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Market-based Instrument for Waste Water Management in Thailand
เครื่องมือทางการตลาดเพื่อการจัดการน้ำเสียในประเทศไทย

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Abstract This study tested the efficiency of some market-based instruments (MBI) in coping with waste water pollution in Thailand. It comprises three policies: 1) tradable water permit at 4.98 Baht/permit, 2) emission charge for households at 0.83 Baht/m^3, and 3) “1” and “2” applied together. The analysis used the computable general equilibrium (CGE) model to investigate the economy-wide impacts of the policies. The simulation results indicated that MBI is an efficient management tool for waste water management. The first policy would maintain the volume of waste water from industry sector at the initial level. The second would decrease household waste water by 28.29 million kg – equivalent BOD/year. The same results were obtained when the two policies used together, but household waste water decreased further to 29.84 million kg – equivalent BOD/year. The policies would enable the government to raise revenue, which can be used for waste water management.

Keywords: waste water management, market-based instrument (MBI), computable general equilibrium (CGE), social accounting matrices (SAM)

บทคัดย่อ การศึกษานี้ทดสอบความมีประสิทธิภาพของเครื่องมือทางด้านตลาดเพื่อการจัดการปัญหามลพิษทางน้ำในประเทศไทย โดยพิจารณา 3 ชุดเครื่องมือ ได้แก่ 1) การใช้ใบอนุญาตปล่อยน้ำเสียที่สามารถจำหน่ายเปลี่ยนมือได้ ณ ระดับราคา 4.98 บาท/ใบอนุญาต 2) การจัดเก็บค่าบริการบำบัดน้ำเสียในอัตรา 0.83 บาท/ลบ.ม. และ 3) การใช้นโยบายที่ 1 และ 2 ไปพร้อมกัน การวิเคราะห์ใช้แบบจำลองดุลยภาพทั่วไป (CGE) ในการหาผลกระทบทางเศรษฐกิจ ผลการวิเคราะห์จากแบบจำลองระบบเศรษฐกิจ พบว่า เครื่องมือทางด้านตลาดสามารถใช้จัดการน้ำเสียได้อย่างมีประสิทธิภาพ โดยที่การใช้นโยบายแรกทำให้ปริมาณน้ำเสีย

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ของภาคอุตสาหกรรมไม่เพิ่มขึ้นจากปริมาณเริ่มต้น นโยบายที่สองทำให้ปริมาณน้ำเสียของชุมชนลดลง 28.29 ล้านกิโลกรัมบีโอดี/ปี และเกิดผลกระทบในทำนองเดียวกันเมื่อใช้นโยบายทั้งสองร่วมกัน แต่ปริมาณน้ำเสียของชุมชนลดลงมากขึ้นเป็น 29.84 ล้านกิโลกรัมบีโอดี/ปี การใช้นโยบายเหล่านี้ก่อให้เกิดรายได้แก่รัฐซึ่งสามารถนำไปใช้จัดการปัญหาน้ำเสียได้

คำสำคัญ: การจัดการน้ำเสีย เครื่องมือทางการตลาด แบบจำลองดุลยภาพทั่วไป บัญชีเมตริกทางสังคม

Introduction

The volume of good quality fresh water supply in Thailand was only about 20% of the total water supply (Pollution Control Department, 2006). The Government had addressed the problem by engineering management through waste water treatment system and by regulation on ambient waste water standards before discharge. Neither measure had not been effective because there were not enough funding for coping with the waste water problem (to be discussed in the next section). This raised the question of what policy options would be suitable for waste water management in Thailand.

Since regulation or engineering measures were inadequate, it was thought that a market-based instrument (MBI) might be more effective as it used price or some other economic variables to provide incentives to users to practice waste water abatement, which would also generate economy-wide impacts. However, no research has been carried out on this area.

The most relevant study is that of Strutt and Anderson (1999), which examined the environmental effects of trade agreements with global computable general equilibrium (CGE) models. They found that most water pollutants declined with the Uruguay round of trade implementation. The declines were less than 1% for biological oxygen demand (BOD), chemical oxygen demand (COD), and dissolved solids. They also reported that the reduction of solid waste was between 1-2%.

In this connection, research to determine the effectiveness of some management schemes in waste water control in Thailand would be of interest to policy makers. This study was thus aimed at testing the efficiency of MBI in coping with waste water pollution problem. The instruments chosen for this study were waste water permit and emission charge. The analysis comprised three policies: 1) tradable water permit, 2) emission charge for households, and 3) “1” and “2” applied together. CGE was used to investigate the economy-wide impacts of these policies.

The next section is a brief overview on waste water management followed by the conceptual framework, methods and data. The simulation analysis is then explained. The results are presented and discussed. The last section consists of the conclusions and recommendation.

Overview

Water quality in Thailand has been deteriorating over the past 10 years; during 2002–2005 the proportion of good quality water supply to the total water supply decreased from 40% to 20% (Figure 1). Waste water crises had occurred in some basins such as Thachin basin. The low water quality was due to microbiological contamination, high BOD, and toxic discharges from various sources. BOD per year from domestic users and agricultural and industrial activities were 241.38, 137.41, and 29.29 million kg, respectively. Much of the discharge was not treated at the source. The Government addressed the problem by, firstly, engineering management via community waste water treatment system and, secondly, by imposing ambient standards on waste water before discharging. The community waste water treatment systems built in many provinces could treat only 45.83% of total discharge. Communities blamed limited funding that restricted the use of energy and chemicals for treatment. This led to ineffective abatement. In addition, enforcement of the waste water control law was largely hampered by the shortage of personnel to monitor waste water discharge. Although it has been in effect for several years, there are factories discharging lower ambient standards waste water into public receiving waters.

It is clear that the water quality management measures did not seek to limit waste water at the source (i.e. at the polluters level), but emphasized abatement at the end; In effect, the polluters have no incentive to decrease or maintain their waste water. Given the lack of community resources to treat waste water effectively and the lack of government personnel to enforce the regulation, it was likely that reliance on these two measures would increase waste water discharges. Thus, waste water crises were foreseen to take place in many basins. This made it necessary to seek an alternative policy.

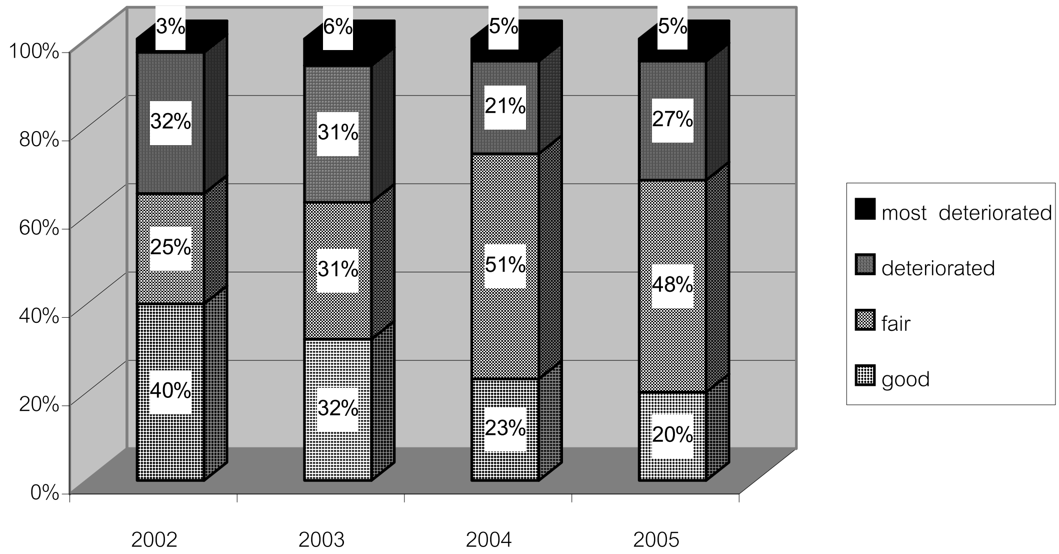

Figure 1 Proportion of water quality in Thailand during 2003-2005

Note: Data from Pollution Control Department (2006)

Conceptual Framework

Two main approaches had been proposed for dealing with externalities (Figure 2). The first method, known as the property right, was proposed by Nobel laureate Ronald Coase and involved allowing the free market system to solve the problem through bargaining or negotiation between the affected parties (Barbier, Pearce, and Markandya, 1990). The Coase theorem is based on some key assumptions that include zero transaction cost, well-defined property right, perfect competition, no income (or wealth) effect, and no free-rider effect. Given these assumptions, the Coasian solution may not work in practice. The second approach is by means of government intervention. Government pollution control policies could take two main forms, namely, MBI and command-and-control (CAC) approach. Other types of intervention could be voluntary incentives, legislation and zoning. In Thailand, CAC was employed through the waste water control law but MBIs have not been used. MBI includes charges, subsidies and marketable permits.

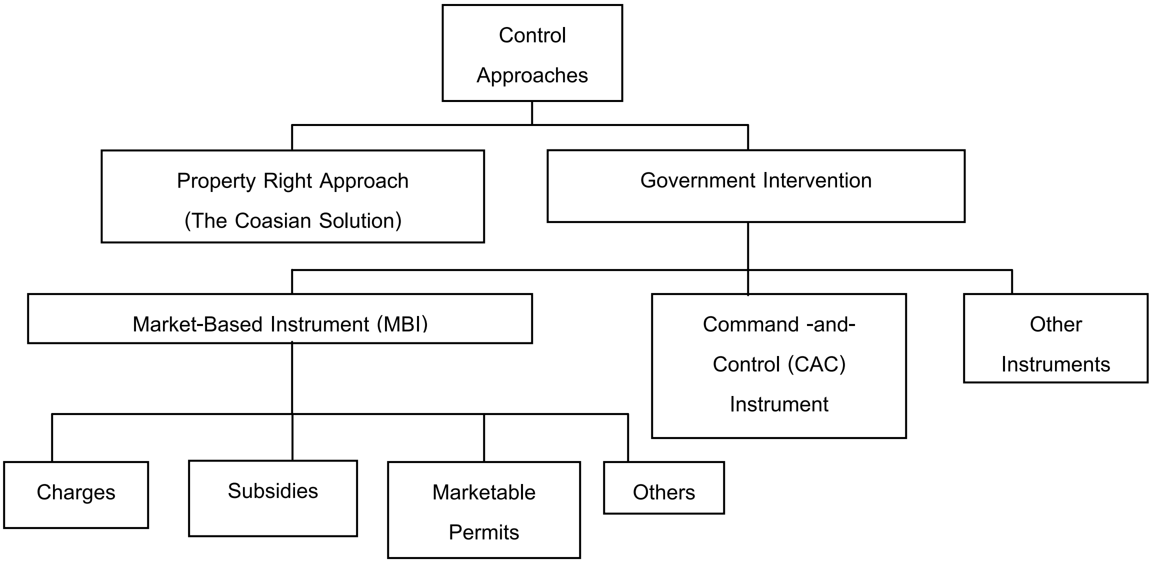

Figure 2 Policies for dealing with externalities

Source: Modified from Crocker (1995)

A charge or tax is, in effect, a negative price that is levied in proportion to the amount of pollution. There are at least four types of charges: emission charges, user charges, product charges and administrative charges (Crocker, 1995). An alternative to tax scheme is for the government to subsidize the polluter per unit of reduction in the level of pollution. The subsidy could also be offered for the purchase of pollution abatement equipment or technology. In theory, both taxes and subsidies should result in the same optimum level of pollution abatement.

Marketable (or tradable) pollution permit is a relatively new instrument. The system operates through pollution credits or pollution allowances. Under a pollution credit, a firm acquires a credit for abating below the standard. The credit could then be traded. Under a pollution allowance, the firm is given a permit to emit a certain amount of pollution. Firms are allowed to sell and buy pollution allowances. Other types of MBI include deposit-refund scheme and eco-labelling or performance rating.

Methods and Data

Computable general equilibrium or CGE model was used to analyze economy-wide impacts and measure welfare changes as a result of the implementation of policies. This model has three characteristics: First, it generates a set of prices consistent with equilibrium in an economy; these prices are based on production and consumption decisions, which in turn determine employment and incomes in various sectors of the economy. Second, it specifies interactions and linkages between markets. Third, the model is based on a specification of the economic structure which is critical for tracing the impact of an external shock or policy change. The model is described below (LÖfgren, Harris, and Robinson, 2001).

In this study, the CGE model comprises various activities/commodities assuming that each activity produces one commodity (in other words, a fixed yield coefficient was assumed). Each activity was assumed to maximize profit subject to a production technology. The technology was specified by a Leontief function of the quantities of value-added and aggregate intermediate inputs from all sectors. The value-added is a constant elasticity of substitution (CES) function of primary factors (i.e. labor, capital and tradable water permits). Meanwhile each of the aggregated intermediate inputs is a Leontief function of disaggregated intermediate inputs divided into agricultural, industrial and service sectors. As part of its profit-maximizing decision, each activity uses a set of primary factors up to the equilibrium where the marginal revenue product of each factor is equal to the factor price. It is assumed that all factors could be substituted and thus mobilized across activities. In addition, the model is subject to a closure rule where each factor can be used no more than its availability and it is assumed that each factor is used up.

Aggregated domestic output is allocated between exports and domestic sales. This assumes that suppliers maximize their revenue for any given aggregate output level, subject to imperfect transformability between exports and domestic sales (i.e. a constant-elasticity-of-transformation function). Domestic demand is a sum of household consumption, government consumption, investment and intermediate inputs. These are served by domestic output and imports. The above consumption pattern assumes a cost minimization subject to imperfect substitutability captured by a CES aggregation function.

In the model, institutions were represented by households, enterprises, the government, and the rest of the world. The households received income from selling the primary factors and transferring from the rest of the world at a fixed-foreign currency of 2004. The income was then transferred to other institutions in terms of buying goods and services, savings, paying taxes, and making transfers to other institutions. Direct taxes and transfers to other domestic institutions were defined as fixed shares of household income. The net income of households (after taxes, savings, and transfers to other institutions) was then spent on consumption. Household consumption covered marketed commodities. Household consumption was allocated across different commodities according to linear expenditure system (LES) demand functions.

The return to capital is not only paid to household but also to enterprises. Enterprises might also receive transfers from the rest of the world. Enterprise incomes were allocated to direct taxes, savings, and transfers to other institutions; they do not consume. Apart from this, the payments to and from enterprises were modeled in the same way as the payments to and from households.

The government collected taxes and received transfers from other institutions. All taxes were at fixed ad valorem rates. The government used this income to purchase commodities for its consumption and spend on social welfare services for households and on subsidies. The quantity of consumption by government was fixed in the model whereas the transferred income from government to households and enterprises varied according to the consumer price index (CPI).

The rest of the world was the only remaining institution. As noted, transfer payments from the rest of the world and domestic institutions and factors were all fixed in foreign currency. Foreign savings (or the current account deficit) was the difference between foreign currency spending and receipts (Bernard, Patry, and Savard, 1998).

In sum, the closure rules for macro system constraints in this model are of three parts: 1) flexible government savings and fixed direct tax rates, 2) flexible foreign savings and fixed real exchange rate, and 3) flexible capital formation and fixed MPS for all non-government institutions.

The activities of this model were disaggregated into 23 production activities (Table 1), which produce 23 commodities and employ three primary inputs as labor, capitals and tradable water permits. On the demand side, there were two household groups (agricultural and non-agricultural), one enterprise, and government. The activities that were considered, and which must buy the permits, were swine, fishery, agricultural industries, textile and printing, fertilizer and pesticides, construction and structural clay products, and engines and other industrial machinery.

Table 1 Activities and commodity codes used in CGE model

Codes	Activities/Commodities			Description
AC1	Activity 1	/	Commodity 1	Paddy
AC2	Activity 2	/	Commodity 2	Field crop
AC3	Activity 3	/	Commodity 3	Fruits
AC4	Activity 4	/	Commodity 4	Swine
AC5	Activity 5	/	Commodity 5	Other livestock
AC6	Activity 6	/	Commodity 6	Agricultural services
AC7	Activity 7	/	Commodity 7	Logging and other forestry products
AC8	Activity 8	/	Commodity 8	Fishery
AC9	Activity 9	/	Commodity 9	Mining and quarrying
AC10	Activity 10	/	Commodity 10	Energy
AC11	Activity 11	/	Commodity 11	Agricultural industries
AC12	Activity 12	/	Commodity 12	Textile and printing
AC13	Activity 13	/	Commodity 13	Other industries
AC14	Activity 14	/	Commodity 14	Fertilizer and pesticides
AC15	Activity 15	/	Commodity 15	Construction and structural clay products
AC16	Activity 16	/	Commodity 16	Engines and others industrial machinery
AC17	Activity 17	/	Commodity 17	Other services
AC18	Activity 18	/	Commodity 18	Restaurant and drinking place
AC19	Activity 19	/	Commodity 19	Transport
AC20	Activity 20	/	Commodity 20	Other activities
AC21	Activity 21	/	Commodity 21	Irrigation
AC22	Activity 22	/	Commodity 22	Transmission water system
AC23	Activity 23	/	Commodity 23	Pipe water supply

Source: Modified from INPUT-OUTPUT 2000 developed by NESDB

There were two data sets used in CGE model for calibration. These are social accounting matrices (SAM) and sets of elasticity. The latter was composed of three groups: 1) elasticity of substitution for activities function, 2) elasticity of substitution for commodity market, and 3) income elasticity for household consumption.

SAM is a useful framework for preparing consistent, multi-sectoral, economic data that integrates national income, input-output, flow-of-funds, and foreign trade statistics into a comprehensive and consistent dataset. Once a SAM for a particular year is constructed, it provides a static image, or a snapshot, of a country's economic structure. SAM is useful in deriving the parameters of an implicit underlying general equilibrium model (Jennifer, 2002).

A conventional SAM does not include the quantity of waste water. In this study SAM was modified by accounting the external costs of waste water discharged from all activities. The main features of a SAM are, firstly, the accounts are represented as a square matrix where the incomings and outgoings for each account are shown as a corresponding row and column of the matrix. The underlying principle of double-entry accounting requires that total revenue (sum of all revenue items in a corresponding row) has to equal total expenditure (sum of all cost items in a corresponding column). Secondly, all the economic activities of the system (consumption, production, accumulation and distributional are comprehensively linked. Thirdly, SAM is flexible. Although it is usually set up in a standard and basic framework, it allows the analysis to be flexible regarding the degree of disaggregation of the activities and the emphasis placed on different institutions of the economic system.

A marketable permit operates in three stages: 1) the government determines the socially acceptable level of aggregate emissions, 2) a fixed number of permits are then issued, and 3) the government establishes a market for permits, which is then allowed to determine the permit price. In benchmark equilibrium, the activities produce goods by employing tradable waste water permits as one of the primary inputs. (Dellink *et al.*, 2004; Miyata and Pang, 2000; Hung and Daigee, 2005).

Simulation Analysis

SAM and sets of elasticity were used to calibrate unknown parameters and to obtain structural equations at benchmark equilibrium. The validity of a CGE model can be examined by using the sensitivity test of Armington elasticity[1]. Then the variation of the equivalent variation (EV)[2] can be observed. A variation of less than 10% is acceptable. Based on the test, it was found that the Armington elasticity changed within an interval of [-70%, 70%], which corresponds to the change of EV within an interval of [-0.46%, 3.43%]. The test thus showed that this model is valid and could be used for simulation analysis.

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[1] This function is also referred to as an Armington function, named after Paul Armington who introduced imperfect substitutability between imports and domestic commodities in economic models.

[2] EV measures the amount that the consumer would pay to maintain his/her welfare at the initial level as a result of price increases.

This study investigated three scenarios: 1) use tradable water permit at 4.98 Baht/permit, 2) use emission charge from households at 0.83 Baht/m^3,and 3) use a combination of tradable water permit and emission charge.

The analysis was carried out against two time frames, i.e. before and after policy implementation in order to capture the effects. In the short-run, the primary factors could not reallocate across the activities within the economic system. This study, however, assumed the medium-run time frame which allows the reallocation of the primary factors (Jennifer, 2002).

CGE model captured the policy effect in terms of percentage changes of all endogenous variables, i.e. domestic production, domestic consumption, export, import, household consumptionn, household income after tax, government income, investment, quantity demands of primary factors, prices of primary factors, CPI, real GDP and EV.

Results

The policy effects are presented in Table 2, 3 and 4. The figures are in the percentage changes of the endogenous variables from a benchmark equilibrium (the stage before the implementation of the policies) to a counterfactual equilibrium (after the implementation of the policies).

The simulation analysis treated the non-internalized external costs as government subsidies at the benchmark equilibrium. Subsequently, the costs were internalized by the mechanisms of distribution and trading of permits among the polluters. This implies that a market for pollution permits was created and therefore the subsidy was automatically removed from the model.

This study considered that the polluters have two choices whether buying or selling permits. Within a limited number of permits, the reallocation of permits occurred among the polluters. Those who want to produce more would need to buy additional permits from those who are producing less.

Table 2 showed the results of the internalization of the external costs by using the tradable permit scheme. The swine and agricultural industries would decrease their production by 0.11% and 0.005%, respectively. Conversely, fishery, textile and printing, fertilizer and pesticides, construction and structural clay products and engines and other industrial machinery would expand their production by purchasing extra permits from swine and agricultural industries. The value added represents the returns to primary factors. It turned out that only a few activities such as agricultural industries and livestock (excluding swine) had decreasing percentage changes in value added while the rest of the activities had increasing percentage changes. However, the changes were slight.

At the macro level, it showed that the CPI, which represents the cost of living of households, insignificantly declined by 0.007%. Consequently, the welfare of agricultural and non-agricultural households measured in terms of EV increased by 15.55 and 63.56 million Baht, respectively. Real GDP declined by 0.004%. Government income increased by 0.07%.

The results implied that the environment target has a minor conflict with the economic target. The waste water permit scheme could retain the quality of the water bodies by maintaining the volume of waste water at the initial level while slightly decreasing the economic growth. But it would increase the welfare of households and raise government income.

In this study it was assumed that the domestic waste water was only from the non-agricultural households. When the households had to pay emission charge, the consumption expenditure decreased. Table 3 showed that non-agricultural households decreased consumption by 0.02% resulting in waste water reduction by 28.29 million kg – equivalent BOD. However, the changes in value added are insignificant, meaning there was a slight effect on the income of households. The real GDP grew slightly by 0.06%. The welfare of non-agricultural households decreased by 285.34 million baht while Government income increased by 0.09%.

When a combination of the two policies was used, swine, fishery, agricultural industries, and textile and printing reduced their production by 0.11%, 0.004%, 0.012% and 0.001%, respectively (Table 4). Non-agricultural households reduced consumption by 0.017% and waste water decreased by 29.84 million kg – equivalent BOD. The cost of living of the non-agricultural households declined by 0.009%. Their welfare decreased by 295.19 million Baht. Real GDP grew slightly by 0.009%.

Compared to tradable permit policy, emission charge has a greater advantage in the sense that it can reduce the quantity of waste water while the tradable permit policy would only maintain the quantity of waste water. However, it would significantly decrease the welfare of non-agricultural households. The tradable permit would substantially improve both the welfare of agricultural and non-agricultural households but insignificantly change the producer surplus.

Table 2 Effects of the implementation of tradable waste water permit policy

(Unit: % change)

Activities/Commodities	Price		Quantity									VAT
	Consump.	Production	X	Xd	E	M	Ahcon	NAhcon	L	K	WP	
Micro level												
Activity 1 /Commodity 1	-0.0101	-0.0101	-0.0051	-0.0001	0.0202	0.0000	0.0030	0.0036	-0.0069	-0.0042	0.0000	0.0000
Activity 2 /Commodity 2	-0.0065	-0.0073	0.0023	0.0000	0.0143	-0.0042	0.0023	0.0029	0.0002	0.0034	0.0000	0.0000
Activity 3 /Commodity 3	-0.0026	-0.0030	0.0029	0.0000	0.0060	-0.0017	0.0015	0.0022	0.0007	0.0034	0.0000	0.0000
Activity 4 /Commodity 4	0.4632	0.4633	-0.1077	0.0027	-0.4136	0.3008	0.0000	0.0000	-0.1244	-0.1002	-0.1075	0.0119
Activity 5 /Commodity 5	-0.0057	-0.0059	-0.0122	-0.0001	0.0115	-0.0037	0.0021	0.0028	-0.0159	-0.0114	0.0000	-0.0001
Activity 6 /Commodity 6	-0.0005	-0.0005	-0.0280	-0.0003	0.0010	-0.0003	0.0000	0.0000	0.0008	-0.0359	0.0000	0.0000
Activity 7 /Commodity 7	0.0029	0.0143	0.0128	0.0003	-0.0169	0.0019	0.0004	0.0013	0.0138	0.0123	0.0000	0.0000
Activity 8 /Commodity 8	0.1724	0.1742	0.0040	0.0001	-0.3443	0.1120	-0.0336	-0.0290	0.0012	0.0046	0.0596	0.0013
Activity 9 /Commodity 9	0.0037	0.0040	0.0097	0.0001	-0.0047	0.0033	0.0006	0.0033	0.0079	0.0104	0.0000	0.0000
Activity 10 /Commodity 10	0.0005	0.0009	0.0096	0.0001	-0.0011	0.0004	0.0009	0.0017	0.0071	0.0108	0.0000	0.0000
Activity 11 /Commodity 11	0.0126	0.0141	-0.0046	0.0000	-0.0143	0.0113	-0.0015	-0.0005	-0.0126	-0.0009	0.0027	-0.0002
Activity 12 /Commodity 12	-0.0019	-0.0023	0.0062	0.0001	0.0021	-0.0017	0.0018	0.0027	0.0045	0.0070	-0.0046	0.0001
Activity 13 /Commodity 13	0.0012	0.0028	0.0132	0.0002	-0.0029	0.0011	0.0009	0.0020	0.0123	0.0136	0.0141	0.0002
Activity 14 /Commodity 14	-0.0023	-0.0026	0.0048	0.0001	0.0015	-0.0020	0.0015	0.0024	0.0032	0.0054	-0.0010	0.0001
Activity 15 /Commodity 15	0.0016	0.0023	0.0111	0.0002	-0.0018	0.0014	0.0008	0.0020	0.0102	0.0115	0.0094	0.0001
Activity 16 /Commodity 16	0.0019	0.0027	0.0177	0.0002	-0.0032	0.0017	0.0008	0.0018	0.0152	0.0190	0.0218	0.0002
Activity 17 /Commodity 17	-0.0044	-0.0046	0.0085	0.0001	0.0000	-0.0040	0.0035	0.0040	0.0001	0.0193	0.0000	0.0000
Activity 18 /Commodity 18	0.0054	0.0058	0.0032	0.0000	-0.0069	0.0049	-0.0001	0.0015	0.0025	0.0036	0.0000	0.0000
Activity 19 /Commodity 19	0.0002	0.0002	0.0083	0.0001	-0.0002	0.0002	0.0009	0.0017	0.0057	0.0100	0.0000	0.0001
Activity 20 /Commodity 20	-0.0572	-0.0581	-0.1029	-0.0010	0.0000	-0.0515	0.0125	0.0120	-0.0712	-0.1095	0.0000	-0.0002
Activity 21 /Commodity 21	-0.0037	-0.0037	-0.0031	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0051	-0.0030	0.0000	0.0000
Activity 22 /Commodity 22	0.0045	0.0045	0.0068	0.0001	0.0000	0.0000	0.0000	0.0000	0.0073	0.0068	0.0000	0.0000
Activity 23 /Commodity 23	0.0003	0.0003	0.0009	0.0000	0.0000	0.0002	0.0007	0.0015	0.0012	0.0007	0.0000	0.0000

Macro level	Real GDP	-0.0039	Wage	-0.0019	After-taxed income	
	Government Income	0.0719	Capital price	-0.0050	- Agricultural household	-0.0040
	Investment	0.0134			- Non-agri. household	-0.0033
	CPI	-0.0066			Utility	
					- Agricultural household	0.0014
					- Non-agri. household	0.0018
					EV (million Baht)	
					- Agricultural household	15.55
					- Non-agri. household	63.56

Note: X = Domestic production , Xd = Domestic consumption, E = Export, M = Import,

Ahcon = Agricultural household consumption, NAhcon = Non-agricultural household consumption,

L = Labor, K = Capital, WP = Waste water permit, VAT = Value added

Table 3 Effect of the implementation of emission charge policy

(Unit: % change)

Activities/Commodities		Price		Quantity									VAT
		Consum.	Production	X	Xd	E	M	AHcon	NAhcon	L	K	WP	
Micro level													
Activity 1	/Commodity 1	0.0032	0.0032	0.0038	0.0000	-0.0063	0.0000	0.0056	-0.0135	0.0039	0.0038	0.0000	0.0000
Activity 2	/Commodity 2	0.0005	0.0006	0.0038	0.0000	-0.0011	0.0003	0.0061	-0.0130	0.0030	0.0043	0.0000	0.0000
Activity 3	/Commodity 3	0.0008	0.0009	0.0046	0.0000	-0.0018	0.0005	0.0061	-0.0130	0.0020	0.0052	0.0000	0.0000
Activity 4	/Commodity 4	-0.0036	-0.0036	-0.0012	-0.0001	0.0032	-0.0023	0.0000	0.0000	-0.0009	-0.0014	0.0013	0.0183
Activity 5	/Commodity 5	-0.0044	-0.0046	-0.0061	-0.0001	0.0089	-0.0028	0.0071	-0.0121	-0.0052	-0.0063	0.0000	0.0000
Activity 6	/Commodity 6	0.0155	0.0155	0.0054	0.0001	-0.0309	0.0101	0.0000	0.0000	0.0158	0.0026	0.0000	0.0001
Activity 7	/Commodity 7	0.0020	0.0101	0.0096	0.0002	-0.0120	0.0013	0.0058	-0.0133	0.0098	0.0095	0.0000	0.0000
Activity 8	/Commodity 8	-0.0007	-0.0007	-0.0002	0.0000	0.0014	-0.0005	0.0064	-0.0128	0.0003	-0.0003	-0.0038	0.0030
Activity 9	/Commodity 9	0.0060	0.0066	0.0112	0.0001	-0.0078	0.0054	0.0113	-0.0410	0.0112	0.0113	0.0000	0.0000
Activity 10	/Commodity 10	-0.0001	-0.0003	-0.0016	0.0000	0.0003	-0.0001	0.0062	-0.0129	-0.0007	-0.0020	0.0000	0.0000
Activity 11	/Commodity 11	-0.0016	-0.0018	0.0041	0.0000	0.0019	-0.0015	0.0065	-0.0126	0.0031	0.0046	-0.0015	0.0001
Activity 12	/Commodity 12	-0.0014	-0.0017	0.0007	0.0000	0.0016	-0.0012	0.0085	-0.0163	0.0018	0.0003	-0.0008	0.0000
Activity 13	/Commodity 13	0.0005	0.0011	0.0100	0.0001	-0.0011	0.0004	0.0078	-0.0168	0.0100	0.0100	0.0076	0.0002
Activity 14	/Commodity 14	0.0009	0.0010	0.0041	0.0001	-0.0006	0.0008	0.0062	-0.0145	0.0046	0.0040	0.0039	0.0000
Activity 15	/Commodity 15	0.0027	0.0040	0.0127	0.0002	-0.0031	0.0024	0.0066	-0.0180	0.0132	0.0125	0.0121	0.0001
Activity 16	/Commodity 16	0.0028	0.0040	0.0206	0.0002	-0.0048	0.0025	0.0077	-0.0172	0.0220	0.0198	0.0177	0.0002
Activity 17	/Commodity 17	0.0116	0.0121	-0.0016	0.0000	0.0000	0.0104	0.0072	-0.0234	-0.0066	0.0049	0.0000	0.0000
Activity 18	/Commodity 18	-0.0013	-0.0014	0.0024	0.0000	0.0017	-0.0012	0.0088	-0.0232	0.0028	0.0022	0.0000	0.0000
Activity 19	/Commodity 19	0.0025	0.0026	0.0074	0.0001	-0.0032	0.0023	0.0057	-0.0134	0.0089	0.0063	0.0000	0.0000
Activity 20	/Commodity 20	-0.0194	-0.0197	-0.0633	-0.0006	0.0000	-0.0175	0.0101	-0.0094	-0.0365	-0.0690	0.0000	-0.0001
Activity 21	/Commodity 21	0.0024	0.0024	0.0030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0029	0.0030	0.0000	0.0000
Activity 22	/Commodity 22	0.0017	0.0017	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0020	0.0000	0.0000
Activity 23	/Commodity 23	-0.0015	-0.0015	-0.0058	-0.0001	0.0000	-0.0013	0.0051	-0.0112	-0.0049	-0.0063	0.0000	0.0000

Macro level	Real GDP	0.0059	Wage	0.0091	After-taxed income	
	Government income	0.0964	Capital price	0.0043	- Agricultural household	0.0060
	Investment	0.0181			- Non-agri. household	0.0071
	CPI	-0.0018			Utility	
					- Agricultural household	0.0031
					- Non-agri. household	-0.0080
					EV (million Baht)	
					- Agricultural household	34.08
					- Non-agri. household	-285.34

Note: X = Domestic production , Xd = Domestic consumption, E = Export, M = Import,

Ahcon = Agricultural household consumption, NAhcon = Non-agricultural household consumption,

L = Labor, K = Capital, WP = Waste water permit, VAT = Value added

Table 4 Effect of the implementation of tradable waste water permit and emission charge policies

(Unit: % change)

Activities/Commodities	Price		Quantity									VAT
	Consump.	Production	X	Xd	E	M	AHcon	NAhcon	L	K	WP	
Micro level												
Activity 1 /Commodity 1	-0.0154	-0.0154	-0.0120	-0.0001	0.0307	0.0000	0.0069	-0.0121	-0.0131	-0.0114	0.0000	0.0000
Activity 2 /Commodity 2	-0.0124	-0.0138	-0.0060	-0.0001	0.0272	-0.0080	0.0063	-0.0126	-0.0075	-0.0052	0.0000	0.0000
Activity 3 /Commodity 3	-0.0072	-0.0082	-0.0031	0.0000	0.0162	-0.0047	0.0053	-0.0135	-0.0046	-0.0028	0.0000	0.0000
Activity 4 /Commodity 4	0.4588	0.4589	-0.1086	0.0026	-0.4097	0.2980	0.0000	0.0000	-0.1246	-0.1015	-0.1042	0.0119
Activity 5 /Commodity 5	-0.0118	-0.0122	-0.0193	-0.0002	0.0238	-0.0076	0.0062	-0.0127	-0.0222	-0.0187	0.0000	-0.0001
Activity 6 /Commodity 6	-0.0041	-0.0041	-0.0319	-0.0003	0.0083	-0.0027	0.0000	0.0000	-0.0100	-0.0378	0.0000	-0.0001
Activity 7 /Commodity 7	0.0082	0.0410	0.0468	0.0011	-0.0484	0.0053	0.0022	-0.0163	0.0455	0.0474	0.0000	0.0001
Activity 8 /Commodity 8	0.1697	0.1716	-0.0041	0.0000	-0.3390	0.1103	-0.0303	-0.0451	-0.0068	-0.0035	0.0559	0.0012
Activity 9 /Commodity 9	0.0047	0.0052	0.0070	0.0000	-0.0061	0.0043	0.0065	-0.0458	0.0064	0.0073	0.0000	0.0000
Activity 10 /Commodity 10	0.0270	0.0538	0.1453	0.0000	-0.0641	0.0243	-0.0016	-0.0196	0.1392	0.1481	0.0000	0.0007
Activity 11 /Commodity 11	0.0078	0.0088	-0.0115	-0.0001	-0.0089	0.0071	0.0022	-0.0162	-0.0198	-0.0077	-0.0062	-0.0002
Activity 12 /Commodity 12	-0.0042	-0.0051	-0.0013	0.0000	0.0048	-0.0038	0.0061	-0.0181	-0.0030	-0.0005	-0.0151	0.0000
Activity 13 /Commodity 13	0.0077	0.0176	0.0569	0.0007	-0.0179	0.0069	0.0029	-0.0209	0.0561	0.0573	0.0566	0.0004
Activity 14 /Commodity 14	-0.0020	-0.0023	0.0008	0.0000	0.0014	-0.0018	0.0044	-0.0160	0.0001	0.0011	-0.0045	0.0000
Activity 15 /Commodity 15	0.0087	0.0128	0.0397	0.0007	-0.0100	0.0078	0.0024	-0.0219	0.0385	0.0404	0.0358	0.0003
Activity 16 /Commodity 16	0.0004	0.0006	0.0135	0.0001	-0.0007	0.0004	0.0050	-0.0191	0.0103	0.0152	0.0111	0.0001
Activity 17 /Commodity 17	0.0006	0.0007	0.0042	0.0000	0.0000	0.0006	0.0068	-0.0234	-0.0018	0.0119	0.0000	0.0000
Activity 18 /Commodity 18	-0.0001	-0.0001	-0.0094	-0.0001	0.0001	-0.0001	0.0052	-0.0270	-0.0097	-0.0092	0.0000	-0.0001
Activity 19 /Commodity 19	0.0032	0.0034	-0.0024	0.0000	-0.0041	0.0029	0.0032	-0.0154	-0.0037	-0.0016	0.0000	-0.0001
Activity 20 /Commodity 20	-0.0782	-0.0793	-0.1280	-0.0013	0.0000	-0.0704	0.0196	-0.0008	-0.1270	-0.1282	0.0000	-0.0003
Activity 21 /Commodity 21	-0.0086	-0.0086	-0.0097	-0.0001	0.0000	0.0000	0.0000	0.0000	-0.0129	-0.0095	0.0000	0.0000
Activity 22 /Commodity 22	0.0519	0.0519	0.0767	0.0008	0.0000	0.0000	0.0000	0.0000	0.0772	0.0767	0.0000	0.0002
Activity 23 /Commodity 23	0.0013	0.0013	-0.0045	0.0000	0.0000	0.0012	0.0028	-0.0133	-0.0032	-0.0052	0.0000	0.0000

Macro level	Real GDP	0.0086	Wage	0.0014	After-taxed income	
	Government income	0.1751	Capital price	-0.0044	- Agricultural household	-0.0027
	Investment	0.0019			- non-agri. household	-0.0013
	CPI	-0.0093			Utility	
					- Agricultural household	0.0031
					- Non-agri. household	-0.0082
					EV (million Baht)	
					- Agricultural household	33.51
					- Non-agri. household	-295.19

Note: X = Domestic production , Xd = Domestic consumption, E = Export, M = Import,

Ahcon = Agricultural household consumption, NAhcon = Non-agricultural household consumption,

L = Labor, K = Capital, WP = Waste water permit, VAT = Value added

Conclusions and Recommendation

The environmental and economic effects of MBI policies could be captured by using SAM and CGE model. In this study the tradable permit policy was proposed to be applied to the manufacturing and agricultural activities and the emission charge policy to non-agricultural households. Various simulations were carried out to show the policy impacts.

The results suggested that MBI policies could improve water quality in the receiving water. This similar result was also reported by Hung and Daigee (2005). The results also indicated that the environment target does not always conflict with economic target. Using the tradable permit policy alone would increase the welfare of the households but slightly decrease the economic growth. Meanwhile using the emission charge policy or a combination of tradable permit and emission charge policies would decrease the welfare of non-agricultural households but decrease the economic growth. Government could also generate revenue from using the MBI policies. This is a profound advantage of MBI for sustainable management of pollution.

This study also found that the use of the combined policies would contribute to a higher reduction of waste water than the use of a single policy (tradable permit or emission charge). However, the implementation of a single policy is deemed to be more practicable. When only a single policy is used, the emission charge scheme wouldl give a better environmental improvement than the use of tradable permit. But the implementation of the emission charge would involve a greater number of polluters than the use of tradable permit.

To implement the tradable permit policy for waste water management in Thailand, the Government should consider two issues: 1) the market for permits will be imperfectly competitive if the number of polluters is small. In this case, big firms may exert market pressure on permit prices, and 2) the scheme may involve high transaction costs such as administrative, monitoring and enforcement costs. However, it can be expected that the scheme would give a higher net gain and effectiveness than that from command-and-control approach.

Thailand has not implemented the MBI policies for waste water management. If any of the policies were used, this would affect the behavior of polluters. They might tend to seek the most cost-effective choice. They might find that investing in abatement technology is more efficient than buying permits. It might also give them more comparative advantage if they developed such technology ahead of the rivals.

The CGE model can measure impact on multi-sectoral level. However, spatial relations are usually of greater interest to policy makers. For instance, CGE analysis yielded the results of a policy shock by percentage change of water demand of an economy, but policy makers would tend to focus more on where the impact is most likely to occur. The CGE model could be further developed to capture the spatial effect. This would give clearer results of environmental and economic effects at a spatial scale and thus lead to a more precise and effective management.

References

Barbier, E. B., D. W. Pearce, and A. Markandya. 1990. "Environmental Sustainability and Cost-Benefit Analysis." **Environment and Planning A** 22 (9): 1259-1266.

Bernard, D., Patry, A., and L. Savard. 1998. **Income Distribution, Poverty Measures and Trade Shocks: A Computable General Equilibrium Model of a Archetype Developing Country.** Papers 9812, Laval - Recherche en Politique Economique. Laval University Québec, Canada.

Crocker, T. D. 1995. "Ecosystem Functions, Economics and the Ability to Function." In J. W. Milon and J. F. Shogren. (eds.). **Integrating Economic and Ecological Indicators: Practical Methods for Environmental Policy Analysis.** Connecticut: Praeger Publishers, 27-44.

Dellink, R. *et al*. 2004. "Dynamic Modelling of Pollution Abatement in a CGE Framework." Economic Modelling 21 (6): 965-989.

Hung, Ming-Feng and S. Daigee. 2005. "A Trading-Ratio System for Trading Water Pollution Discharge Permits." **Journal of Environmental Economics and Management** 49 (1): 83-102.

Jennifer, M. 2002. **A CGE Analysis of the Short-run Welfare Effects of Tariff Liberalisation in Uganda.** Helsinki: UNU world Institute for Development Economics Research.

LÖfgren, H., R. L. Harris, and S. Robinson. 2001. **A Standard Computable General Equilibrium (CGE) Model in GAMS.** TMD Discussion Paper No. 75. Washington, D. C.: International Food Policy Research Institute.

Miyata, Y. and X. Pang. 2000. **A General Equilibrium Analysis of Environmental and Economic Interaction with Material Circulation—A CGE-modeling Approach.** Proceedings of German-Japanese Workshop on Integrated Approaches towards Sustainability, Munich, 2000.

Pollution Control Department. 2006. **Summary of State of Thailand's Pollution in Year 2005**. Ministry of Natural Resources and Environment, Bangkok.

Strutt, A. and K. Anderson. 1999. **Estimating Environmental Effects of Trade Agreements with Global CGE Models: A GTAP Application to Indonesia.** Paper presented in OECD Workshop on Methodologies for Environmental Assessment of Trade Liberalization Agreements, Paris, 26-27 October.