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Economic Growth and Social Capability Building for Environmental Management in Southeast Asia

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Abstract

This paper is intended to analyze the social capacity building for environmental management in Southeast Asia. The environmental pollution is being increasing rapidly in accordance with economic growth. Pollution which is the direct result of ever increasing economic activity in the region and the appropriate pollution control measures have been analyzed by adopting two economic and management approaches. The first is a fact-finding for economic growth and its relationship with environmental quality by adopting Environmental Kuznets Curve approach. The second is an institutional approach for analyzing environmental laws and environmental management agencies. Then the social capability for environmental management has been discussed. This capability depends on three factors viz.: socio-economic activities, actors and institutions, and trends in environmental quality. Our main focus is air quality monitoring system, which is divided into four stages viz.: air quality monitoring, data analysis and disclosure, emissions inventory study, and abatement or control policy. Japan's experience in combating SOx and other air pollutants has been taken as a reference point. In accordance to, an analysis has been offered for setting up continuous air pollution monitoring stations, relationship between economic growth and air quality, and the capacity building process for air quality management in East Asia. Our findings show great similarities between observed air quality trends and Environmental Kuznets Curve estimations. We conclude this paper with an observation that socio-economic factors, environmental quality and social capability have a strong relationship with each other.

1. Introduction

1.1 . Background and Purpose of Research

The previous studies focusing environmental management capability building can be classified into two main schools. The first classification is based on the institutional approach. The emphasis is on 'how to establish environmental law system and environmental management administration.' The second classification is based on 'Environmental Kuznets Curve' (EKC). The emphasis are have laid on the fact-finding or collection of the data regarding economic growth and environmental quality to draw EKC and then to build the social capacity for meeting the environmental targets.

Among the institutional approach, the studies by O'Connor (1994) and Harashima and Morita (1995) are the main achievements. O'Connor's study for OECD discusses the turning point at a certain time period for establishment of environmental management for various Southeast Asian countries. He indicated that turning point for Japan in 1979, Korea, Taiwan, and China in 1980, and Thailand and Indonesia in 1988. However, that study does not indicate the facts, which can be testified for the proposed capability to establish environmental institutions. Similarly, the study by Harashima and Morita also discusses institutional building process during the environmental policy making period for countries like Japan in 1965, Korea in 1980, and China in 1987. However, their relationship between the proposed policy making period and environmental management capability is not very clear.

The fact-finding studies based on EKC are mainly supported by World Development Report 1992 of the World Bank. Fig.1 shows EKC based on economic growth as 'X-axis' and degraded environmental quality (pollution) as 'Y-axis.' The relationship between those two indicators is shown by curve 'A' as a development pattern followed by the developed countries. A shift from curve 'A' to curve 'B' indicates the shift towards lower level for the turning point in the environmental pollution levels. Similarly, a shift from curve 'A' to curve 'C' indicates the shift towards lower level for the turning point in economic growth level. Therefore, curve 'D' is a combination of curves 'B' and 'C' and indicates the shift in both the environment levels and the economic growth level. Hence, in the case of developing countries if they take advantage of backwardness or late-comers, then they can follow the development path similar to curve 'D'.

We have already analyzed the possibility of EKC hypothesis based on original elasticity between economic growth and environmental pollution (Matsuoka and et al. 1998). In that study we focused on the volume of emissions of SOx per capita, NOx per capita, and CO_2 per capita. We also focused on coverage ratio of safe water supply, urban sanitation, and forest area. All these environmental indicators were compared with GDP per capita as an economic growth indicator. Our results suggested that the only relationship that follows EKC is between the volume of emissions of SOx per capita and GDP per capita. In that study the turning point is maintained at GDP per capita of US $4,421 and PPP (purchasing price parity) of GDP per capita of US $3,412. Hence, the conclusion of that study suggested that when the countries can reach that level of economic growth, they can build their environmental capability for effective implementation of SOx reduction policy. However, that study can not provide an analytical framework for the research on 'how to make the process for building environmental management capability clear.'

In this study, taking into consideration the limitations of previous studies on both institutional approach and EKC approach, we add the third factor of environmental capability to analyze its dynamic relationship with the other two factors viz.: economic growth and environmental quality. However, the building process for the holistic environmental capabilities is very complex and it can not be directly analyzed in a single framework. Therefore, we analyze the environmental monitoring capability that is assumed as the basic capability for the environment management. Among this environmental monitoring we focus on air pollution monitoring system with an especial focus on SOx emissions, as it is the only pollutant that follows EKC. We initially analyze Japan's case and then take it as a reference point to analyze the Southeast Asian countries' case with regard to SOx emissions.

1.2. Framework for Research

The framework of our previous study (Matsuoka et al. 1998) as shown in Fig.2 is the basis for developing the analytical framework for this study. The present study framework has been set-up on social environmental system as shown in Fig.3 This system is divided into three sub-systems. The first sub-system is based on actors, institutions and behaviors. The second sub-system is based on socio-economic patterns, which are heavily dependent on economic growth. The third sub-system is of environmental quality. In the first sub-system of social environmental management, the behavior of actors is influenced by the institutions and that behavior effects the environmental quality in question. Moreover, the environmental quality has influence over the awareness/behavior of the actors and as per that awareness the actors try to build or constitute new institutions. Furthermore, institutions, actors' behavior, and environmental quality have a strong relationship with economic growth as has already been discussed. Hence, social environmental system consists of various actors, institutions, and behaviors. However, among these factors the most important one is environmental monitoring system. Therefore, this study focuses on the capability building for environmental monitoring system.

2. Factors and Indicators in Environmental Management System

2.1. Factors and Indicators

At first we set-up the factors and indicators for the environmental monitoring system. There are many important previous studies including Kazi et al. (1997), Davos et al. (1991a, 1991b, 1991c, & 1993), Simpson (1988), Tamori (1995), Imura et al. (1999), and UNEP and WHO (1996). Among these the study carried out jointly by UNEP and WHO under GEMS (Global Environmental Monitoring System) project is the most important one. This study covers environmental monitoring system in 20 major cities and most of these cities are located in the developing countries. We have quoted this study in our research as GEMS report.

The factors and indicators for our study are taken from GEMS report after a critical analysis of each factor and indicator. Fig.4 shows the factors of environmental monitoring system quoted from GEMS report. This report is mainly focused on air quality management and it divides air monitoring management capability into four factors viz.: measurement of air quality, assessment and disclosure of the data, estimation of emissions, and enable management. There are several indicators for each factor and each indicator should be scored in a range from 0.5 to 4.0 points. Each of the four factors discussed can achieve the highest score of 25 points, which combines to make 100 points for the whole system. The score of 25 points for each sector has been distributed to different indicators at different weights. For example, in the fist factor for measurement of air quality, 13 points go to the indicator for implementation of air quality measurement/recording system. This includes number of air quality polluters measured, consistency and number of readings per day/hour, and the length of available data for up to 5 years. Under the same factor, 5 points are kept for the number of monitoring staff and so on. Table.1 shows all the indicators with their maximum points. According to GEMS report, an equal weight of 25 points had been given to each of the four factors. However, a critical analysis of those factors suggests that there is a hierarchical structure among those factors. For example measurement of air quality is the basic and first step to build the whole system.

2.2. Economic Growth and Environmental Monitoring System

GEMS report has built a relationship between environmental monitoring and GDP per capita as shown in Fig.5 The report suggests that the factors like assessment and disclosure of the data, estimation of emissions, and enable management, also increase if economic growth increases. However, as per assessment of available data, this relationship does not follow the suggested pattern after a certain level of economic growth. The factor of assessment and disclosure of data is highly dependent of political and institutional set-up of the country. Hence, our research indicates that GEMS report is not very clear. Therefore, we use the composition analysis using the score of four major factors of GEMS report. Fig.6 shows the result of our composition analysis. We have analyzed that the factor of estimation of emissions is different from the three other factors; although, GEMS report suggests that assessment and disclosure of the data is a different factor. We assume that the emissions inventory factor is relatively a high technology level, while the rest of the factors are basic without an essential requirement of high-tech.

According to our research results, we define measurement of air quality, assessment and disclosure of data, and enable management as the primary or basic functions as these can even be implemented with the help of low level technology. Among these three factors, measurement of air quality is the very basic function as the lack of correct data or information regarding the environmental quality will make is impossible to produce a good analysis of the environmental quality and to formulate and implement right policies to enable management. On the other hand, the factor of inventory of environmental emissions is a higher function that can be effectively implemented only with the help of high level technology.

Therefore, we take into consideration the number of environmental monitoring stations in each country as representative indicators for assessing the capability of environmental management. We take the case of Japan as a reference point to assess our three dimensional system of economic growth, environmental quality, and social capability building.

3. Air Quality Monitoring System, Economic Growth, and Environmental Quality in Japan

3.1. Air Quality Monitoring System in Japan

When we conduct a quantitative analysis of air quality monitoring data, the basic shortcoming in the previous studies is the unavailability of the appropriate time-series data for each country. The GEMS report or EKC studies commonly used cross-country data or the data from different country in different situation and assumed it as the data for the county in question. Hence, they have failed to generate reliable results. However, in Japan during 1999, we can use numerical data available on CD-ROM format. This data along with time-series data helps us to analyze the number of monitoring stations, economic growth, and environmental quality.

The first factor for measurement of air quality includes number of continuous monitoring stations with effective maintenance and operation, and also the availability of measurement technology to collect the pollution data at the required time intervals. Fig.7 shows the number of continuous air pollution monitoring stations, number of municipalities with at least single air pollution monitoring stations, and municipalities with multiple pollution monitoring stations in Japan. Analyzing that data, it reveals that monitoring stations were started from 1963 in Japan and their number almost came to steady state in 1980 in case of single station municipalities and in 1978 in case of multiple station municipalities. This shows that urban areas with multiple stations achieved the steady patterns two years earlier then the general trends in Japan.

As far as the essential number and optimal location for monitoring stations is concerned, UNEPA studies and GEMS report for 20 major cities suggest that at least one station each in residential, commercial, and industrial area is required. Thus, the minimum number should be three for urban cities, if the zoning is properly enforced.

3.2. Establishment of Monitoring System and its Relationship with Economic Growth and Environmental Quality

We analyze the impact on the environmental capability with each additional monitoring station. The impact is higher for the additional monitoring station if the existing number of the stations is less. In other words we can say that the impact of setting-up an additional monitoring station in the earlier period for environmental capability is higher than the impact in the later period, when there are more stations in operation. Hence, we take the number of monitoring stations in log scale to evenly assess their impact on the environmental quality. Fig.8 shows the concentration of SOx emissions and the number of monitoring stations in Japan. The total number of continuous and long-term stations is 14 as five are located in Tokyo, four in Yokohama, three in Kawasaki, and one each in Yokkaichi and Sakai. Average peak of SOx concentrations was during 1967 and the number of stations during that time was 94 with a log value of 1.973. As per least square (regression) method, the number of monitoring stations required for those peak SOx concentration calculated as 71.4 with a log value of 1.854. The number of monitoring stations in 1996 was 1730 with a log value of 3.238. A comparative analysis of the number of monitoring stations in log terms with the peak SOx concentrations in 1996 shows that the turning point of SOx is at 60% of the log value for the existing stations during 1996.

Fig.9 shows SOx concentrations and the number of monitoring stations in five major cities of Japan. Looking at the trends of SOx concentrations and the number of monitoring stations in those five major cities, we realize that the statistical analysis indicates that an essential number for monitoring stations to be 19.4 or 1.288 in log terms to achieve the turning point. However, the actual number of monitoring stations in those five cities is 75 with a log value of 1.875. This shows that the turning point is at 70% of the log value for the number of existing stations. Based on this analysis, we can highlight two points. Firstly, in case of Japan, if the number of monitoring stations is taken as an indicator for environmental management capability, then the turning point for environmental quality is at about 60% to 70% of the existing number of the stations. Secondly, at the turning point, annual SOx concentrations would be 0.060ppm and PPP-GDP per capita would be US $5,032.

Based on the above assessments and taking into consideration about the advantage of late comers or backwardness as per EKC, we can predict the shifting of income, pollution, and number of the stations towards original point. In case of Southeast Asian countries, we can assume PPP-GDP per capita at US $5,000 as an essential level for economic growth to reach the turning point. The turning point for continuous and reliable monitoring stations would be in a range of few tens (for example, in between 40 to 60). According to USEPA (United States Environmental Protection Agency) standard guidelines the necessary number of stations for a city of 1 million people should be 15 and for a city of 10 million people should be 35.

4. Economic Growth and Air Quality Monitoring System in Southeast Asia

4.1. Trends for Air Quality Monitoring Stations

In this section, based on the Japanese experience, we analyze the relationship among three factors: economic growth, environmental quality, and the process for environmental monitoring capability. At first we touch on the development of air quality monitoring system. This system can be divided into two main stages as per level of technological involvement. The first stage includes sample collection at a fix location, transportation of that sample to the laboratory, and finally analyzing the sample. This stage is called manual analysis stage. The second stage is the continuous measurement with automatic process for analysis. The first stage 'manual analysis stage' can be further divided into two sub-stages depending on the automatic sample collection or the manual sample collection process. The second stage can also be divided into two sub-stages depending whether the continuous analysis is being done with the help of telemeter or without telemeter. Hence, automatic sample collection with continuous telemeter readings is the highest stage. Table.2 shows the ambient air quality in Southeast Asian countries. In case of SOx, NOx, CO, and O3 maximum hourly value is set and data should be monitored after every hour. Therefore, in that case it is essential to connect all the monitoring stations with telemeter system.

Table.3 shows the number of air quality monitoring stations in Southeast Asia. In Singapore, manual analysis system was started during early 1970s and the system was completely converted to automatic monitoring and analysis system by using telemeter and networking in 1994. Hence, Singapore built its capability for air quality monitoring in that year. In case of Malaysia, manual monitoring and analysis system was started from late 1970s at nation-wide level. In 1992 automatic telemeter system was introduced and it is planned that by the year 2000, Malaysia will have a completely automatic system with a network of 50 monitoring stations across the country. Thailand introduced manual analysis system in late 1970s and the automatic system was introduced during 1980s. However, the automatic telemeter system was started in 1992 and completed in 1997. As a matter of fact, due to financial crisis, the telemeter system is not being working effectively as the monitoring data is collected only once a day. As far Indonesia, manual analysis system was adopted in late 1970s and only during 1990s, when Jakarta Metropolitan Area had set-up automatic system, that in other major cities the same system is being set-up with the support of Austria and Japan. However, telemeter system has not yet been installed. Finally, in Philippines' case, they also started their manual system from early 1970s just like Singapore. Though, they also managed to set-up an automatic system during 1990s in Metro Manila, but those instruments could not be used on sustainable basis due to lack of maintenance. In 1990s ADB (Asian Development Bank) also gave the donation to set-up the monitoring equipment, but again the lack of maintenance made it difficult to use that instrument effectively. At present, there are 10 monitoring stations in Metro Manila, but the total staff in Environmental Management Bureau and that for air quality monitoring is only five. Hence, they can not manage the monitoring stations effectively and the data collection activity remains at once a week. Therefore, for Philippines, the first priority should be the of setting-up of effective monitoring system, at least in Metro Manila and then to set-up the same system across the country.

4.2. Economic Growth and Building of Air Quality Monitoring System in Southeast Asia

As we have already discussed in section 1.1 about our previous study on EKC. We used data of 1980 from 29 countries to analyze the elasticity between GDP per capita and SOx emissions per capita. The regression line had shown the statistically significant crossing point at X-axis. Based on that reason, we made clear the possibility of EKC in case of SOx emissions. Fig.11 shows results of our study and also indicates those points for Japan and as well as for Southeast Asian countries. With the help of this figure, as per parallel to the regression line, we establish the present position for each country. Fig.12 shows the results of our calculations. Based on Fig.12 , it is evident that Singapore has already reached the turning point during early 1990s. Malaysia also achieved the turning point during mid 1990s. Thailand will reach at the turning point by end of 1990s or early 2000. Indonesia will take a little more time as it may arrive at the turning point by 2010. However, for Philippines, we cannot estimate the exact time required for achieving the turning point due to unavailability of the essential data.

Comparing with the situation of air quality monitoring system in Southeast Asia, as discussed in the previous section 4.1, we can get the similar results for EKC and also for the environmental monitoring capability in each country. Therefore, with the exception of Philippines, Singapore, Malaysia, Thailand, and Indonesia have already set-up the automatic monitoring stations expeditiously after 1980s as per their rapid economic growth. Moreover, telemeter system has already been installed in those countries except Indonesia, where telemeter system is under installation. Furthermore, those Southeast Asian countries completed the setting-up of nation-wide automatic system prior to their respective turning points, and this is a different trend from the Japan. Therefore, Southeast Asian countries very expeditiously built the air quality monitoring capability on nation-wide basis. However, this rapidness also caused some technological problems and only Singapore is different as it has a long and sustainable history for manual analysis system.

5. Conclusion

In this research, which is primarily based on EKC to draw a trend between economic growth and environmental quality, we have added the third dimension as air monitoring system for environmental management capability. We have taken the case of Japan as a reference point and analyzed the case of five Southeast Asian countries. Similar to Japan's trends, those five countries have also got a very strong relationship among all the three dimensions. However, the major difference for those countries is evident from the pace of setting-up nation-wide automatic monitoring system. We also made clear the effectiveness of our research framework to analyze the social capability building process for environmental management. However, this study is mainly focused on SOx as a typical pollutant. Therefore, for NOx, CO, and PM10 we will make other efforts to analyze those pollutants as they also cause a very serious non-point source pollution problems in the developing countries.

Acknowledgement

We undertook a field study in August and September 1999 for collection of data to analyze EMS (environmental management systems) in Southeast Asia. Therefore, we express our deep gratitude and thanks to the following institutions and their officials: Singapore: Ministry of Environment, Malaysia: Ministry of Science, Technology, and Environment (MOSTE), Department of Environment, Thailand: MOSTE, Pollution Control Department, Indonesia: JICA/BAPDEL Environmental Management Center, BAPDEL, Philippines: DENAR, Environmental Management Bureau.

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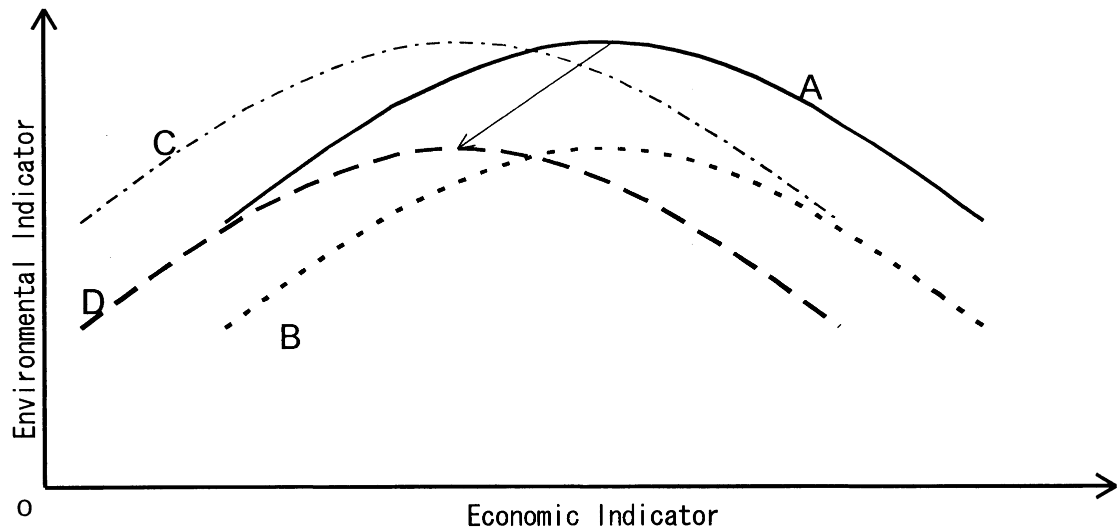
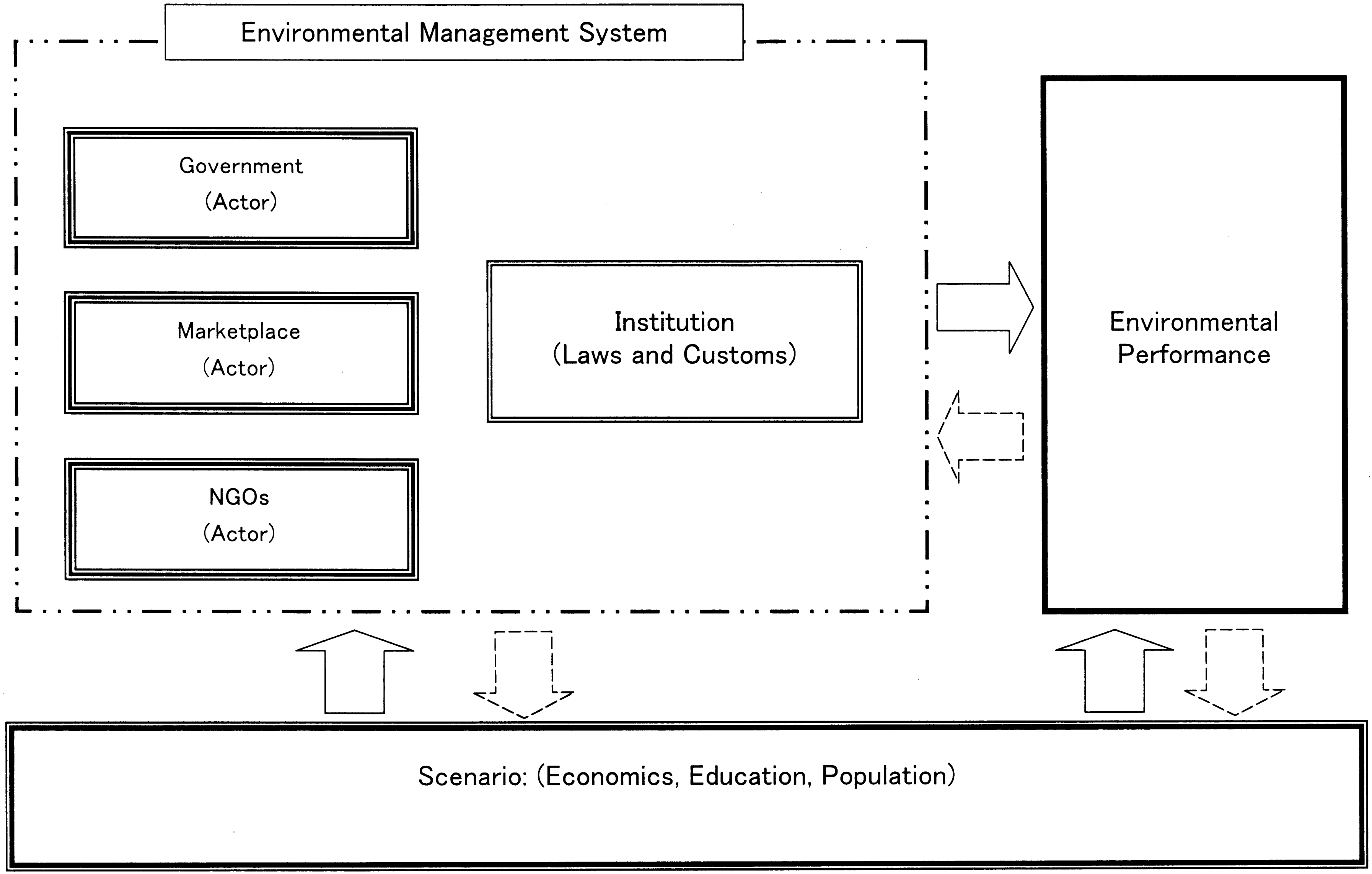
Figure 2-1 Environmental Kuznets Curve



Source: Matsuoka, S., Matsumoto, R. and Kochi, I. (1998) Economic Growth and Environmental Problem in Developing Countries: The Environmental Kuznets Curve Do Exist? (in Japanese), *Environmental Science*, 11(4), 349-362

Figure 2-2 Structure of Environmental Management System



Source: Matsuoka, S., Kochi, I. and Shirakawa, H. (1999) Social Evaluation on International Environmental Cooperation: a Case of Japan's Environmental Project in Thailand, *Journal of International Development and Cooperation*, 5(1), 11-22

Figure 2-3 Social Environmental Management System

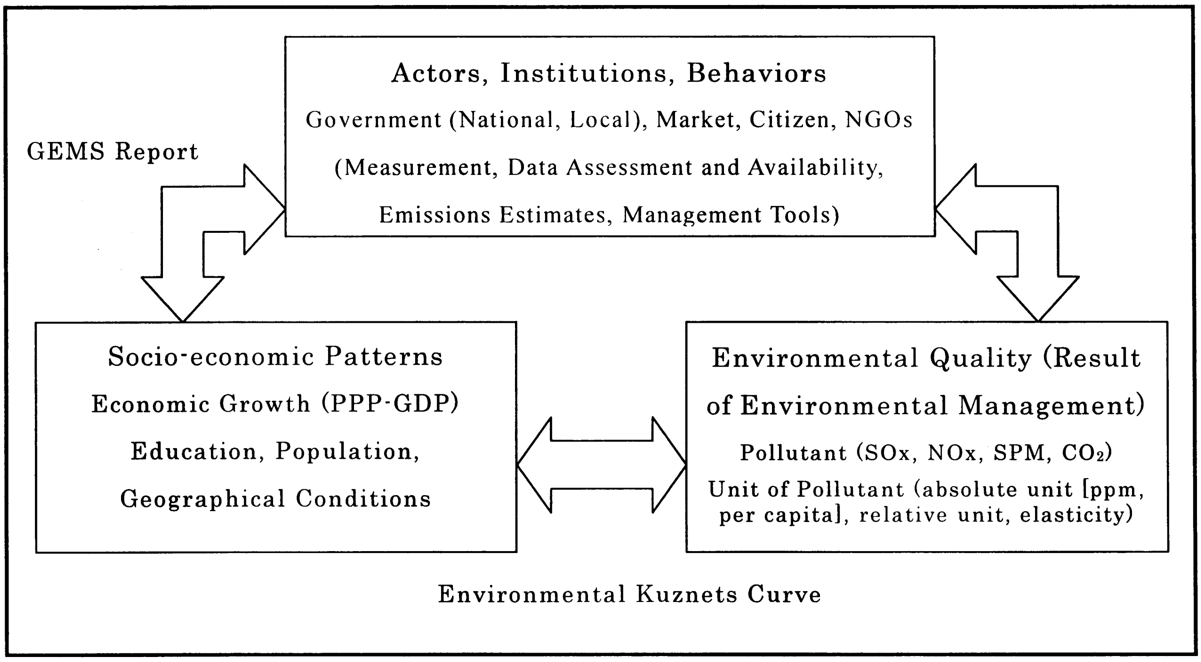
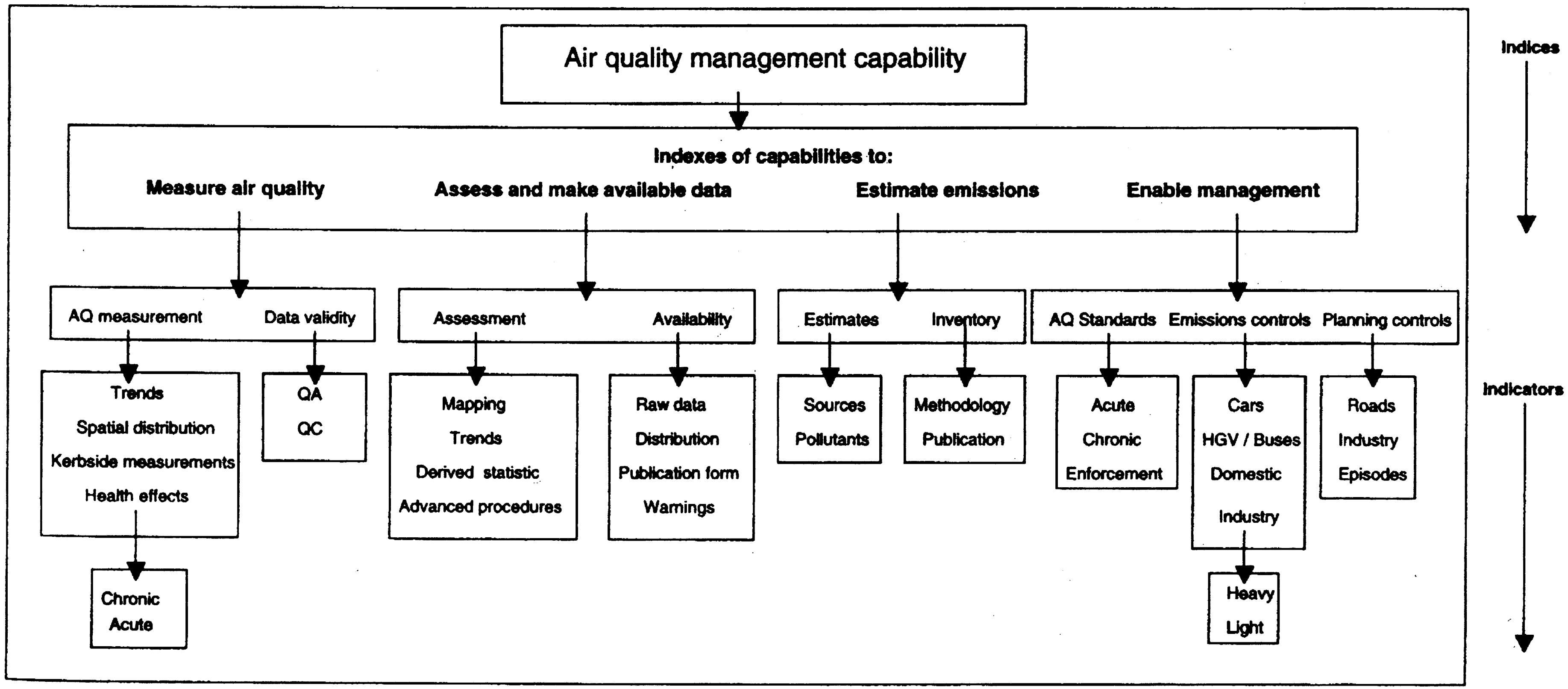
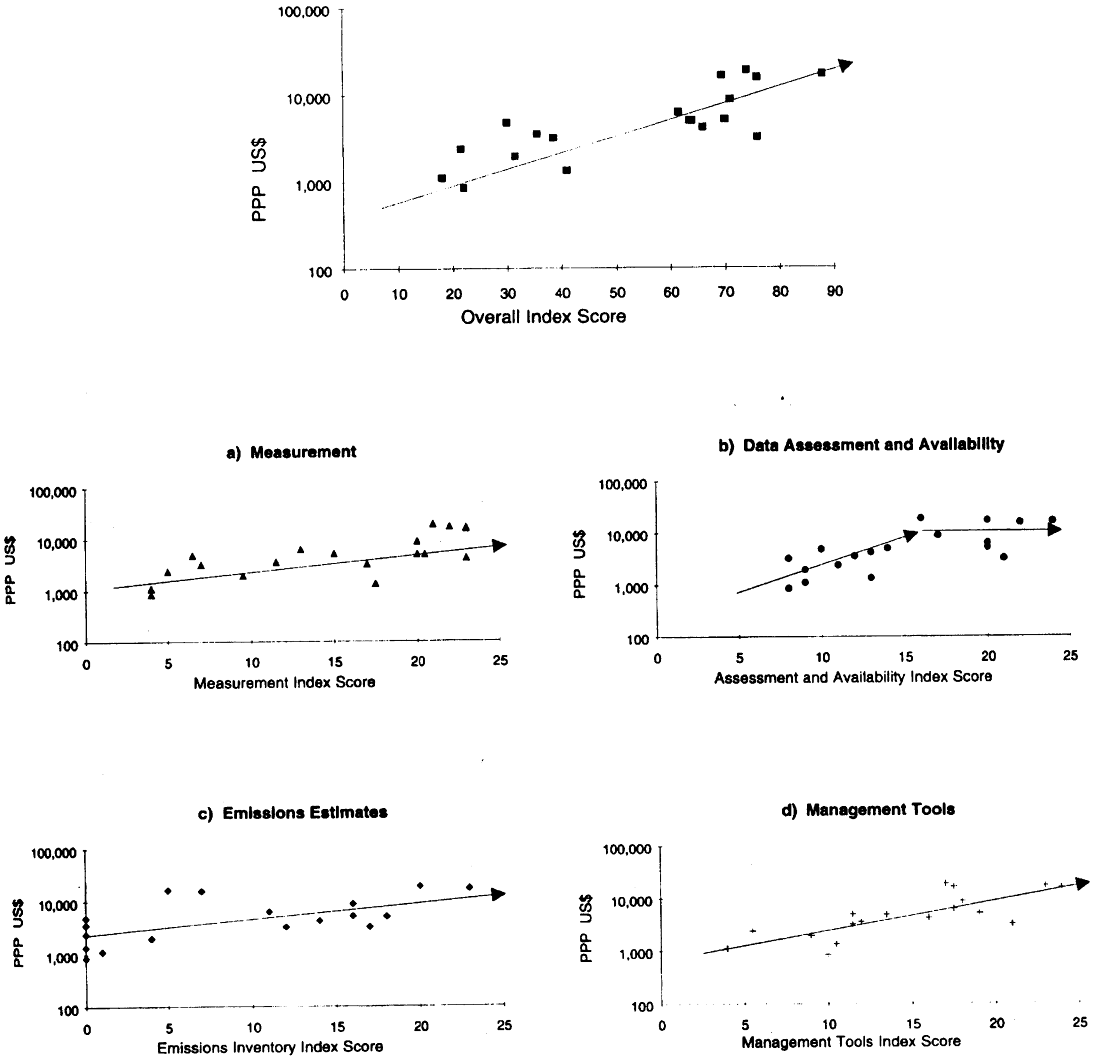


Figure 2-4 Factors of Environmental Monitoring System (GEMS Report Model)



Source: UNEP&WHO (1996), *Air Quality Management and Assessment Capabilities in 20 Major Cities*, MARC (Monitoring and Assessment Research Center, London)

Figure 2-5 Relationship between Environmental Monitoring and GDP per capita



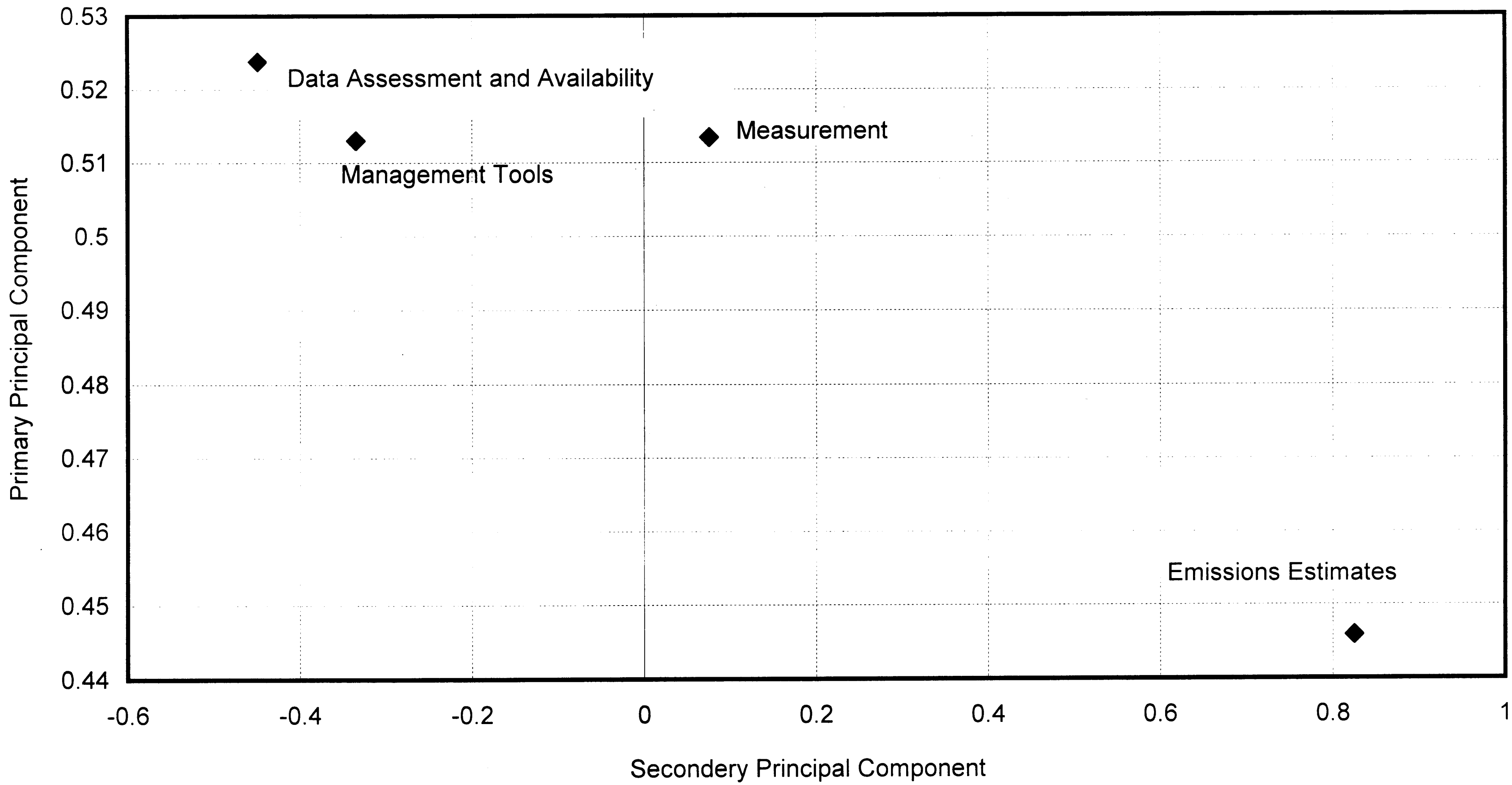
Source: UNEP&WHO (1996), *Air Quality Management and Assessment Capabilities in 20 Major Cities*, MARC (Monitoring and Assessment Research Center, London)

Table 2-1 Indicators of Environmental Management (in GEMS Report)

Indicator of Air Quality Measurement Capacity (Total: 25 points)	Monitoring at least one site in a residential area with a frequency of greater than one day (more than 1 years) (each pollutant: 0.5 point)	NO_2, SO_2, Particulate matter, CO, Pb, O_3
	Monitoring at least one site in a residential area and provides daily or hourly mean values day (more than 1 years) (each pollutant: 0.5 point)	NO_2, SO_2, Particulate matter, CO, O_3
	Measure trends (more than 5 years) (each pollutant: 0.5 point)	NO_2, SO_2, Particulate matter, CO, Pb, O_3
	Measure spatial distribution (more than 3 stations) (each pollutant: 0.5 point)	NO_2, SO_2, Particulate matter, CO, Pb, O_3
	Measure road side concentrations day (more than 1 years) (each pollutant: 0.5 point)	NO_2, SO_2, Particulate matter, CO, Pb
	Data quality (sub total 12 points)	Calibrations, Site audits, Auditing by independent body, Inter-comparison
Data Assessment and Availability (Total: 25 points)	Indicators of the capacity to analyze data (sub total 14 points)	Statistical analyze (mean, percentiles, trends, mapping), Computer use
	Indicators of data dissemination (sub total 11 points)	Newspaper, Television, Published reports, Air quality warnings
Emissions Estimates (Total: 25 points)	Source emission estimates (each source: 1 point)	Domestic, Commercial, Power-generating, Industry, Cars, Motorcycles, Others, HGV/buses
	Pollutant emissions estimates (each pollutant: 1 point)	NOx, SO_2, Particulate matter, CO, Pb, Hydrocarbons
	Accuracy of emissions estimates (sub total 9 points)	Estimates from actual measurements, Estimates from fuel consumption, Include non-combustion process, Cross check, Future inventory plan
	Availability of the emissions estimates (sub total 2 points)	Published in full: 2points, Partially available: 1 point
Management Capability Assessment Tools (Total: 25 points)	Capacity to assess air quality acceptability (sub total 8 points)	Air quality standards, Regulations, Local standards, Future plan
	Capacity to use air quality information (sub total 17 points)	Emissions controls, Penalties, EIA in new development area, Unleaded petrol, Additional emission controls among the warning

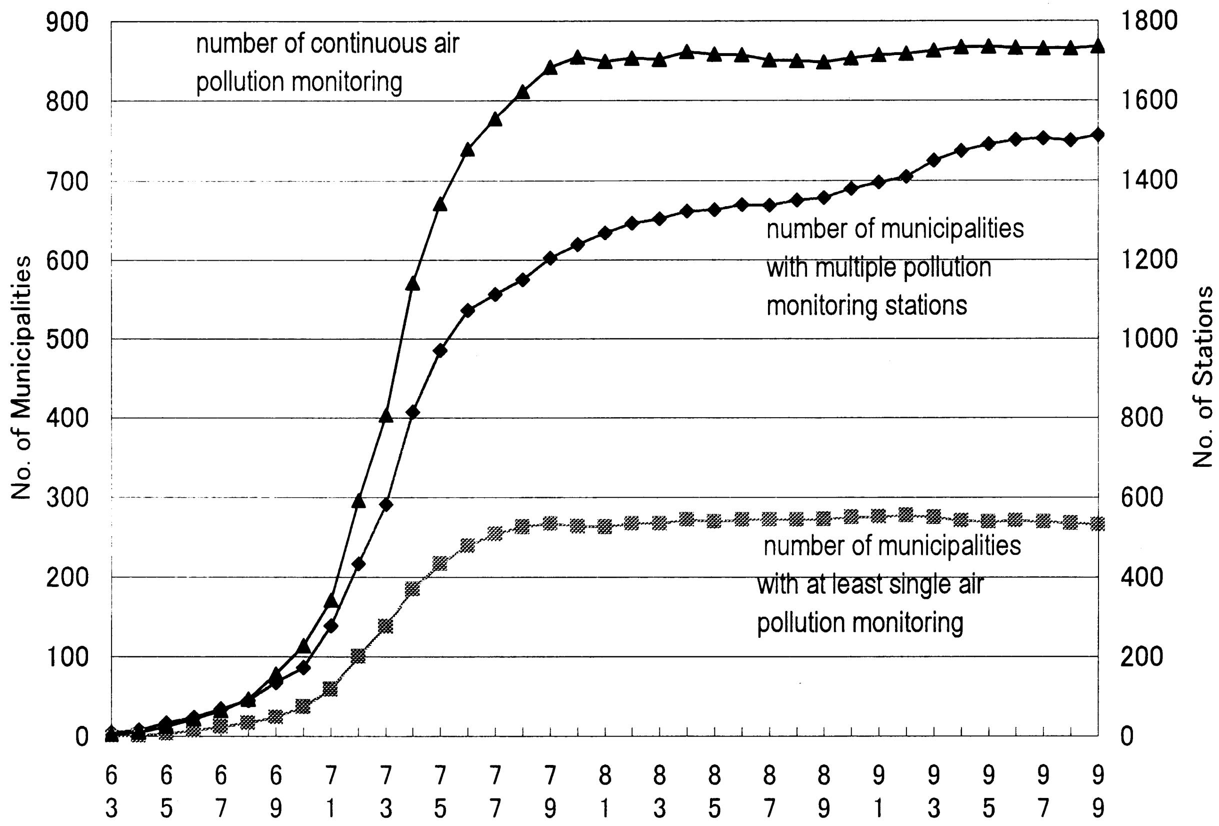
Source: UNEP&WHO (1996), *Air Quality Management and Assessment Capabilities in 20 Major Cities*, MARC (the Monitoring and Assessment Research Center, London)

Figure 2-6 PCM of GEMS Data



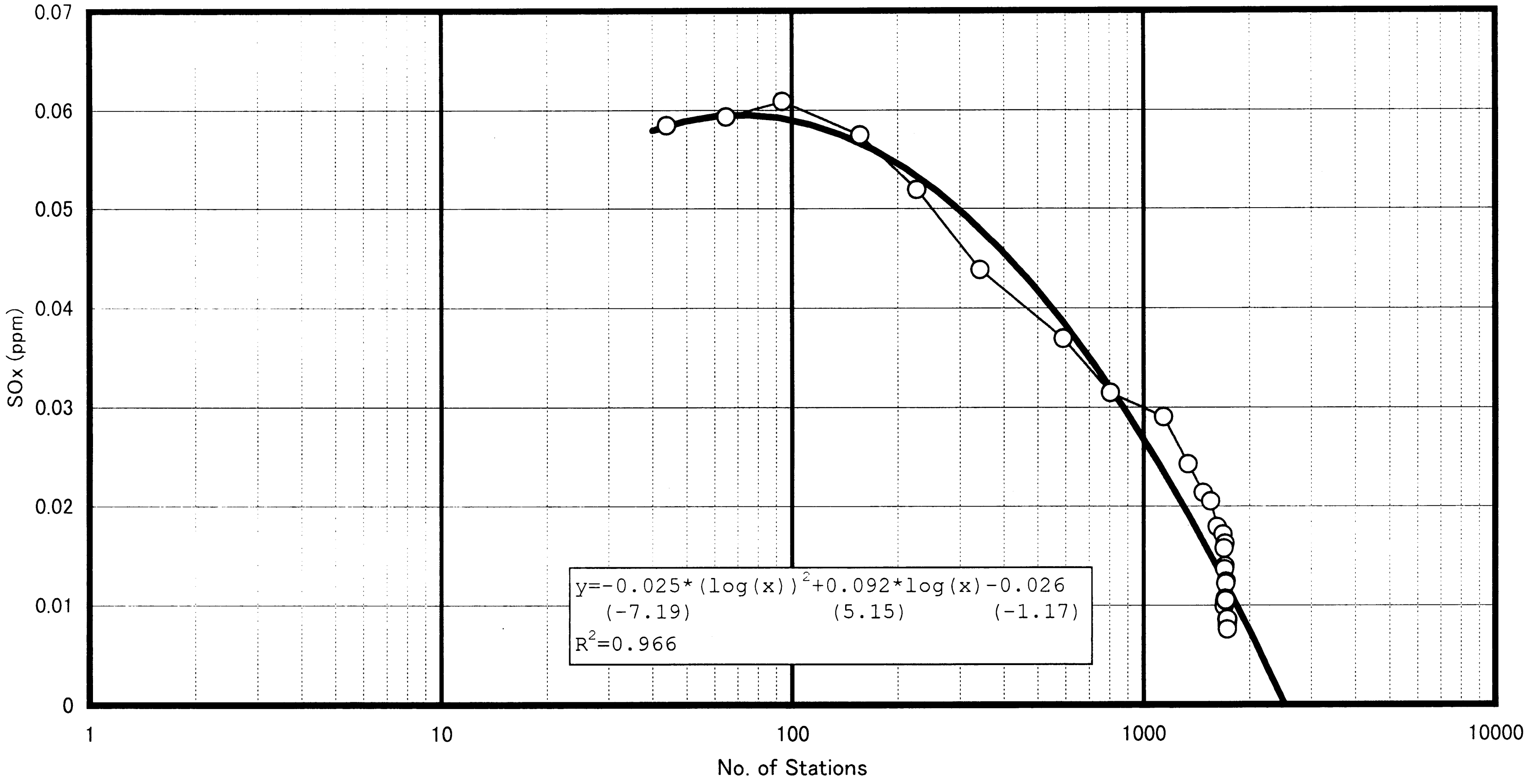
Source: UNEP and WHO (1996), *Air Quality Management and Assessment Capabilities in 20 Major Cities*, MARC (Monitoring and Assessment Research Center, London)

Figure 2-7 Number of Stations and Municipalities



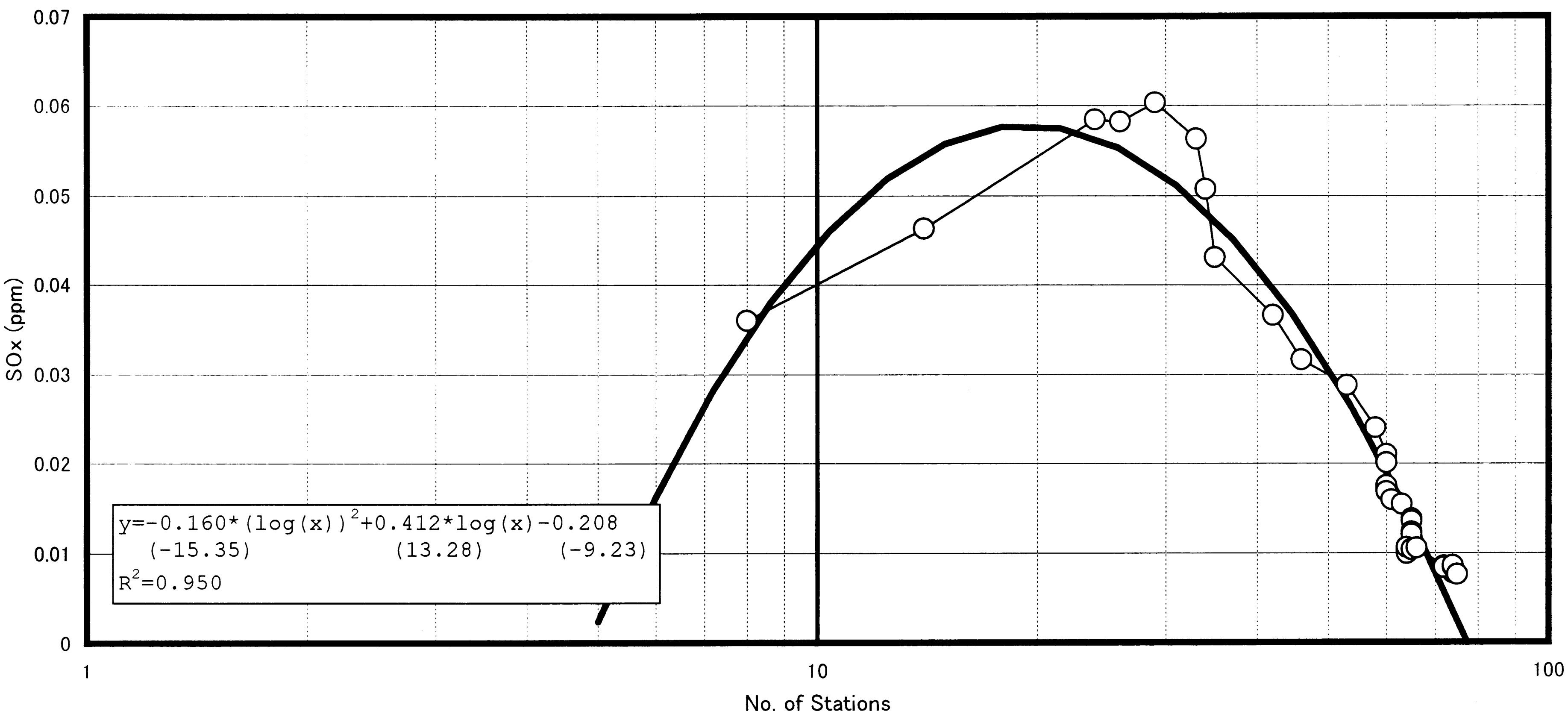
Source: EPA(Environmental Protection Agency in Japan), Taiki Jyoji Kanshi Kenkyukai (ed.) (1999) Heisei 9 nen Ippan kankyo Taiki Sokuteikyoku Kekka Houkoku (CD-ROM edition, Gyousei

Figure 2-8 SOx Concentrations and Number of Monitoring Stations in Japan



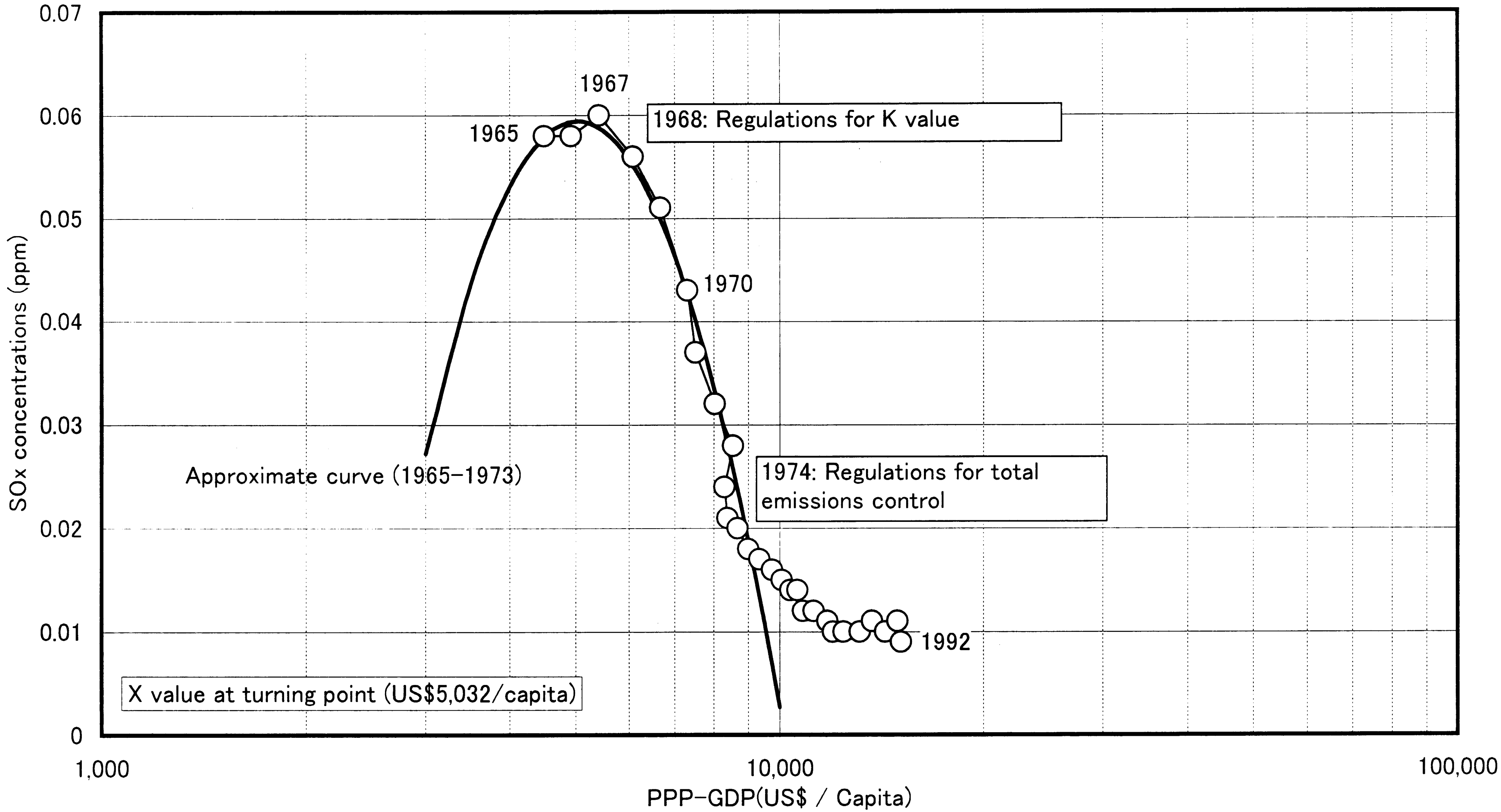
Source: EPA(Environmental Protection Agency in Japan), Taiki Jyoji Kanshi Kenkyukai (ed.)(1999) Heisei 9 nen Ippan kankyo Taiki Sokuteikyoku Kekka Houkoku (CD-ROM edition), Gyousei

Figure 2-9 SOx Concentrations and Number of Monitoring Stations in Five Major Cities of Japan



Source: EPA(Environmental Protection Agency in Japan), Taiki Jyoji Kanshi Kenkyukai (ed.)(1999)Heisei 9 nen Ippan kankyo Taiki Sokuteikyoku Kekka Houkoku (CD-ROM edition), Gyousei

Figure 2-10 Economic Growth and SOx Concentrations in Japan



Note: The value of SOx concentrations is taken as average of the value measured at 14 long term monitoring stations
Source: Envrionmental Agency (1999),
The present situation of Air Pollution in Japan adopted from Gyosei, PWT (1998): PWT(Penn-World Tables, http://www.nber.org/pwt56.html

Table 2-2 Number of Monitoring Stations in Asian Countries

	Singapore		Malaysia		Thailand		Indonesia		Philippines		Japan(SOx)
	Manual	Automatic	Manual	Automatic	Manual	Automatic	Manual	Automatic	Manual	Automatic	Automatic
1970											390
1971	21								6		599
1972	(n.a.)								6		791
1973	17								6		1,071
1974	12								4	6	1,257
1975	15								4	6	1,359
1976	17						1		(n.a.)	6	1,426
1977	17		9		3		1			6	1,488
1978	18		25		4		1			6	1,535
1979	19		147				3			6	1,587
1980	14		197				8			6	1,611
1981	14		316				9			6	1,622
1982	14		343				9			6	1,626
1983	14		(n.a.)			8(n.a.)	17			6	1,648
1984	14		(n.a.)				17			3	1,647
1985	14		(n.a.)				17			0	1,638
1986	15		241				16		8		1,625
1987	11		(n.a.)			13(n.a.)	16		(n.a.)		1,625
1988	12		(n.a.)				11				1,623
1989	12		224				11				1,622
1990	12		219				11				1,620
1991			217			17(n.a.)	17		2	5	1,621
1992				3			19	1	5	5	1,618
1993				3			19	4			1,610
1994		15		3			19	4			1,616
1995		15		3	14	23(14)	19	4			1,618
1996		15		13			19	4			1,605
1997		15		29			19	7			
1998		15		39							
1999		15		39	20	54(37)		[27(20)]			
2000				[50]				[66(59)]			
2001 after								[79(72)]			

Note: [ ] is future plan number of monitoring stations.
( ) is number of monitoring stations in rural area.

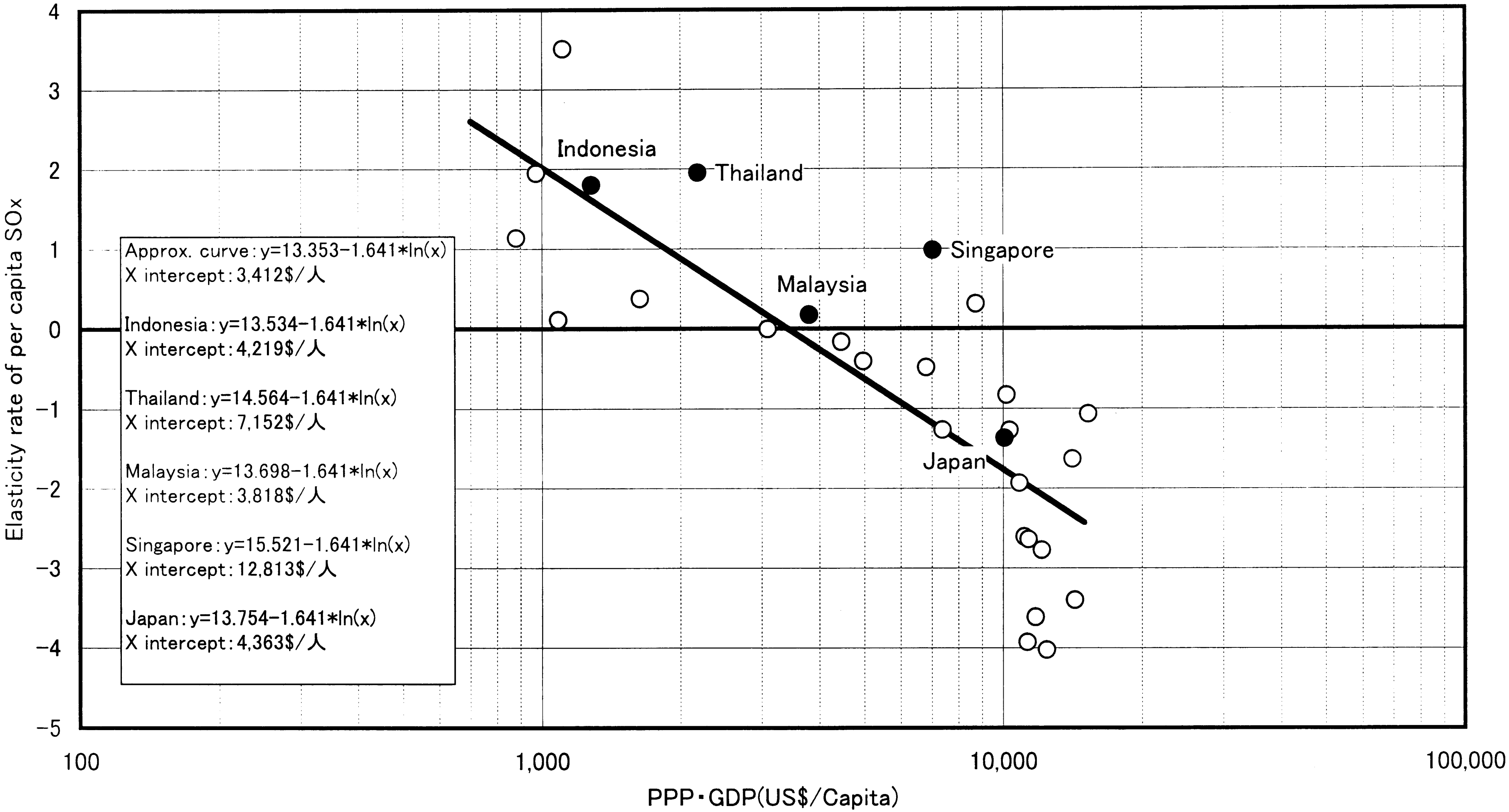
Source: Pollution Control Department, ENV, Singapore, Pollution Control Report: 1987-1997
Prime Ministers Office, Singapore, Anti Pollution Unit: Annual Report: 1970-1986
DOE, MOSTE, Malaysia, Environmental Quality Report : 1990-1997
MOSTE, PCD, Thailand (1996) Pollution Thailand 1995
World Bank (1997) Urban Air Quality Management Strastegy in Asia: Jalarta Report
World Bank (1997) Urban Air Quality Management Strategy in Asia: Metro Manila Report
Taiki Jyoji Kanshi Kenkyukai, EPA, Japan, (1999) Heisei 10 nenban Nihon no Taiki Osen Jokyo

Table 2-3 Air Quality Standard in Asian Countries

	Unit Time	Japan	Singapore	Malaysia	Thailand	Indonesia	Philippine
TSP ($\mu g/m^3$)	1 hour	200[SPM]				90	
	8-h mean						
	24-h mean	100[SPM]	(PM10 150)	260(PM10 150)	330(PM10 120)	230(PM10 150)	230(PM10 150)
	Annual mean		(PM10 50)	90(PM10 50)	100(PM10 50)		90(PM10 60)
SO_2 ($\mu g/m^3$)	10 minutes			500(0.19ppm)			
	1 hour	(0.1ppm)		350(0.13ppm)	780(0.30ppm) (local: 1300)	900	
	24-h mean	(0.04ppm)	365(0.14ppm)	105(0.04ppm)		365	180(0.07ppm)
	Annual mean		80(0.03ppm)			60	80(0.03ppm)
CO (mg/ m^3)	1 hour		40(35ppm)	35(30ppm)	34.2(30ppm)	30	30
	8-h mean	(20ppm)	10(9ppm)	10(9ppm)	10.26(9ppm)		10(9ppm)
	24-h mean	(10ppm)				10	
NO_2 ($\mu g/m^3$)	1 hour			320(0.17ppm)	320(0.17ppm)	400	
	24-h mean	(0.04-0.06ppm)		(0.04ppm)		150	150(0.08ppm)
	Annual mean		100(0.053ppm)			100	
HC ($\mu g/m^3$)	3-h mean					160	
O_3 ($\mu g/m^3$)	1 hour	(0.06ppm)	235(0.12ppm)	200(0.10ppm)		235	
	8-h mean			120(0.06ppm)			60(0.03ppm)
	1 year					50	
Pb ($\mu g/m^3$)	24-h mean					2.0	
	1 Month mean				1.5	1.0	
	3 Month mean		1.5	1.5			1.5
	Annual mean						1.0

Source: EPA(Environmental Protection Agency in Japan), Taiki Jyoji Kanshi Kenkyukai (ed.) (1999) *Heisei 10 nenban Nihon no Taiki Osen Jokyo*, Gyousei, Ministry of Environment,Singapore(1998)Annual Report '97, MOSTE･DOE(1998)Malaysia Environmental Quality Report 1997, MOSTE･PCD(1996)Pollution Thailand 1995, BAPEDAL(1999)Peraturan Pemerintah Republik Indonesia Nomor 41 Tahun 1999, Philippine(1999)Philippines Clean Air Act of 1999

Figure 2-11 Elasticity Analysis for SOx Emissions and PPP.GDP



Note: Assume latecomer advantage as per EKC for developing countries, they can achieve turning point at lower level of income per capita in comparision to developed countries. However, the turing points of PPP.GDP per capita for Singapore and Thailand are higher than Japan. The reasons may be: possibility of overestimation of PPP.GDP, choice for pollution index and material index, and special geographical and social characteristics or energy consumption patterns

Figure 2-12 Environmental Kuznets Curve for Souteast Asian Countries