviously, some remedy is needed. However, the remedy is suggested in the form of resource allocation through political processes where there is strong indication that the costs of complete government control of public water resources would prove to be prohibitive.

Following the regulations since 1969, the natural flow concept implied in judicial decision has begun to give way to a new concept--the reasonable use determinant based on the value of the use to the society. By this criterion, the outcome of a court decision is less predictable, and recourse will be taken more frequently to legal action. Furthermore, water will be allocated among alternative users by judicial discretion. We believe that even when judges are well qualified to determine matters of justice and equity of personal rights, they are not necessarily equally adept in matters involving primarily the determination of economic benefits and costs. As water becomes relatively more scarce with future increases in population and in production, the uncertainty hinging on judicial determination of water rights will become a crucial problem in maintaining economic productivity.

Granted that the market system, by itself, cannot be expected to solve all problems in water use, yet in combination with institutions of private property it offers a more promising answer than is usually recognized to achieving a wealth maximizing allocation of the water resource. Under such a combination, the role of the government is limited to the creation and the enforcement of rules under which the market exchange can operate.

A private property system offers a less costly process for water resource allocation than the political process. What is needed is the vesting or the definition of these rights so that they are certain instead of being subject to unpredictable judicial interpretation. The definition may even be, in some respect, arbitrary as long as it creates the certainty. Alternative users and uses can then compete and only the most productive will receive the right provided, of course, that transferability is confirmed by law.

Under such well defined property rights, information cost can be minimized because the individual competing for the water right does not need all the data which must be acquired by the government if centralized planning is chosen. He needs only weigh his immediate benefits against costs. Rights will be thus exchanged until the marginal values to the buyers and the sellers are equal, and wealth maximization is implied.

Furthermore, once the water rights are fully vested, fewer cases will be brought to court because the result of any decision will be more predictable. An out-of-court settlement, when legally permissible, is essentially the market transaction of water rights and follows the same rules of the game that govern the transactions of other goods and services. The transaction thus tends to settle at a price which represents the marginal values between the trading parties. Once again, the wealth maximizing allocation of resource is implied.

In conclusion, we find that the absence of private contracting in the field of water resources in Thailand is the result of the high transaction cost and enforcement cost, both created by current legal constraints. Water pollution in the Mae Klong river is thus confirmed as being consistent with the wealth maximization postulate. Any indiscriminating attempt by the government to solve the problem by imposing more regulations, apart from those that would reduce the transaction and enforcement costs, is a violation of the Pareto condition. We do not suggest that water pollution is "good" or that nothing could be done about it. We do, however, emphasize that under existing legal constraints (the nonexclusive and nontransferable nature of water rights) then indeed nothing further should be done to impose or implement restriction if maximizing the "wealth of society" is truly what we have in mind. Unless the costs of transaction and enforcement are lowered, any additional governmental effort at solving the water pollution problem can eventually make the society worse off.

NOTES

1. See, for example, Ronald H. Coase, "The Problem of Social Cost," Journal of Law and Economics 3(October 1960) : 1-44; Steven N.S. Cheung, "The Structure of a Contract and the Theory of Nonexclusive Resources," Journal of Law and Economics 8(1970): 51
2. A.C. Pigou, The Economics of Welfare (London : Macmillan, 1920), p. 161.
3. For an excellent discussion of the problems of private development of water resources, see John V. Krutilla and Otto Eckstein, Multiple Purpose River Development (Baltimore: John Hopkins Press, 1958), Chapter 3.
4. William J. Baumol, "On Taxation and the Control of Externalities," American Economic Review 62(June 1972): 307-22; Gardner M. Brown Jr. and C.B. McGuire, "A Socially Optimum Pricing Policy for a Public Water Agency," Water Resource Research 3(March 1967): 33-44; John T. Wender, "Corrective Taxes and Pollution Abatement," Journal of Law and Economics 16(October 1973). 365-68.
5. Larry E. Ruff, "The Economic Common Sense of Pollution," Economics of the Environment, eds. Robert Dorfman and Nancy S. Dorfman (New York: W.W Norton, 1970), p. 13.
6. See Table 1: Suggested Stream Standards for Developing Countries, reproduced from M.B. Pescot, "Technical Aspects of Water Pollution Abatement in the ECAFE Region," mimeographed (Bangkok: Asian Institute of Technology, 1972), Table 4.
7. See, for example, Allen V. Kneese, Sidney E. Rulfe, and Joseph H. Horned, Managing the Environment : International Economic Cooperation for Pollution Control (New York: Praeger, 1971); Allen V. Kneese, "Analysis of Environmental Pollution," The Economics of Environment, eds. Peter Bohm and A.V. Kneese (Macmillan, 1971); A.V. Kneese and Blair T. Bower, "Causing Offsite Costs to be Reflected in Water Disposal Decision," The Economics of Environment, eds. Dorfman and Dorfman, pp. 135-154; Ralph Turvey, "On Divergence between Social and Private Costs," Economica (August 1963) : 309-13; John H. Dales, "Land, Water, and Ownership," Canadian Journal of Economics (November 1968): 791-804.
8. W.J. Baumal and W.E. Oates, The Theory of Environmental Policy. Englewood Cliffs, N.J. : Prentice Hall, 1975.

It should be noted at this point that evidence supporting our argument may seem inadequate especially the one on the difference in land values in the study area. Time as well as financial limitations are the main reasons. Effort is presently made to re-examine the situation with special emphasis in obtaining information which will help in establishing measures for the extent of pollution, the value of benefits and costs as well as their distribution of the pollution abatement presently taking place.

This is, hopefully, where some of the new approaches of economic analysis of natural resource and environment can be empirically put to test within the framework of sound economic theory. Ultimately, we are hoping that the forth coming results will, somehow, find their way to being incorporated in the development planning decision of the government. Up to the present time, economic analysis has been looked upon with skepticism and regarded more as mental exercises than as practical ideas which can be used as guidelines for development planning. Therefore, it is not surprising that there has been very little interaction between economic analysis on the one hand and development planning on the other whereas, in fact, institutional changes should be based upon serious studies, be it economic or interdisciplinary. The needs for and the types of studies, in turn, will be dictated by the initial institutional changes. Only then, maybe, a true "efficiency" can be achieved.

9. Pigou, Economics of Welfare, p. 168.
10. Frank H. Knight, "Some Fallacies in the Interpretation of Social Costs," Quarterly Journal of Economics (August 1924): 597.
11. See, for example, Prasopsook Boondej, "Mae Klong is Polluted," (Thai) 30 Bot Bandith (1973).

Note also that finally an "Improvement and Conservation of National Environmental Quality Act B.E. 2518 has been passed and went into effect in 1975. (See Appendix V.)

12. Jack Hirshleifer, James C. Dehaven and Jerome W. Milliman, Water Supply: Economics, Technology and Policy (Chicago: The University of Chicago Press, 1970), p. 222; J.W. Milliman, "Water Law and Private Decision Making : A Critique," Journal of Law and Economics 59(October 1959).
13. Richard J. Frankel, "Socio-economic Aspects of Water Pollution Control," mimeographed. (Bangkok: Asian Institute of Technology, 1972), p. 32.
14. Kasemsan Suwanarat, "Water Pollution in Mae Klong," (Thai). Mimeographed. (Bangkok: Department of Health, 1971), pp. 6-7.
15. Jack G. Beale, "Protection and Management of the Thailand Environment, Phase I, Policy, Legislative and Administrative Initiatives," prepared under assignment from the United Nations Environment Programme (Bangkok: National Committee of Environment, 1974), p. 16. (Hereafter cited as Protection of Thailand Environment Phase I.)
16. See, for example, Klong Control Act B.E. 2445; Klong Prapa Act B.E. 2456; Navigation on Thai Territorial Act B.E. 2456; Public Health Act B.E. 2484; National Irrigation Act B.E. 2485; Factory Acts B.E. 2482; 2503; and 2518.
17. State enterprises are defined as:
 - (1) Any business enterprise solely owned by the government or any government department or organization;
 - (2) Any business enterprise with 51% of its share held by the government or any government department or organization; and
 - (3) Any business solely owned or with 51% of its share held by enterprises in item (1) and (2).
18. Section 4 of the 1969 Factory Act states that "This Act shall not apply to factories owned by the State or government organizations and operated by the State or government organization."

19. See, for example, People Irrigation Act B.E.2484, Section 6, 9, 10; The Field Dykes and Ditches Act B.E. 2505, Section 15, 16; The Thai Civil Code Section 1339, 1340, and 1355.
20. See Public Health Act B.E. 2484 Section 19 items 2,4,5,6,7 and 10 for the definition of "nuisance."
21. Public Health Act. B.E. 2484, Section 19 item 7.
22. The Factory Act B.E. 2482, Section 32.
23. The Factory Act B.E. 2503, Second Issue, Chapter III, item 24.
24. Vijiit Nirapaijit, The Thai Civil Code Volume 1-6 (Thai) Section 1304, p. 252.
25. Watana Ratanawichit, The Thai Penal Code with its Amendment (Bangkok: Odean Store, 1967), Section 228, p.69.
26. Boondej, Mae Klong is Polluted, p. 492.
27. The Thai Civil Code, Section 1305.
28. Based on classification by Stephen James Schmutte, "Interrelation of Law and Economics: The Case of Stream Pollution," Ph. D. dissertation, Purdue University, 1971.
29. The court system in Thailand consists of
 - (1) the district courts which handle only cases with maximum imprisonment of one year or maximum fine of 6,000 baht, or both;
 - (2) the primary courts or provincial courts which compose the civil and the criminal courts;
 - (3) one appellate court; and
 - (4) one supreme court.
30. See Supreme Court cases: 175/2494, 600/2498, 1042/2498, 768/2499, 1719-1720/2499, 1095/2500, 1568/2505, 74/2507, 1121/2507, 949/2508, 317/2509, 428/2492, 749/2510.
31. The Thai Civil Code, Section 1337.
32. Exception has been made when the land is leased for agricultural production. A farmer was granted compensation for crops destroyed by the action of an upstream water user (Chan Chai Kliang v. Truek Chumani, Supreme Court 1042/2498).

33. See Appendix II for a list of minimum standards for industrial wastes.
34. See Appendix III.
35. Reproduction of cabled instruction from the United Nations Environment Programme as presented in Beale, Protection of Thailand Environment Phase I, p. 1.
36. Public address by Field Marshall Thanom Kittikajorn, the Prime Minister of Thailand, on the Day of World Environment, June 5, 1973, p. 1.
37. Suchada Suwannapirom, "Location and Distribution of Sugar Mills in Thailand, A Comparative Study of the Eastern and Western Regions," master's thesis, Faculty of Economics, Thammasat University, Bangkok, 1975.
38. See Appendix III.
39. See Appendix IV.
40. Ministerial Regulations Issued under the Factory Act B.E. 2512, Chapter 5, item 22.12.
41. The Factory Act B.E.2512, Section 50. The fine was raised in 1975 but with no benefit to a damaged party seeking compensation.
42. See Samut Sakorn provincial court records for red number cases 53/1970, 54/1970, 55/1970, 56/1970, 57/1970, 58/1970, 59/1970, 60/1970, 61/1970.
43. Ibid.
44. See Rajburi court record red number cases 53/1975, 52/1975, 422/1974, 419/1974, 55/1975, 54/1975.
45. Beale, Protection of Thailand Environment Phase I, p. 5.
46. Ibid. The same page as the preceding note.
47. Ibid. p. 7.
48. Ibid. p. 23.
49. Robert J. Muscat, Development Strategy in Thailand: A Study of Economic Growth (New York: Frederick A. Praeger, 1966.)

Muscat cites, on page 68, that "The most conspicuous example of simple wastage has been the expenditure of over 200 million baht (including funds appropriated in the government's 1963 budget) in an attempt to develop an oil field in northern Thailand and in the construction of a refinery at the field. Despite ample advice to the contrary, based on poor results from testing wells, the Ministry of Defense proceeded to build a 1,000 bb/day refinery ... the field has thirty producing wells averaging about 3 bb/day each and...consequently it requires ten days of flow to supply the refinery for one day's operation."

APPENDIX I

Government Enterprises and the Percentage
Share Held by Government

Agency and Enterprise	Nature of Business	Share Held by Government					
		1964		1968		1974	
		Under 50%	Over 50%	Under 50%	Over 50%	Under 50%	Over 50%
<u>Office of the Prime Minister</u>							
Lignite Energy Authority	Power generation and distribution		x		100	100	
Thai TV Company	TV Station		x		100	100	
Wire Diffusion Company	Radio Station		60		60	80	
Yanhee Electricity Authority	Power generation & dist.		x		100	100	
Prime Minister Office Press	Printing		100		100	100	
Sport Promotion Organization			--		100	100	
Tourist Organization of Thailand	Tourism		--		100	100	
Zoo Organization	Public zoos		--		100	100	
Northeast Electricity Authority	Power generation & dist.		--		100	100	
Special Way Development Autho.	Road & highway const.		--		--	100	
<u>Ministry of Defense</u>							
Fang Oil Refinery	Oil refining		x		100	100	
Bangjak Refinery	Oil refining		x		100	100	
Fuel Organization	Government and retail service stations		x		100	100	
Weaving Organization	Textile spinning, weaving		x		100	100	
Tanning Organization	Mfh. leather, shoes, etc.		x		100	100	
Glass Organization	Bottle mfg. asbestos dealer		x		100	100	

APPENDIX I
(Continued)

Agency and Enterprise	Nature of Business	Share Held by Government					
		1964		1968		1974	
		Under 50%	Over 50%	Under 50%	Over 50%	Under 50%	Over 50%
Battery Organization	Battery mfg.		x		100		100
Preserved Food Organization	Preserved food process		x		100		100
Bangkok Dock Company	Ship repair		x		100		100
War Veterans Organization	Holding company		x		100		100
Wood Industry Company	Logging, construction, charcoal processing		x		x		x
Engineering Company	Construction contracting		87		86.8		50
Sena Press Company	Printing		x		99.3		99.3
Paper Clip & Pin Factory	Mfs. Clips, pins		x		x		x
Thai Jute Mill Co.	Gunny bag mfg.		x		x	x	
Lopburi Company	Construction		--		94.8		x
<u>Ministry of Finance</u>							
Housing Development Bank	Banking		x		x		x
Provincial Bank	Banking		51		x		x
Thai Commercial Bank	Banking		x	19.0		19.0	
Agricultural Bank	Banking		71		100		98.26
NEDCOL	Banking		100		x		x
Bang-pa-in Paper Mill	Paper mfg.		100	sold		sold	
Cholburt Sugar Industry	Sugar refining		100		99.0		99.5
Northeast Gunny Bag Company	Gunny bag mfg.		100		99.8		99.99
Supanburi Sugar	Sugar refining		100		100.0		100.0
Marble Company	Marble quarry		100		51.8		99.70
United Thai Hotel & Tourist	Hotels		84		85.2		85.20
Thai Tobacco Monopoly	Cigarette mfg.		x		100.0		100.0
Playing Card Factory	Playing cards		x		100.0		100.0
Ayuthya Liquor Distillery *	Distilling		x		100.0		100.0
Siam Cement	Cement mfg.	0.12		0.12		0.12	
Thai Product Marketing	Agricultural marketing		51		x		x

* A Total of 40 distilleries in the countries are owned by the Department of Excise Tax in 1978; all located in the vicinity of some public streams.

APPENDIX I
(Continued)

Agency and Enterprise	Nature of Business	Share Held by Government					
		1964		1968		1974	
		Under 50%	Over 50%	Under 50%	Over 50%	Under 50%	Over 50%
Gunny Bag Factory	Gunny Bag Mfg.		--		100.0		100.0
Office of Lottery	Lottery		x		100.0		100.0
Saving Bank	Banking		x		100.0		100.0
Krung Thai Bank	Banking		x		87.9		98.28
National Econ. Promotion Co.			--		100.0		100.0
Thai Gunny Bag Co.	Gunny bag mfg.		--		82.32		x
Bangkok Bank Ltd.	Banking	x		22.53		30.0	
Bank of Asia	Banking	0.13		0.15		0.13	
Chemical Fertilizer Co.	Fertilizer mfg.		--		49.9		95.34
Boonrod Brewery Co.	Beer mfg.	0.05		0.05		5.30	
Saving Bank Press	Printing		--		100.0		100.0
Office of Rubber Subsidy Fund	Financial loans		--		--		100.0
Bangsaen Hotel	Hotel & restaurant		--		--		100.0
Kao Yai Hotel & Golf Court	Hotel, restaurant, & golf court		--		--		100.0
Bangpra Golf Court	Golf court		--		--		100.0
Bank of Thailand	Central banking		100.0		100.0		100.0
<u>Ministry of Agriculture</u>							
Refrigeration & Ice Organization	Cold storage		x		100.0		100.0
Forest Industry Organization	Logging, saw milling		x		100.0		100.0
Thai Plywood Company	Plywood mfg.		x		100.0		100.0
Fish Marketing Organization	Wholesale central market		x		100.0		100.0
Nabon Rubber Plantation	Plantation & technical services		x		n.a.		n.a.
Thai Rice Company	Milling		x		n.a.		n.a.
Irrigation Cement Company	Cement mfg.	19.0		x		x	
Rubber Plantation Org.	Plantation & technical services		x		100.0		100.0

APPENDIX I
(Continued)

Agency and Enterprise	Nature of Business	Share Held by Government					
		1964		1968		1974	
		Under 50%	Over 50%	Under 50%	Over 50%	Under 50%	Over 50%
Krung Thai Bank Co.	Banking		--		87.9		87.9
Dairy Product Promotion Org.	Dairy product promotion & sale		--		--		100.0
<u>Ministry of Communication</u>							
State Railways	Railroad operation		x		100.0		100.0
Port Authority	Bangkok port		x		100.0		100.0
Telephone Organization	Communication		x		100.0		100.0
Express Transport Org.	Trucking		x		100.0		100.0
Thai Airways Co.	Domestic airline		90.0		99.3		100.0
Thai Airways International Transport Company	International airline		70.0		70.0		70.0
Aviation Radio Co.	Bus transportation		x		99.64		99.67
Tugboat Company	Tugboating		--		88.46		91.42
Thai Maritime Navigation Co.	Coastal shipping	6		n.a.		n.a.	
ETO Motor Vehicle Co.			x		100.0		99.98
Thai Airway, Aircraft Maintenance Company	Airway and aircraft maintenance		--		99.98		n.a.
			--		--		70.0
<u>Ministry of Interior</u>							
Metropolitan Electricity Authority	Bangkok power dist.		x		100.0		100.0
Provincial Electricity Auth.	Provincial power dist.		x		100.0		100.0
Marketing Organization	Market construction, marketing operation		x		100.0		100.0
Poultry Raising Organization	Poultry production		x		100.0		100.0
State Pawn Shops	Pawnbroking		x		100.0		100.0
Police Pressq	Printing		x		100.0		100.0
Apornpan Panit	Shirt mfg., police dept. uniforms & retail		x		n.a.		n.a.

APPENDIX I
(Continued)

Agency and Enterprise	Nature of Business	Share Held by Government					
		1964		1968		1974	
		Under 50%	Over 50%	Under 50%	Over 50%	Under 50%	Over 50%
Pitakamagki Company	Retail firearms		x		n.a.		n.a.
Metropolitan Water Supply Auth.	Bangkok water supply		--		100.0		100.0
Provincial Water Supply Auth.	Provincial water supply		--		100.0		100.0
Welfare Housing Office	Welfare housing construction & leasing		x		100.0		100.0
Rattapoom Company	Construction contracting		--		100.0		100.0
National Housing Authority	Housing study & const.		--		--		100.0
<u>Ministry of Cooperatives</u>							
Bank for Cooperatives	Central Co-op bank			56.0	n.a.		n.a.
Thai Salt	Salt dealers	47.0		x		x	
Pure Gas Company	Fuel gas	29.0					
<u>Ministry of Health</u>							
Pharmaceutical Factory	Mfg., packing, sale of pharmaceutical products		x		100.0		100.0
<u>Ministry of Education</u>							
Musical Choreographic Org. Suksapan Panit	Cultural Bookstore & printing		x		100.0		100.0
			x		x		x
<u>Ministry of Development</u>							
Mining Organization	Mining		x		100.0		100.0
Thai Salt Company	Salt dealers		x		68.48		
Irrigation Cement Company	Cement production	19.0		26.67		37.50	
Thai Rice Company	Milling		x	0.17		0.17	

APPENDIX I
(Continued)

Agency and Enterprise	Nature of Business	Share Held by Government					
		1964		1968		1974	
		Under 50%	Over 50%	Under 50%	Over 50%	Under 50%	Over 50%
<u>Ministry of Economic Affairs</u>							
Bangkok Bank	Banking	30.0		Transferred to Min. Finance			
Warehouse Organization	Agricultural marketing		x		100.0		100.0
Rice Bureau	Rice marketing		x		100.0		100.0
Sugar Industry	Sugar Wholesaler		99.0	48.0		48.0	
Thai Navigation Co.	Shipping		70.0		69.8		100.0
Vorasiri Company	Retailing		57.0		x		x
Agricultural Product Co.	Agricultural marketing	40.0			51.0		51.0
Thai Jute Company	Gunny bag import (monopoly)		70.0		99.95		99.95
Bangkok Rice Reserve Project	Rice marketing		--		100.0		100.0
Krabi Provincial Co.	General merchandising		100.0		82.3	36.57	
Kanchanaburi Provincial Co.	" "		100.0		56.14	31.19	
Chachaengsao Provincial Co.	" "		100.0		551.91	34.60	
Chiangrai Provincial Co.	" "		100.0		72.50	39.88	
Trang Provincial Co.	" "		100.0		51.00	30.00	
Nakorn Pathom Provincial Co.	" "		100.0		51.00	38.25	
Nakornrajsima Provincial Co.	" "		100.0		54.43	32.02	
Narativas Provincial Co.	" "		100.0		85.06	--	
Prachin Provincial Co.	" "		100.0		81.50		100.0
Pattani Provincial Co.	" "		100.0		74.00		74.0
Pang Nga Provincial Co.	" "		100.0		51.00	31.04	
Petburi Provincial Co.	" "		100.0		50.95	39.80	
Puket Provincial Co.	" "		100.0		91.26	39.68	
Rajburi Provincial Co.	" "		100.0		63.15	36.09	
Lampoon Provincial Co.	" "		100.0		64.40		100.0
Samutsakorn Provincial Co.	" "		100.0		51.00	34.00	
Surajtani Provincial Co.	" "		100.0		70.22	35.11	
Ayuthia Provincial Co.	" "		100.0		67.20	33.60	
Udonrtani Provincial Co.	" "		100.0		64.69	30.80	

APPENDIX I
(Continued)

Agency and Enterprise	Nature of Business	Share Held by Government					
		1964		1968		1974	
		Under 50%	Over 50%	Under 50%	Over 50%	Under 50%	Over 50%
Oaw Kham Tin Company	Mining	--		7.92		28.3	28.3
<u>Ministry of Industry</u>							
Thai Sugar Organization	Sugar refining	49.0		n.a.		n.a.	
Thai Usahakam	Handicrafts, retail		x		n.a.		n.a.
Aokam Tin Company	Mineral survey	28.0		--		--	
Naraipan	Handicraft		x		x		x
Gunny Bag Factory	Gunny bag mfg.	39.0			100.0		100.0
Thai Paper Mill	Paper mill		x		100.0		100.0
Bangkok Sewing Weaving Fact.	Weaving		x		100.0		100.0
Bamboo Products Factory	Bamboo products		x		x		x
Glue Factory	Glue mfg.		x		x		x
Bangkok Handicraft Factory	Handicrafts, etc.		x		x		x
Alum Factory	Alum mfg.		x		100.0		100.0
Ceramic Factory	Ceramic mfg.		x		100.0		100.0
Bangkok Umbrella Factory	Umbrella mfg.		x		--		--
Chiengmai Umbrella Factory	Umbrella mfg.		x		x		x
Bangkok Beer Company	Brewery		50.0		x		x
Knitwear Factory	Knitwear mfg.	x		x		x	
Dyeing Factory	Dyeing		x		x		x
Thai Industrial Trading	Gov't factory supplies		x		100.0		100.0
Shoe Polish Factory	Shoe polish mfg.		x		x		x
Bang-pa-in Paper Mill	Paper			Min. Finance	100.0		100.0
Supanburi Sugar Factory	Sugar mfg. & sale		100.0		100.0		100.0
Lampang & Uttradit Sugar Factories	Sugar mfg. & sale		100.0		100.0		100.0
Mining Industry Center	Mineral sale		--		--		100.0

APPENDIX I
(Continued)

Agency and Enterprise	Nature of Business	Share Held by Vovernment					
		1964		1968		1974	
		Under 50%	Over 50%	Under 50%	Over 50%	Under 50%	Over 50%
Uttradit Provincial Co.	General merchandising		100.0		87.75	39.89	
Chiangmai Provincial Co.	" "		100.0		59.00		62.00
Nakornsitamaraj Provincial	" "		100.0		55.87	40.86	
Loi Provincial Co.	" "		100.0		91.97		91.97
Surin Provincial Co.	" "		100.0		90.24		97.84
Ubonrajatani Provincial Co.	" "		100.0		75.88	38.94	
Cholburi Provincial Co.	" "		100.0	38.00		40.00	
Nakornpanom Provincial Co.	" "		100.0	20.00		20.00	
Lampang Provincial Co.	" "		100.0	12.63		12.63	
Yala Provincial Co.	" "		100.0	44.73		44.73	
Sukotai Provincial Co.	" "		100.0	40.00		40.00	
Nongkai Provincial Co.	" "		100.0	38.50		40.00	
Songkla Provincial Co.	" "		100.0	---		40.00	
Agricultural Crop Company	Agricultural produce trading	---		0.09		40.00	

APPENDIX II

Minimum Standards for Industrial Wastes

BOD (5 days 20 C	max	20 mg/l
Suspended solids	max	30 mg/l
Dissolved solids	max	2,000 mg/l
pH value	between 5 and 9	
Permanganate value	max	60 mg/l
Sulphide (as H ₂ S)	max	1 mg/l
Cyanide (as HCN)	max	0.2 mg/l
Oils and grease	none	
Tar	none	
Formaldehyde	max	1 mg/l
Phenols and cresols	max	1 mg/l
Free chlorine	max	1 mg/l
Zinc		
Chromium		
Arsenic		
Silver	individually or in total, max	1 mg/l
Selenium		
Lead		
Nickel		
Insecticides	none	
Radioactive materials	none	
Temperature	max	104 F
No disagreeable tastes and odor		

Standard for sewage effluents discharging
into inland streams of high dilution ratio

Volume of dilution	Max. permitted suspended solid, mg/l
8-150	30
150-300	60
300-500	150

Source : Ministerial Regulation issued under the Factory Act of 1969, chapter 5, Section 36, item 6: A licensee has the duty of arranging for refuse disposal, sewage system, ventilation.

APPENDIX III
Document 1

Regulations by the Department of Industrial Factories for the Sugar Factories in the Mae Klong Area to Correct and Improve their Waste Treatment System, Production Season 1974/75.

1. Additional construction of cooling towers and additional installation of water pumps are required to meet the correct capacity in treating the condenser water.

Reason. The cooling towers were able to treat only 50-60 percent of the used water in the preceding year due to inadequate capacity. Part of the used water still has to be discharged directly into the river

2. The factories must construct separate cooling ponds for the condenser cooling water and cooling water from other sources. The latter, once cooled, can enter the recirculation system or be discharged into the river since it has no degradable residuals.

Reason. During the previous production season, different types of used water were not separated. They are all conveyed to the cooling pond of the cooling tower.

3. The cooling tower must have the longest possible period of self-recirculation. The cooling ponds must have a "surplus" capacity ready for overflowing waste water from the sugar concentration process. Mechanical or other appropriate treatments may be applied. If the factories choose to release the used water into the river, the used water must meet the minimum standards requirements set by the Ministry of Industry.

After a reasonably long period of recirculation, degradable residuals in the condenser water pond will accumulate to such a degree that a change for clean water is necessary. However, this change of water must be done gradually. About 20-50 percent of the highly contaminated water will be conveyed to the waste water pond every 3-4 days. It will then be transferred to the government's central treatment plant. Not all factories will be allowed to change their water at the same time. A schedule will be worked out.

Due to the additional construction of the cooling tower and cooling ponds at every sugar factory, the central treatment plant is not expected to be able to receive all the waste water collected at the factories. Thus, mechanical treatment is now required. Each day, only about 5-10 percent of the total holding capacity of the wash water pond will be received at the central treatment plant while the same volume of clean water from the river is added to the recirculation system of the factories.

Reason. With the cane crushing capacity of 65,000 tons/day, for thirteen sugar factories, there will be 32,500 cubic meters/day of waste water released. Proper design of the cooling tower should evaporate and reduce the waste water by 25,920 cms/day, making insignificant the volume of waste water finally reaching the storage pond.

However, to compensate for any potential reduction in the working capacity of the cooling tower which might result from incorrect design a "surplus" capacity of the storage pond and a "standby" mechanical treatment device are also required.

4. Proper cleaning of the cooling tower is required.
5. The factories must neutralize their wash water by milk-of-lime treatment before transfer to the central treatment plant.
6. An order has been issued to the factories for an installation of a dust collector with a capacity of at least 80 percent by weight. Installation was expected to be completed by the first of November, 1974.
7. An order has been issued to the factories to procure additional electrical generators in case the provincial power palnt cannot provide the amount of electricity needed.
8. Factories have been provided with a design for, and a recommendation for the installation of, a sugar steam collector.
9. The regular working staff of the factories must now include full time engineers specializing in waste treatment as well as engineers specializing in other stages of the manufacturing process. Waste treatment engineers are required to submit a report with full details regarding the design and proposed corrections in the waste pipeline system of the existing treatment plant to the Department of Industrial Factory as soon as possible.
10. In principle, the minimum standards set forth by the 1969 Factory Act with regard to the discharge of waste water into any public waterway will be strictly enforced.

Office of Environmental Pollution Control,
Department of Industrial Factories
September 11, 1974.

APPENDIX IV

Document 2

The Five-Year Plan for Water Quality Control and Reclamation
in the Chao Phraya, Mae Klong, and Tachin Rivers

1. Surveys and studies will be carried out in detail regarding the types of industrial factories releasing waste water, directly and indirectly, into the rivers, and the types of effluents. Once the information on waste water is obtained, proper technical treatment of poisonous substances such as mercury, cadmium, and arsenic. Especially, mercurial residual which is nondegradable after being released into the rivers will accumulate in aquatic organisms. New standards and regulations will be designed for effective control. Factories releasing mercurial residuals may be required to change their production process or to employ a closed system, releasing no waste whatever into the public stream.
2. The surveys will examine existing information on the quantity of waste water, the appropriateness and adequacy of existing treatment plants, the locations of factories, and the area of land for additional treatment plants. Any factory that cannot construct its own waste treatment plant due to financial shortage or for other reasons will be required to relocate in an industrial settlement where a central treatment facility is maintained by the government.
3. In deciding where the industrial zone should be, the Department of Industrial Factories will cooperate with the Office of Town and County Planning in drafting an Act on Industrial Use of Land.
4. The minimum standards of waste water will be revised to suit each surrounding. Regional information will be used in setting up such waste standards and regulations as are consistent with the local surroundings. To achieve this goal will require correct information and a large staff of officials.
5. In issuing an industrial factory permit, the Office of Environmental Quality Control under the Department of Industrial Factories should see to it that the applicant complies with ministerial regulations regarding the standards of waste.
6. Before any permit is issued for a new factory or for the expansion of an existing factory, a study shall be initiated to determine the maximum assimilative capacity of the river in that area to receive treated waste water, and waste discharge shall be regulated in accordance with the collected data and information. Once the maximum assimilative capacity of the river has been reached, no additional license shall be issued unless the factory is to use a closed system for waste treatment.

7. Proper training and education regarding the causes and the solution of environmental pollution are necessary for an effective environmental protection policy. Especially, officials at the Department of Industrial Factories must be well trained and educated from specialized institutes, locally or abroad. For better cooperation the factories, the factory authority and its employees should also be trained and educated to understand the causes and problems of using public property (land or water) as an outlet for waste disposal.

8. Specialists will be acquired from abroad to help in setting up the administrative system and the standards of waste allowed to be discharged.

9. For an effective control of industrial waste discharge, the Department of Industrial Factories needs to increase its working manpower and its waste measuring and testing equipment to achieve a continuous monitoring system.

10. A budget request has been submitted by the Department.

Office of Environmental Quality Control
Department of Industrial Factories
January 6, 1975.

APPENDIX V

Translation

IMPROVEMENT AND CONSERVATION
OF NATIONAL ENVIRONMENTAL QUALITY ACT B.E.2518

BHUMIBOL ADULYADEJ, REX.

Given on 12th February B.E. 2518

Being the 30th year of the Present Reign.

His majesty King Bhumibol Adulyadej is graciously pleased to proclaim that :

Whereas it is expedient to have a law on improvement and conservation of national environmental quality:

Be it, therefore, enacted by the King, by and with the advice and consent of the National Legislative Assembly acting as the National Assembly as follows:

Section 1. This Act is called the "Improvement and Conservation of National Environmental Quality Act B.E. 2518."

Section 2. This Act shall come into force as from the day following the date of its publication in the Government Gazette.

Section 3. In this Act, "environmental quality" means the balance of nature, i.e., fauna, flora, natural resources and man-made things, which is for the benefit of livelihood of the people and the sustenance of human being and nature.

Section 4. There shall be a board called the "National Environment Board" consisting of the Deputy Prime Minister as Chairman, the Under-Secretary of State for Defence, the Under-Secretary of State for Interior, the Under-Secretary of State for Agriculture and Co-operatives, the Under-Secretary of State for Industry, the Under-Secretary of State for Public Health, the Secretary-General of the National Economic and Social Development Board, not more than five persons qualified in ecology and not more than five representatives of independent institutions or organizations or other persons to be appointed by the Council of Ministers as members and the Secretary-General of the National Environment Board as member and secretary.

The representatives of independent institutions or organizations or other persons appointed as members shall not be Government officials, officials

¹Government Gazette, Vol. 92, Part 40, Special Issue, dated 19th February B.E. 2518 (1975).

of a State enterprise or officials of a local government, who hold permanent position or receive salaries.

Section 5. The National Environment Board has the duties as follows :

- (1) to submit policy and opinion concerning the improvement and conservation of environmental quality to the Council of Ministers;
- (2) to consider and formulate the implementation of policy in respect of the drawing up of projects or schemes concerning the environmental quality;
- (3) to consider and give opinion on projects of government agencies, State enterprises and private sector, which may have adverse effect on the environmental quality to the Council of Ministers or Government agencies concerned, as the case may be;
- (4) to submit schemes for development, improvement and conservation of the environmental quality to the Council of Ministers;
- (5) to recommend the standard of the environmental quality on matters including measures to be adopted for inspection thereof and to recommend sanctions against violations to the Council of Ministers;
- (6) to submit a report on the situation of the country relating to the environmental quality to the Council of Ministers at least once a year;
- (7) to co-ordinate works between government agencies, State enterprises and private sector on matter concerning the environmental quality;
- (8) to consider any other matter concerning the environmental quality as the Council of Ministers or the Prime Minister may request;
- (9) to perform other functions as may be designated by law to be those of the National Environment Board.

In the performance of above mentioned duties, the National Environment Board may entrust the Office of the National Environmental Board with the operation or submission of recommendations to the Board for further proceedings.

Section 6. The National Environment Board shall have the power to require government agencies, state enterprises and other persons to submit documents or data concerning the projects and scheme for its consideration and may, in this connection, summon a person concerned to give explanation thereof. If it is of the opinion that any project or scheme may cause gross damage to the environmental quality, it shall recommend remedial measures to the Council of Ministers.

Section 7. A member appointed by the Council of Ministers shall be in office for a term of three years and may be re-appointed for a period of not more than one consecutive term.

Section 8. In addition to the expiration of term of office under Section 7, a member vacates office upon

- (1) death;
- (2) resignation;
- (3) being a bankrupt;
- (4) being an incompetent or quasi-incompetent person;
- (5) being imprisoned by a final judgment of imprisonment except being a punishment for an offence committed through negligence or petty offence.

When a member vacates office before the expiration of term of office, the Council of Ministers may appoint another person to fill the vacancy.

The member appointed under paragraph two serve only for the remainder of his predecessor's term of office.

Section 9. At a meeting of National Environment Board, if the Chairman does not attend or is not present at the meeting, the meeting shall elect one member to preside over it.

Section 10. A meeting of the National Environment Board requires the presence of not less than one-half of the total number of its members so as to constitute a quorum.

Section 11. The decision of a meeting shall be made by a majority of votes. In casting votes, each member shall have one vote; in case of an equality of votes, the chairman of the meeting shall have an additional vote as a casting-vote.

Section 12. There shall be an Office of the National Environment Board having the duties as follows:

- (1) to perform the works as may be entrusted by the National Environment Board;
- (2) to study and analyse the environmental conditions and quality to be used for planning and determining the standard of the national environmental quality as well as to formulate guidelines for the enhancement of the national environmental quality;

(3) to recommend the National Environment Board for adopting measures with a view to improving and enhancing the national environmental quality;

(4) to watch over government agencies, state enterprises and private sector in order to ensure compliance with the standard of the national environmental quality;

(5) to receive for consideration and remedy a petition from any person who has been aggrieved or damaged by an act which has adverse effect on the environmental quality;

(6) to perform the duty as the center of co-ordination and public relation in respect of the environmental quality within the country and with foreign countries;

(7) to encourage or carry out the study, research and propagation of problems of the environmental quality in co-operation with educational establishments and other agencies;

(8) to promote and encourage the study of the environmental quality at every level of education;

(9) to perform other functions as may be designated by law to be those of the Office of the National Environment Board.

Section 13. The Secretary-General of the National Environment Board shall be in charge of the general supervision and control of the official service of the Office of the National Environment Board.

Section 14. The National Environment Board or the Office of the National Environment Board may invite any person to give fact, explanation, or technical opinion or advice as it deems fit and may ask for co-operation from any person with a view to ascertaining any fact or surveying any activity which may have adverse effect on the environmental quality.

Section 15. The National Environment Board may appoint an ad hoc committee to consider or carry out any matter as may be entrusted by the National Environment Board.

Section 9, Section 10 and Section 11 shall apply to the meeting of the ad hoc committee mutatis mutandis.

Section 16. The ad hoc committee may appoint a sub-committee to consider or carry out any matter as may be entrusted by the ad hoc committee.

Section, Section 10 and Section 11 shall apply to the meeting of the sub committee mutatis mutandis.

Section 17. The Prime Minister shall have charge and control of the execution of this Act.

Countersigned by
Sanya Dharmasasakdi
Prime Minister.