Urban Environmental Management

Challenges in Asia

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Preface

Urban environmental management is a challenge faced by many cities in Asia. At the same time, developing cities in Asia confront a number of other issues as well. While on the one hand some cities are enjoying the benefits of rapid economic growth, many of these cities are also experiencing a huge influx of poor from the surrounding areas, and some cities are unable to control urban sprawl. While it could be said that environmental problems are the result of economic development, it is also true that economic development can be a key to solve at least some of the environmental problems. Understanding these issues and their driving forces is paramount to improve overall urban environmental problems. At the same time, there are a number of actions being taken both at the local and national level towards addressing the urban problems.

The present report entitled *Urban Environmental Management Challenges in Asia* addresses the problems and issues on urban environmental management in Asian cities and the policy and actions being implemented. The report consists of four parts. Section I discusses urbanization trends in Asia as well as the relationship between economic growth and environmental problems. Section II brings together the issues in urban environmental management under three sectors, water and sanitation, transport and air quality management, and solid waste management. This section also discusses the responses taken in each of those sectors, such as involving the private sector and communities, implementing financing mechanisms, and reforming institutional and legislative frameworks. From these issues, specific case studies are presented in Section III. The first is a case study on the development of a methodology to account the environmental management assets of the City of Kitakyushu. It describes how the city developed its assets on air quality, water and sanitation, and solid waste management and how these assets were used to overcome pollution. The second case study is an assessment on energy consumption and greenhouse gas emissions and policy implications in selected East Asian mega-cities. This first case addresses local and regional environmental impacts, while the second addresses global environmental issues, which are entering the policy agenda of some cities in Asia. Section IV concludes the report discussing the concept of sustainable

cities and new concepts in urban environmental management, such as urban ecosystems, ecological footprints, and the role of information technology, highlighting the experience of Japanese cities.

Many people have rendered their valuable help and assistance in the research as well as in the preparation of this report. Mentioning all of them here is not possible. But special thanks should be given to some individuals, as without their cooperation this report would not be possible: Prof. Akio Morishima, Chair of the Board of Directors for his constant encouragement; Prof. A.T.M. Nurul Amin, Graduate Education Coordinator of the School of Environment Resources and Development of Asian Institute of Technology, and Dr. Ooi Giok Ling, Adjunct Senior Research Fellow of the Institute of Policy Studies, Singapore, for valuable comments; and Ms. Chie Ishizu, Project Secretary; Ms. Christine Pearson, Project Officer, Kitakyushu Office; and Mr. Hidekazu Kakizoe, Division Chief, for providing logistic support.

Kitakyushu

Mara Regina Mendes

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Section I – Introduction: Economic development, urbanization and environment in Asia

1. Introduction

Cities play a central role in the evolution and advance of culture, economy, and politics. The "urbanized" economy expands due to the advantages of economic concentration in cities. Demand for various services emerges and increases the amount of employment in service industries. Then wage gaps with the neighbouring areas and disparities in work opportunities causes a population flow to the city. This influx of people then creates a self-reinforcing cycle, generating more demand for services.

In the case of developing countries, the pace of urbanization is rapid compared to their level of industrialization, resulting in irregular settlements. It has been pointed out that the phenomenon of "over-urbanization" occurs as the urban population swells more than the level of economic development can support. Thus, it is now recognized that poverty is an important driving factor in the growth of cities in developing countries. The types and severities of urban environmental problems differ depending on the development level of "hardware" (infrastructure such as mass transportation systems, water supply and sewerage systems, and waste treatment facilities) and "software" (such as legal systems and market economy mechanisms) for a given level of urban economic activity. With this over-urbanization phenomenon, urban environmental infrastructure is a cause of shortages, and poverty is an important factor preventing the formation of financial mechanisms that could facilitate urban environmental infrastructure improvements (Kidokoro 1998).

Nevertheless, since the 1980s, the economic growth of cities has been helped along by increases in foreign direct investment (FDI), as cities became connected to the global economy. Factors such as these are changing the patterns of urban growth. While such urban economic growth can be a factor that drives improvements in urban environmental infrastructure, it also encourages urban population growth. Moreover, this can intensify problems associated with both environment and environmental infrastructure. In following sub-sections, the issues related to urbanization, economic growth, environmental problems, and their inter-relationship are discussed.

2. Urbanization in Asia

In the year 2000, about 30% of the population in the Asia region lived in cities (World Bank, 2003). There are, however, major disparities in the pace of urbanization within the region. Figure 1 shows the growth of urbanization in Asia from 1960–1999. As can be seen, urbanization proceeded rapidly first in Japan followed by South Korea during the 1960s; over 79% of the populations of both countries now live in urban areas. In Southeast Asia, urbanization started at a slower rate but gained momentum

during the 1970s and 1980s. In Indonesia, for instance, the annual urbanization rate increased by an average of only 2.5% between 1960 and 1970, but by 5.1% from 1970 to 1980, 7.5 % from 1980 to 1990, and 10.3 % from 1990 to 2000. The urban population represented about 30% of the population in Malaysia and in the Philippines in 1960; it has been growing at 3% to 5% per year, and in 2000, the urban population was just under 60%. In Thailand, as well as in Indonesia, the urban population is around 30% and the urbanization pace is accelerating.

South Asian countries (Nepal, Bangladesh, Pakistan, India) have been experiencing only a gradual rise in their urban populations, but growth has been intensive in several major cities. Urban populations are rising around 3 to 5% per year since the 1960s.

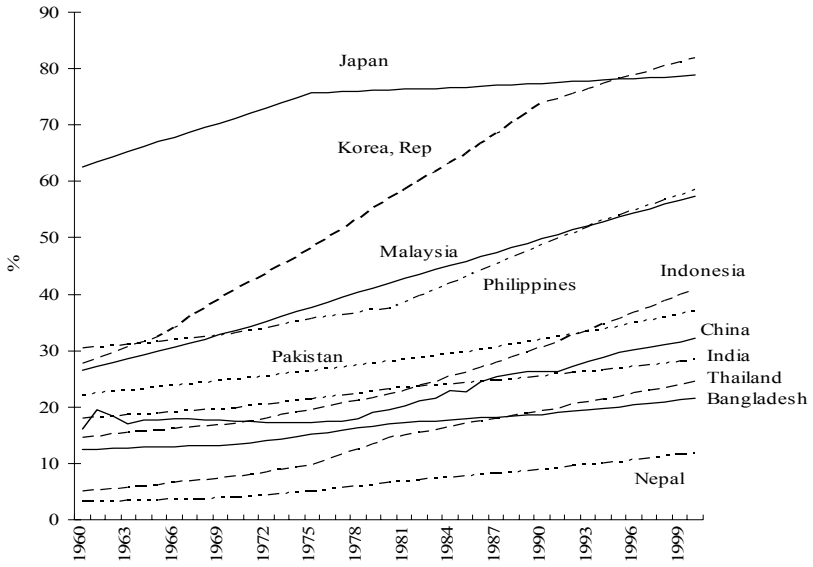

Figure 1. Urbanization trends in Asian countries (1960–2000)

Source: World Bank, 2003.

The speed of Asia's urbanization is without historical precedent. The urbanization of Europe in the 19th and 20th centuries occurred much more slowly. Moreover, while urbanization in developed countries has reached a stable state, the developing countries in Asia were the main global players in population growth and urbanization in the latter half of the 20th century. Since the 1970s, Asia has been engaged in a process of rapid economic growth through industrialization, with urban populations growing rapidly. Rapid urbanization in Asia has been synchronous with dramatic rates of economic growth as well as severe environmental problems.

Asia now has more major cities than any other region in the world. Table 1 shows the distribution of larger cities in Asia compared with the world total. China and India, the most highly populated countries, have the largest number of major cities.

Table 1. Population in Asian urban agglomerations of more than 3 and 5 million population, 1990

	More than 5 million		More than 3 million	
	Number of Cities	Population (millions)	Number of Cities	Population (millions)
China	4	36.11	8	50.91
India	4	37.27	7	49.17
Indonesia	1	9.42	2	12.42
Japan	2	31.01	2	31.01
Korea	1	11.33	2	16.08
Pakistan	1	7.67	2	11.75
Philippines	1	8.40	1	8.40
Thailand	1	7.16	1	7.16
Vietnam	-	-	1	3.17
Sub Total	15	148.37	27	190.08
Others	20	190.29	42	268.37
World Total	35	338.66	69	458.45

Source: World Bank 2003, UN-HABITAT 2001

Urbanization has been closely linked with the growth of manufacturing industry. Japan's rapid industrialization started in the 1960s. Twenty years later, South Korea initiated a range of policies aimed at accelerating industrialization. China's Open Door policy was initiated in the late 1970s. It was followed by increasing economic openness and export-led growth models in Malaysia, Philippines, Indonesia, India, and Thailand. Average annual rates of economic growth of 10 % and above were achieved and sustained by some of these countries.

2.1 Foreign direct investment and urbanization

The economic growth of Asian cities has been catalyzed by increases in FDI. The rising trend started at the beginning of the 1980s in Singapore and followed by other countries. This has been particularly pronounced in East and Southeast Asian countries (Singapore, Thailand, Indonesia, China, and Vietnam) but has also been evident in South Asia (India and Pakistan). The Asian currency crisis of 1997 produced only a short-term drop in FDI to most of these countries. Figure 2 shows the trends in FDI in major Asian countries.

This increase in FDI was a factor promoting economic growth in the regions stated, but a more important factor is the intimate linkage of the development of cities to the global economy. Douglass (1995), Yeung and Lo (1995) and Tasaka (1998) focus on the fact that FDI into East and Southeast Asia created a new international division of labour in this region, and that the cities in this region are developing a new spatially-organized structure that is functionally connected. In other words, they see the rapid economic growth of this region not simply as being achieved due to the higher investment levels, but also due to the functional urban network that is forming. These

are described by Douglass (1995) as "Pacific-Asia urban corridors" and their interconnectedness (Figure 3) is viewed as an additional driver of economic growth.

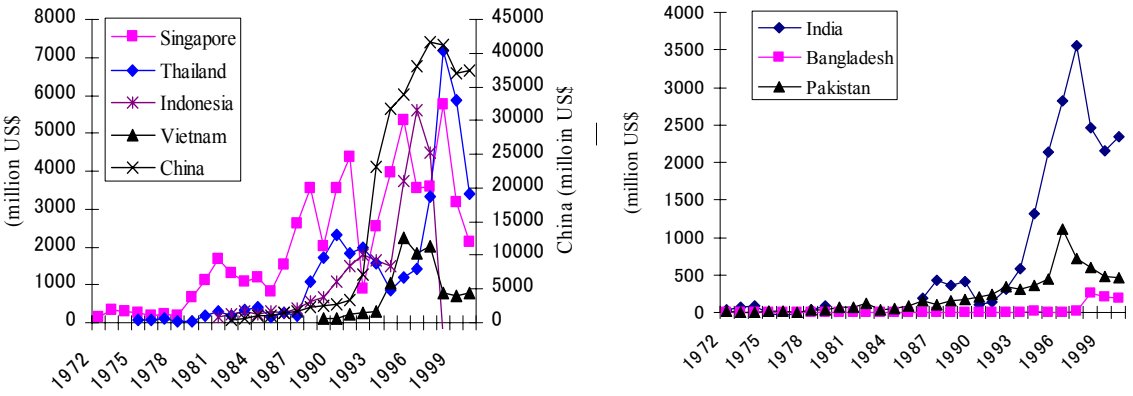

Figure 2. Net Foreign Direct Investment, 1970–2000

Source: World Bank 2003

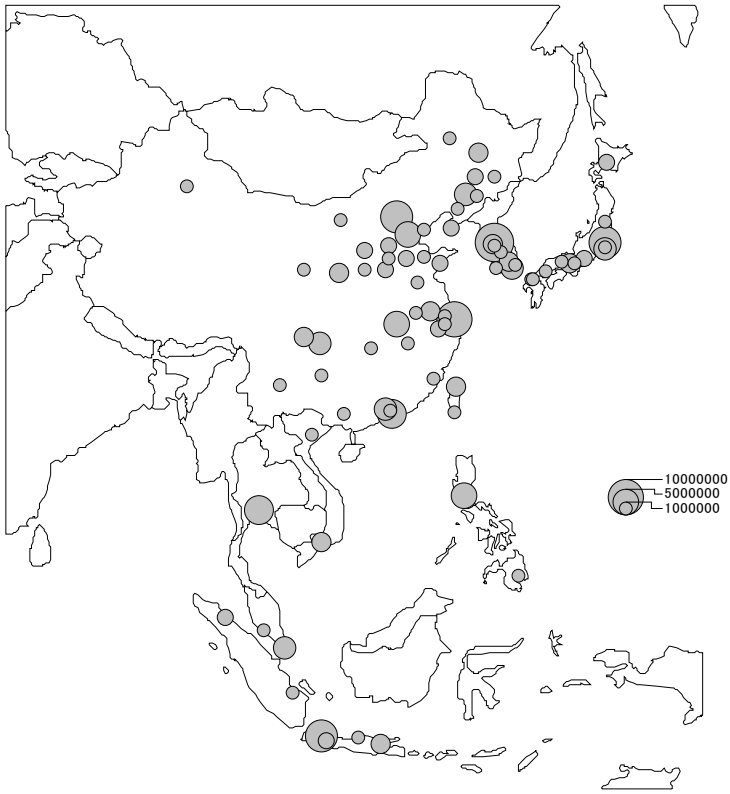

Figure 3. Major cities in Asia representing urban corridors

Source of population data: Brinkhoff (2005)

2.2 Urban poverty and informal housing

These rapid rates of urbanization and economic growth have also led to pernicious levels of urban poverty in many Asian cities. Rapid urbanization and the consequent growth of the informal sector in low-income areas are a main source, but not the only one, of informal housing[1], which can be classified as illegal housing, squatter housing, irregular housing, and slums. Irregular or informal settlements give shelter to the majority of urban poor. Figure 4 presents the share of informal housing in major Asian cities.

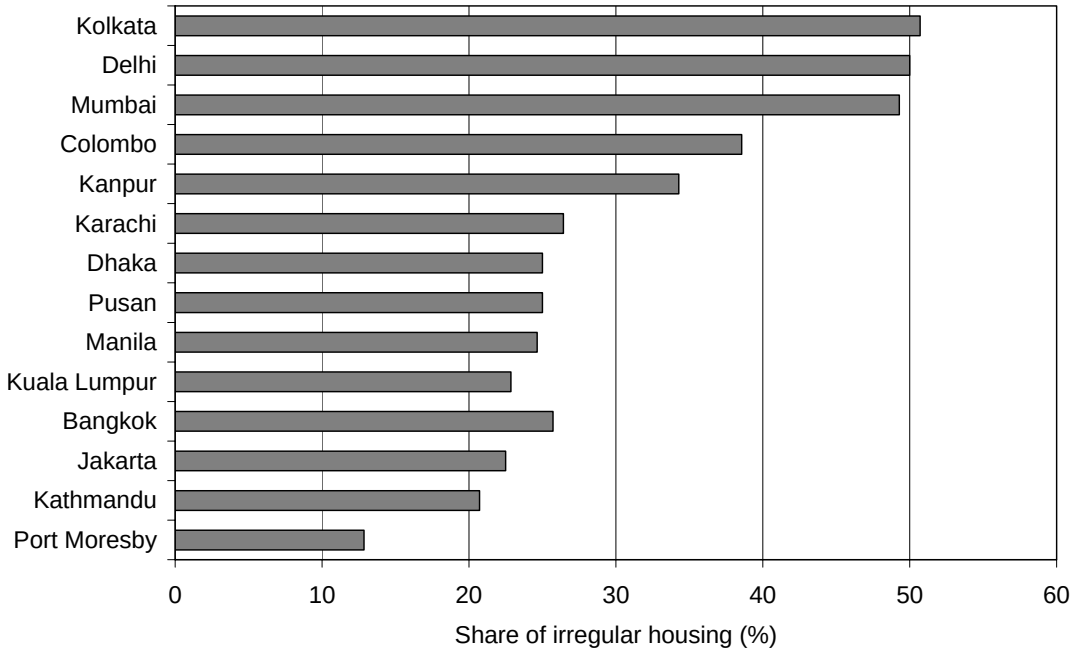

Figure 4. Share of informal housing in major Asian cities

Source: Ministry of Environment, Japan (MOE 1995)

Informal housing settlements are usually considered transitional areas. They are often located on the fringe of cities, on riversides, dumps or under bridges, without infrastructure or with low-quality infrastructure. The lack of control in these areas attracts poor people from inner city or rural migrants in search of work. However, irregular settlements are also found in cities that have already developed economically, as the Hong Kong's squatter areas (Smart 2001). Some illegal and irregular housing is produced by commercial developers or politically influential parties who speculate that property investments will be regularized later (World Bank 2003a).

[1] Housing is described as informal when it does not conform the laws and regulatory frameworks set up in the city in which it occurs (UN-HABITAT 2003)

2.3 Dynamics of urbanization

Yeung and Lo (1996) and Tasaka (1998) have shown that the dynamics of urbanization in East Asia and Southeast Asia started to change rapidly in the 1980s. Tasaka (1998) characterizes urbanization in developing countries as "urban involution", describing the characteristics of urbanization in developing countries by three terms: "concentrated urbanization" (urbanization occurs while the rural population level is higher than that in developed countries); "primate cities" (over-concentration of economic, political and cultural functions in primary cities); and "over-urbanization" (inflow of population beyond a level the city can productively absorb). Among the factors associated with over-urbanization are high levels of unemployment and employment insecurity; large-scale inadequacies of infrastructure such as mass transportation systems, water supply and sewerage systems, and waste treatment facilities; environmental pollution; severe stress on urban governance; and overall poverty levels that hamper the formation of financial mechanisms that could facilitate urban environmental infrastructure improvements (Kidokoro 1998). Designing market-based financing tools for urban centres with substantial levels of urban poverty is a challenge for policymakers in Asian countries and it will be discussed within the Section II.

It is important to bear in mind that besides the mechanisms for urban growth described here, that are other driving forces for the urbanization process in Asia, and they vary in different countries. Urbanization in Asia is not a uniform process.

The changes in the mechanisms of urban growth described above can be seen as imparting a huge impact on urban environmental issues. As the pace of urbanization accelerates, environmental problems may worsen due to inadequate urban environmental infrastructure. On the other hand, the promotion of economic growth could speed up the solutions to environmental problems. The direction of research about these relationships between economic growth and environmental problems will be further discussed below.

3. Economic growth and environmental problems

It is accepted that environmental degradation is inevitable in a growing economy, but it has also been observed that the rate of this degradation does not continue to rise indefinitely. The Environmental Kuznets Curve (EKC) hypothesis states that after continued economic growth and development, the incidence of environmental pollution levels off with GDP growth and then starts to fall. The Kuznets curve was named after Kuznets (1955) who hypothesized that income disparity widen as economies grow, but after a certain income level is reached, the income disparity narrows. The curve takes the form of an inverted U (Figure 5).

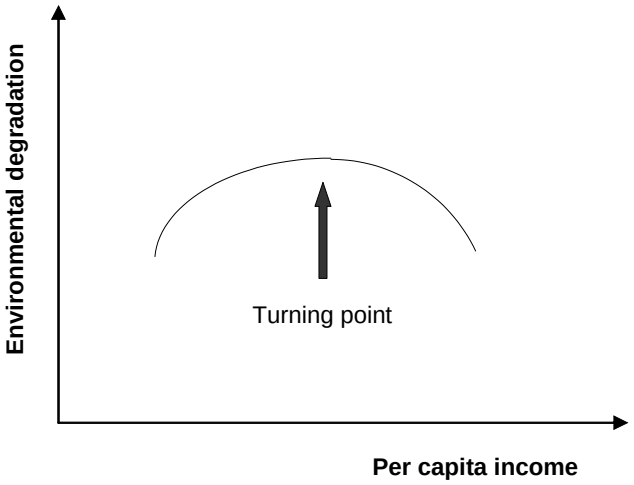

Figure 5. Environmental Kuznets Curve – an inverted U shaped relationship between environmental degradation and per capita income

Much has been discussed whether the EKC can be discerned when studying various pollutants. Research by Grossman and Krueger (1995) and Cole, Rayner and Bates (1997) are representatives of such work. They show the relationship between income per capita and various air pollutants. The results obtained by Cole, Rayner and Bates (1997) are shown in Table 2.

Table 2. Selected pollutants and income at turning point

Pollutant	1985 US$	
Sulphur dioxide	5,700 -	6,900
Sulphur dioxide (transport)	9,400 -	9,800
Suspended particulates	7,300 -	8,100
Suspended particulates (transport)	15,000 -	18,000
Carbon monoxide	9,900 -	10,100
Nitrogen oxide (industrial)	14,700 -	15,100
Nitrogen oxide (transport)	15,100 -	17,600
Municipal solid waste	monotonic increasing	

Source: Cole, Rayner, and Bates (1997)

Their analysis shows that if transportation is the source of a pollutant, the turning point is delayed. For example, in the case of sulphur dioxide, the turning point is generally between US$ 5,700 and US$ 6,900, but if transportation is the source, the turning point rises to between US$ 9,400 and US$ 9,800. Different turning points are identified for several pollutants. Although a turning point was found for several air and water pollutants, it was not for generation of household wastes. Municipal solid

waste has been generated in increasing rate representing a serious problem for developed societies and it deserves further attention (see Section II).

There has been some criticism about the analytical methods and interpretations regarding research on the EKC (Stern et al. 1996, Stern 1998, Stern and Common 2001). Stern et al. (1996) criticize the EKC hypothesis for implying that environmental policies are not necessary and that the environment will automatically improve along with economic growth. Stern (1998) asserts that polluting industries in developed countries simply moved overseas to developing countries that had weaker environmental regulations, because environmental regulations at home had become more stringent as the economy grew. Such corporate activity has been described by the Pollution Haven Hypothesis[2]. Along similar lines, Suri and Chapman (1988) point out that even without the trigger of environmental policies, imports of products from overseas increase as the economy grows, so domestic manufacturing industries competing with these imports move overseas in pursuit of cheaper labour, and the resulting decline of domestic manufacturing activity may lead to a reduction in domestic pollution.

In this respect, the focus of recent research is shifting away from trying to prove the existence and timing of a turning point, and to find the mechanisms that lead to improvement in pollution along with economic growth. Panayotou (1997) analyzes panel data on sulphur dioxide (SO_2) emissions from 30 developed and developing countries from 1982 to 1994. He demonstrates that if the economic level is the same, the environment will be worse the greater the GDP per square kilometre, the higher the share of industry in GDP, and the faster the pace of economic growth. He also considers the impacts of factors such as policies and institutional factors and he uses enforcement of contracts as the representative policy variable for the analysis, which revealed that the degree of quality of institutional arrangements not only makes the turning point occur at an earlier economic level, but also that it tends to suppress the level of pollution. This shows that if the government can use legislation to protect people's property rights from damage caused by pollution and introduce effective environmental regulations, for example, it is possible to mitigate the environmental deterioration associated with economic growth.

Torras and Boyce (1998) raise the issue that some people are forced to endure environmental deterioration, i.e. there is the problem of social inequality, and they investigate the relationship between social inequality and the EKC hypothesis. The targeted environmental indicators are sulphur dioxide, smoke, heavy particles, dissolved oxygen, faecal coliform, access to safe water, and access to sanitation. Besides income, they use descriptive variables such as the Gini Index[3], which shows income disparity, adult employment rate, political rights,[4] and urbanization rate. Some of the analytical results contradict the hypothesis, but generally, they support it.

[2] Pollution Haven Hypothesis refers to the possibility that industries that are highly pollution intensive i.e. dirty industries, have been migrating from developed to the developing economies with weaker environmental standards. On the other hand, the developing countries that are in need of financial resources for industrial development benefit from this migration and became net exporters in these sectors. Additionally, the multinational industries tend to diffuse their greener technlogy among interparts in the host country, which is stated by the Pollution Halo Hypothesis (Zarsky 1999).

[3] Gini Index measures the extent to which the distribution of income (or consumption) among individuals or households within a country deviates from a perfectly equal distribution. A value of 0 represents perfect equality, a value of 100 perfect inequality.

[4] For political rights, they rate it according a system developed by Finn (1996).

Regarding political rights, they show that for almost all items studied the level of environmental pollution is lower when the political rights are stronger. Concerning income inequality, the analysis shows that the environment (measured by SO_2 and smoke) deteriorates as the Gini Index increases (in other words, as income disparity widens). However, in the case of dissolved oxygen, it indicates that the environment improves as the income disparity widens.

Cole (2003) considers the relationship between trade and the EKC hypothesis in a study targeting several pollutants (sulphur dioxide, nitrous oxide, and carbon dioxide, and biological oxygen demand) in several countries. The analysis shows that the correlation between income and environmental indicators takes the shape of an inverted U. In addition, regarding the correlation with trade, it indicates higher emissions of sulphur dioxide as the degree of trade specialization increases, although those impacts are quite small. Regarding other environmental indicators, almost no impact from trade is evident.

Finally, some theoretical research has been conducted on EKC based on economic theory (Lopez 1994, McConnell 1997). Its hypothesis is that technological innovation and individual preferences relating to the environment are major factors that move an economy toward the turning point.

In this regard, Roca (2003) criticizes as too optimistic the view that higher environmental awareness alone will lead to a better environment. Roca points out that in the process of establishing environmental policy, differences of opinion emerge and a variety of interests collide, due to differences in stakeholder attitudes about environmental improvements. In short, when the interests of different stakeholders cannot be easily reconciled, solutions to environmental problems will be delayed even if individual environmental awareness is high. Thus, models that have no mechanisms to reconcile interests between economic entities are not practical.

Roca's point, stated in a different way, is that if institutional arrangements exist that enable reconciliation between the interests of stakeholders, it is possible to lower the economic development stage at which the turning point occurs. In order to consider this, it is necessary to investigate the ways in which the interests are reconciled, based on actual cases of success in environmental improvement.

In short, variety of factors influence when the peak is reached and how far and quickly the pollution declines as following: economic growth; sources of pollution; policies and regulations; political and social characteristics; and institutional arrangements. Understanding these factors and the relationships between them will help in deriving sustainable solutions to the impending environmental problems in the region, even while rapid growth continues.

Economic growth alone cannot improve environmental quality (Stern, Common, and Barbier 1996). Environmental quality is influenced by many factors, both direct and indirect. Panayotou (1997) demonstrated that with the profile of economic growth remains the same, level of pollution will be worse with greater GDP per square kilometre, higher share of industry in GDP, and faster pace of economic growth. With respect to the enforcement of contracts as a representative policy variable, he concluded that better-quality institutional arrangements not only made the turning point of the EKC occur earlier in economic development, but also tend to reduce the level of pollution. Environmental performance also depends on political rights and income inequalities (Torras and Boyce 1998). The level of environmental pollution is

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reported to be lower when political rights are stronger in a particular city. Torras and Boyce report that environmental quality (measured by sulphur dioxide and smoke) deteriorates as income disparities widen (as implied by an increased Gini Index).

In addition to the factors above, technological innovation and individual preferences are major determinants that move an economy toward the EKC turning point (Lopez 1994, McConnell 1997). However, when the interests of different stakeholders cannot be easily reconciled, solutions to environmental problems will be delayed even if individual environmental awareness is high (Roca 2003). Hence, if institutional arrangements exist that enables reconciliation among the interests of stakeholders, it is possible to bring forward the EKC turning point. Shifting from industrial production toward tertiary industries in major cities would also help to reach the EKC turning point earlier. Such trends have been noticed in a few cities though in many of them it is still in the initial stages.

Thus, by establishing necessary institutions, stronger political rights, sound environmental policies and legislation, and multi-stakeholder partnerships, and moving industry outside urban centres, it should be possible to control pollution in Asian cities even as rapid economic growth and urbanization continue. The section II looks at current issues and recent developments in urban environmental management.

4. Outlook

Changes in the urbanization mechanisms that have been observed since the late-1980s may accelerate the pace of urban economic growth. Nevertheless, research to date about the relationship between economic growth and environmental problems indicates that quality of institutional arrangements and social inequalities have a large impact on environmental improvements. This means that it is not only "hardware" such as urban environmental infrastructure that determines the extent of urban environmental problems, but also the maturity of "software" such as legal systems and mechanisms for income distribution. Research is likely to clarify these facts.

Another important challenge for the future is to find the best ways to reconcile different stakeholder interests. The roles of government and the private sector change significantly when Private Finance Initiatives (PFI) and other approaches are introduced to improve the urban environmental infrastructure, and private corporations take over the role of the provision of public goods—traditionally the role of government. In this regard, in the future, it will also be important to consider the ideal roles of government and the private sector relating to urban environmental management.

Note: Text written by Dr. Hiroaki Shirakawa and Dr. Sudhakar Yedla and edited by Dr. Mara Regina Mendes from the Urban Environmental Management Project of IGES.

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Section II – Issues and Challenges for Urban Environmental Management in Asia

1. Introduction

Asia has been experiencing very high population growth and urbanization as well as migration as discussed in previous section. Asian cities will witness a large population increase, which will have important implications for a variety of urban environmental issues, such as water supply and sanitation, waste and wastewater generation, urban infrastructures as well as mobility. This section presents an overview of major urban environmental problems faced by Asian cities, focusing on challenges and trends on water supply and sanitation, urban transportation, and waste management. These three sectors represent the main urban environmental problems, especially in the developing cities in Asia. The diversity of economic and social condition in Asian cities leads to different realities in these sectors, which are also discussed here.

2. Water supply and sanitation

Water supply and sanitation is historically considered as the most important urban environmental infrastructure, having serious environmental health and socioeconomic consequences. Most of the health concern was averted in Europe and North America by addressing this challenge (Leitmann 1999). In developing countries, as UN-HABITAT (2003) indicates, a considerable number of urban dwellers do not have 'improved' access to water supply and sanitation.

2.1 Issues and challenges in water supply and sanitation

Municipal water supplies are considered priority in urban infrastructure; however, municipal water supplies are still insufficient in several areas. Figure 1 shows the coverage and availability of water supplies in some of the major cities in Asia. In Pacific coastal cities of Korea and China, the coverage in 1997 was nearly 100% and water was available 24 hours a day. Southeast and South Asian cities still suffer from serious problem of inadequate infrastructure. For example, the coverage in Jakarta was only 27% and the availability was 18 hours a day. In addition, the coverage is 100% and 97%[1] in Mumbai and Chennai (India) respectively, but the water availability is only for 5 and 4 hours, respectively (McIntosh and Yniguez 1997). Sewage systems, when existent, were developed much later than water supply systems.

[1] There is the possibility that this figure does not include the slum area (Sattethwaite 2003).

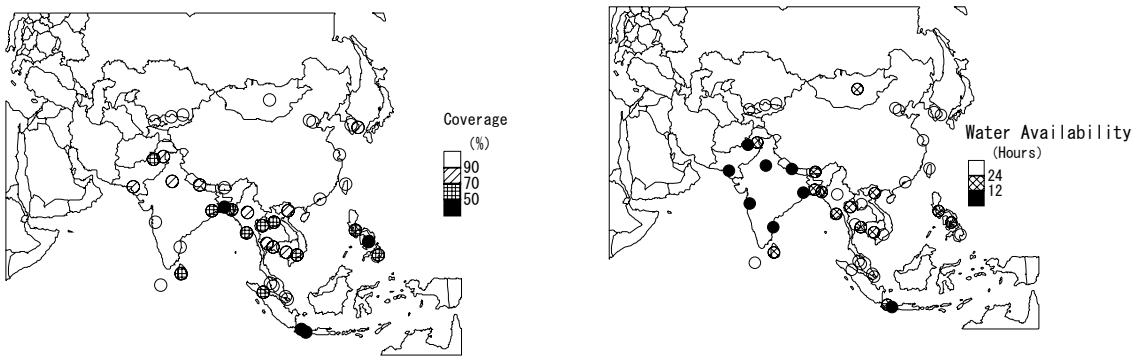

Figure 1. Coverage and water availability in Asian cities
Source: McIntosh and Yniguez (1997)

Realizing the severity of the problem, water and sanitation has been given high priority in the United Nations Millennium Development Goals (MGD)[2] and the goal to *halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation* was set. In order to realize this target, the water supply connectivity should be increased from the existing 93% to 96% and basic sanitation coverage from the existing 78% to 89%. Hence, 619 million people in cities should be connected with water supply and an additional 675 million people should be connected to sanitation until 2015. The major challenge for the cities is not only to build the new infrastructure but also to improve the situation of the existing water utilities, which are mainly relying on the heavy subsidies from the government. Operational and management inefficiency is also a problem in water supply systems in Asian cities and an immediate action is necessary to improve the overall situation. In short, Asian cities are experiencing major challenges in achieving these urban water supply and sanitation goals in the form of *lack of investment* and *poor governance*.

Most of the cities in this region suffer either lack of infrastructure or poor systemic efficiency in wastewater treatment. Sewerage system and wastewater treatment is still a big challenge even for the developed countries. In Japan, the coverage is about 60 % and the user charges only cover about 40 % of operational costs (Imura et al. 2003). In China, only 16% wastewater is being treated as the standards (Song 1997). Although countries like India and Thailand benefit from a high percentage of their wastewater being treated, the performance efficiency of these plants are very low. Other countries in this region viz. Indonesia (Bandung, 23%), Bangladesh (no record of wastewater treatment), Malaysia (Penang, 20%), and Pakistan (Karachi, 10%) suffers from serious lack of wastewater treatment (UN-HABITAT 2003)[3]. This number worsens if we look into the figures of the people without 'adequate'[4]

[2] Further information on the MDG can be found at http://www.developmentgoals.org/

[3] Information on wastewater treatment facilities and other water related indicators for major cities in the region can be found in UN-HABITAT (2003).

[4] There is an argument that most of the statistics for the provision of water supply and sanitation are provided by the government, which includes all the households connected with the facilities

provision of these services, as UN-HABITAT (2003) shows that 98 million and 297 million urban dwellers are without "improved" provision of water supply and sanitation respectively and this number is between 500-700 million and between 600-800 million for "inadequate" water supply and sanitation.

The wastewater management is a critical challenge, as it requires massive investments and efficient wastewater treatment plants. Due to disposal of untreated wastewater, most of the freshwater resources are being depleted further increasing the cost for supply potable water. Therefore, a huge investment is required, besides the policies for wastewater disposal and control of water pollution. The problem of inefficiency of the existing wastewater treatment plants also needs to be addressed. Unlike potable water supply, the willingness to pay for wastewater treatment is too low, requiring intensive awareness raising and regulations on industrial and commercial sectors.

Table 1 summarizes the issues in urban water supply and sanitation according the income level in the city.

Table 1. Water supply and sanitation issues according to the income level

Sector of problem area (per capita income)	Low (less than $2,000)	middle (2,000-14,999)	High (more than $15,000)
Water supply service	Low access by poor residents and informal neighborhoods	Generally reliable, but rising demand causing shortages in resource supply	Good supply but high total consumption; some concern with trace pollutants
Sanitation	low coverage of latrines and public toilets, poorly maintained; low sewerage coverage	More access to improved sanitation, but still large numbers of residents in large cities not covered especially in informal settlements; most wastewater discharge untreated	Full coverage; most wastewater treated

Source: Modified World Bank (2003)

2.2 Meeting the challenges: financing and management strategies

The conventional basis to finance and manage urban water infrastructure and services lies with the concept of public goods. Sagasti and Bezanson (2001) briefly traced the basic concept of public goods and indicated that the traditional concept has changed requiring a collective action by various actors. Nevertheless, in most of the countries, public sector is still responsible to provide these public goods. The share of government budget, for urban infrastructure and environmental services, is not

irrespective of weather they can get reliable and effective service. Hence, it is recommended that 'adequate' provision should include the reliability and effective services to achieve the environmental health targets, which are related with the provision of these services.

increasing in line with the increasing demand. The gap between supply and demand is widening with rapid urbanization and economic growth. To bridge this gap, the existing proportion of budget may be used more efficiently, and new financial mechanisms should be tested. To improve the situation of urban environmental infrastructure and services, local financial capacity should be strengthened. Most of the local and national governments lack the financial capacity to improve, or even maintain the infrastructure and services. Conventional and new financial mechanisms should be applied to improve the financial capacity. The conventional mechanisms include government budget and recovery of user charges while the new mechanisms include private sector participation, corporatization and commercialisation, municipal bonds, environmental fund, introduction of economic instruments, as well as Foreign Direct Investment (FDI). Other important measures being carried out in this region are *institutional strengthening* and *capacity building*, *autonomy to public sector departments*, and *direct cost-cutting measures*.

The conventional financing sources are mainly local and national governments. The governments provide financial support from their budgets as well as from direct user charges. The problems with conventional financing have emerged during the last decades, as the increased demand for the infrastructure and services require huge investments, the repair and maintenance of aged infrastructure requires substantial funding, the low efficiency requires more finance per each unit of the infrastructure and services; and there are very low user charges coupled with lower recovery rates (McIntosh and Yniguez 1997). All of these concerns need to be addressed to improve the coverage, quality, and efficiency of the infrastructure and services.

In order to use resources more efficiently, many cities in the region are undertaking various measures to reduce the cost of repair and maintenance, as well as to improve the efficiency of operations. One of the most common measure is contracting out repair and maintenance and in many cases operations also, to private sector.

User charges are an important issue for most of the urban environmental infrastructure and services. The level of user charges is quite low in relation with the cost-recovery targets. In many countries, the level of existing user charges is too low even to meet the operation costs alone. In Japan, revenue from user charges covers only about 40 % of the operation and maintenance costs of sewerage system (Imura et al. 2003). Furthermore, due to the socio-political barriers, the recovery of user charges is much lower than the estimated targets. There is a higher willingness to pay in comparison with the existing level of user charges, if quality and reliability of environmental services is improved (Altaf et al. 1997).

Improvements in conventional financial mechanisms may increase the financial capacity at a considerable level; however, to fill the gap between demand and supply new financial mechanisms are very important, as it is seen in many developed and in some developing countries. Possible financing sources could be generated through property rights, market creation, fiscal instruments, charge system, financial instruments, liability systems, performance bonds, and deposit-refund system (Panayotou 1998).

2.2.1 Private Sector Participation

In the region, private sector participation (PSP) is becoming an important issue. PSP include mega projects involving international private sector, small projects involving local private sector, and community-based projects involving community organizations.

There is a wide literature available on the various aspects of PSP, including pros and cons, types, mechanisms, and risk averting measures for PSP (ADB 2000, Plummer 2002, Budds and McGranahan 2003, and Akinotoye et al. 2003). The recent focus is on pro-poor PSP, as there are various risks involved for private sector, communities, and government to introduce PSP in urban environmental infrastructure and services (Hardoy and Schusterman 2000, and Satterthwaite 2003).

The experiences in the region show that PSP is becoming a major financing source after conventional government budgets; however, to achieve the underlying objectives of urban environmental infrastructure and services through PSP, some measures are vital. The role of actors should be clearly defined. Private sector and governments are the major actors to finalize the agreements; however, the communities or consumers should also be taken into confidence, through information dissemination and public hearing. This would also help to finalize the policies for risk mitigation, as there is variety of risks for each of the stakeholder. These risks could be broadly categorized as political, social, financial, economic, legal, managerial, technical, environmental, and physical (Kwak 2000).

There are some visible projects in the region, which can generate learning for improving PSP in future projects. In water and wastewater sector, Metro Manila in the Philippines, Johor Bahru in Malaysia, and Macau in China are mega projects widely described (ADB 2000 and Chang et al. 2004). Weihai in China is an example of local PSP while Karachi's Orangi Pilot Project in Pakistan is a community-based PSP in wastewater management (KIN 2004).

FDI has also been reported as a source of funds for constructing urban environmental infrastructure including water supply and wastewater treatment infrastructure. Gentry (1999) suggests that FDI is viewed as a desirable form of international private sector investment for achieving the targets of MDG; however, FDI investments on waste and wastewater sector are not following the same level of investments as in other sectors such as telecommunications sector. A reason this lower investment level might be related to the risks involved and the lower willingness to pay for the services (Memon et al. 2003). Government should play a more important role in regulating the sector towards decreasing risks as well as promoting awareness in order to attract FDI. The maximum share of FDI in selected Asian cities is as following: Johor Bahru, 30%, Metro Manila, 40%, and Macau, 85% (Memon et al. 2003).

3. Urban transport and air pollution management

Improvement in transport system promotes economic growth by increasing mobility and improving physical access to resources and markets. Roads are considered as the "veins of urban centres" and urban transportation is the critical link for the economic

development of any city. Asia as a region with promising and rapid economic growth is all set to witness one of the rapid and most surging growths in urbanization as well as urban transportation. Such trends have already been noticed in relatively more developed cities in Asia (World Bank 2004).

Over the last two decades, rapid population growth and spatial expansion has led to a sharp increase in demand for urban transport facilities and services in many cities in this region. However, several factors have hindered the adequate provision of services to match the ever-increasing demand. In many cities, densification and spatial expansion have occurred with little or no development planning, while in some cases the failure of the instruments of governance has resulted in a significant wastage of resources or substandard quality of infrastructure. Furthermore, the huge capital costs and time required to develop high capacity transit systems have prevented the timely implementation of such systems in rapidly growing urban areas (IGES 2003).

Solutions to urban transportation issues are, to great extent, linked with the city and transportation planning. However, unlike cities in Europe, Asian cities lack proper city planning and growth of urban centres has been haphazard. Hence, the transportation issues are addressed "as they come". In recent years, however, there has been growing recognition of the need to promote sustainability in planning improvements for transport systems and policies. Growing awareness about multiple dimensions to the impact of transport and the costs that it imposes – economic, social, and ecological supports the need for "sustainability".

3.1 Issues and challenges in urban transportation

Factors influencing urban transportation vary from country to country depending on the economic growth levels. Population growth and urbanization as well as inadequate infrastructure are considered as the major determinants of transportation problems in Asian urban hubs.

As pointed out previously, Asia has been experiencing very high population growth and urbanization as well as migration. This will have important implications for access to mobility, the organization of freight movements and, in particular, the role of interconnectivity among major urban areas as the centres of employment, production, and consumption. Infrastructure development is essential to enable better access to basic services for an increasing population.

Although proper infrastructure is essential, significant infrastructure investment gap in the developing Asian countries has been noticed, amounting to about half of the estimated total investment requirements in the transport sector. Such a gap would have to be filled through a combination of improved productivity and methods of financing. However, globalization, reduced investor confidence and the Asian financial crisis have had significant slowdown effects on investment levels and demand in this region (UN-ESCAP 1994). Increasing inter-regional and intraregional trade as a result of globalization lead to increased transportation activity in this region. This has again stimulated demand for infrastructure, creating new financing challenges. Currently with the recovery of economies, the gap is set to reduce and private sector and International financing agencies have a major role to play in further reducing this gap. However, with overall world trade increasing at around 10 % a year in volume terms, the implications for infrastructure and transport services are

significant, and it has become essential for Governments to find ways to finance new infrastructure, together with ways to increase the capacity of existing assets.

With above forces driving the change, Asia is confronted with variety of transportation problems and challenges. A few such challenges are growing motorization, financial burden on the public revenue, poor and inadequate public transport, severe traffic congestion, air pollution, lack of participation by stakeholders in the planning process, growth of vehicular stock, meeting the travel needs of the poor, institutional weakness and capacity-building (IGIDR 2001, AIT 2002, UN 2001).

3.1.1 Growing motorization, congestion and vehicular control

There has been a considerable increase of motorization in almost all countries in this region with a few exceptions in Central Asian cities (World Bank 2004). However, there are significant variations in the level and rate of motorization among cities, partly due to differences in income levels and government policy. The number of vehicles in Bangkok grew more than sevenfold between 1970 and 1990 where as in Beijing it was threefold increase between 1991 and 2000. Similar trends in growth occurred in Jakarta and Kuala Lumpur. Trends of rapid growth in motorization was observed in Indian cities since mid 90's following the introduction of economic reforms that lowered costs and increased the affordability of passenger cars (Ramanathan 2000). During this phase, Mumbai has registered an annual growth of motorized vehicles of about 10 % in recent years, while between 1995 and 2000, Delhi's total motor vehicle population grew from 2.4 to 3.3 million (Iyer 2001, IGIDR 2001).

Other indicators of increased motorization are vehicle density and cars per 1000 persons. The strong fleet growth compared with low road network growth has resulted in rising vehicle-densities in nearly all countries and thus reflects an increasing pressure on networks. The highest density can be found in Hong Kong, China, at 283 vehicles per road-kilometre. At the lower end, India shows a ratio of only four vehicles per road-kilometre (World Bank 2003b). Brunei, Australia, and Japan have the highest rates of cars per 1000 population, with about one private car per two persons. India, China, Myanmar, Nepal, and Bangladesh have the lowest motorization, with rates of less than five per thousand.

The exponential growth of motorized two- and three-wheelers is another visible trend in Asian cities. In many countries, such as Thailand, Malaysia, and Indonesia, two- and three-wheelers make up over half of all motor vehicles and the number is expected to grow very rapidly in China, Vietnam, India, and other low-income countries (AIT 2002).

Congestion is a common mark of motorization in most growing cities of the region. The central parts of many capitals, such as Bangkok, Delhi, Dhaka, Jakarta, Metro Manila, and Seoul, are particularly congested, with weekday peak-hour traffic speeds reported to average 10 km per hour or less. One estimate put the average travel time for work trips in Asia at 42 minutes. In large cities, this number can be much higher, as in the case of Bangkok, where the average is estimated to be about 60 minutes. The commuting time to work in some cities is as high as 90 minutes (UN-HABITAT 2001, World Bank 2004). Such high level of congestion gives away significant social

loss. A study on Bangkok estimated that the direct economic costs of congestion could be as high as 163 billion baht annually. A recent World Bank study estimated that a 10 % reduction in peak-hour trips in Bangkok would provide benefits of about US$ 400 million annually (UN 2001).

Controlling vehicular growth needs a two-sided approach. One is appropriate pricing and the other is demand side measures to control the growth and usage of vehicles. Due to imperfect systems of transport pricing, prices do not reflect the true cost of the provision of the transport services and facilities. This is very clearly observed in developing countries of this region like India, Philippines, and so on. This leads to insufficient funds to develop and maintain infrastructure, distortions in modal choice, and the generation of externalities (pollution and congestion).

3.1.2 Inadequate public transport services

Compared with private cars, public transportation is more sustainable on economic, financial, social, and environmental grounds. Public transportation provides the basic transportation for millions of poor and other disadvantaged people in this region. However, the inadequate and poor quality services extended by the public transportation system fails to meet the expectations and leads those people who can afford it to turn to private modes of transport. Another common problem in many cities is that women, people with disabilities, and other disadvantaged groups have poor access to public transport services and that it is found difficult to meet their basic mobility needs.

In Asia, few cities with higher economic power could establish a strong public transport system. Many cities such as Hong Kong, Singapore, and Tokyo, where the modal share of public transport is 70 % or more of total person trips, are deemed public-transportation oriented. In other cities like Bangkok, Jakarta, Manila, and Mumbai the modal share of public transport varies between 40 and 60 % of total person trips (AIT 2002).

Public transport is capital intensive and lack sufficient investment making it a difficult fact to the States. Private sector participation and partnerships are gaining importance in this sector. Another important aspect of public transport is “pricing”. Improper pricing policy can result in significant impacts on real estate value, essential commodities, cost of living and would influence the dynamics of slums in mega-cities.

3.1.3 Increased burden on the State

Providing road infrastructure to meet the growing traffic and vehicles is the responsibility of the state and the failure to charge users for various reasons make it much more difficult to the state to meet these huge investments involved. Consequently, transport infrastructure development has remained mainly the responsibility of the public sector, putting an enormous financial burden on national and urban local governments. Private sector investment has been very marginal even in mega-cities like Bangkok and Mumbai.

3.1.4 Air pollution

Transportation has been a significant contributor to air pollution and 70% of air pollution in Delhi was contributed by transport sector (Ramanathan 2000). In Bangkok, Beijing, Delhi, Dhaka, Karachi, Jakarta, Manila, Mumbai, Seoul, and Tehran, suspended particulate matter (SPM) exceeds the World Health Organization guidelines (World Bank 1997). With respect to the health problems, PM10 and PM2.5 are considered very important and transport sector is a major contributor of these pollutants. The conditions are no different with respect to the levels of other pollutants such as carbon monoxide, sulphur oxides, lead, and nitrogen dioxide. The existence of a large number of vehicles with poor emission control standards and the low quality of available fuel are the two primary reasons for this situation. In some cities, the prevalence of three-wheelers with two-stroke engines has further aggravated the situation. The World Bank has estimated the economy wide costs of air pollution in many Asian Cities and it was surprisingly high, almost matching 10% of the city income in some cases. In developed countries of the region such as Japan, the problem of NOx pollution is very explicit indicating the role of the transport sector in air pollution.

Figure 2 shows the average concentrations of air pollutants in 15 major Asian cities from 1990 to 1999. Suspended particulate matter (SPM) and PM10 are particularly serious problems. For example, SPM concentrations in Beijing (China), Calcutta (India), and Chongqing (China), are just under four times, and New Delhi just under five times, the World Health Organization (WHO) environmental standards (90 $\mu g/m^3$) .

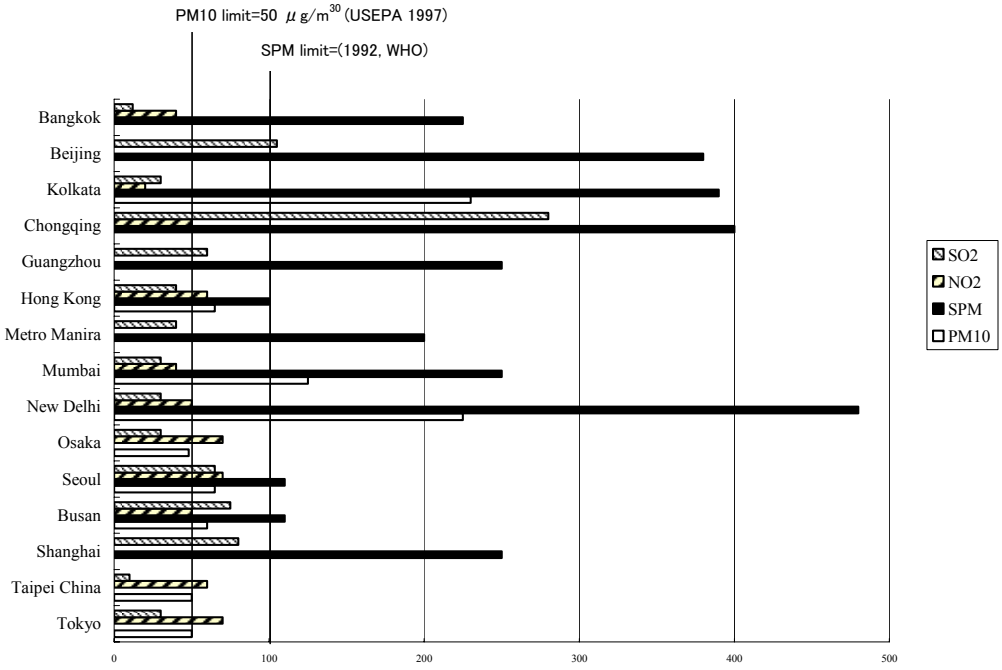

Figure 2. Average annual pollution concentrations, by city (1990-1999).

Source: *Reduce Vehicle Emissions in Asia* (ADB 2003)

Besides combustion and other uses of coal in factories and elsewhere, automobile emissions are also thought to be major causes of these high SPM and total suspended particulate (TSP) levels.

3.1.5 Other issues

Apart from the above direct issues, there exist few very important but indirect issues in transport sector. They belong to institutional aspects and participation of stakeholders. Two of such important issues are *institutional weakness and capacity building* and *lack of participation by stakeholders in the planning process*.

Urban local governments in most cities have serious capacity constraints on planning, developing, and managing efficient transport systems. In many cities, a common problem is fragmented responsibility for transportation among many agencies. This tends to encourage a sectoral approach to planning with plans being prepared with different financing and implementation arrangements and lack effective institutional mechanisms to examine their mutual compatibility or interrelationships. Because of this, urban transport development in many cities confronts serious difficulties, including delays in project implementation, wasteful investment, and so on. Lack of appropriate institutional arrangement to form partnerships with private sector is another major capacity limitation observed in the region. Few cities in the region are in the planning or initial phase of achieving betterment on these aspects of planning and capacity development.

Another common deficiency in the practices of urban transport development is that not all stakeholders are involved in the decision-making process. Although changes have started to take place slowly in some countries, large institutional mechanisms to ensure the participation of all social groups including women, the poor and other marginal groups are still non-existent.

3.2 Strategies and trends in urban transport development

In spite of the low economies, several Asian cities have taken up measures to improve their urban transport systems and initiated measures to integrate urban transport in development planning. The following sections examine some of the major issues in urban transportation.

3.2.1 Improvement in public transport and rail-based systems

With the increased awareness of the advantages of public transport, many cities in the regions have been actively considering to strengthen their public transport system through the improvement of existing services and the introduction of new services. Premium (air-conditioned) bus services are now available in a large number of cities in the region. Cities with relatively higher incomes such as Bangkok, Kuala Lumpur, Shanghai, and Shenzhen have introduced higher-quality buses on their roads. Low-income cities also have started higher quality buses, though on experimental basis.

Cities with more advanced forms of transportation such as Singapore and Hong Kong, China have successfully integrated their various public transport services provided by multiple operators, such as the underground and bus systems. Some low-income cities like Mumbai have successfully implemented metro rail transport system. Delhi has been planning to introduce a metro network system with a network of buses feeding to the newly developed metro rail system (IGIDR 2001).

Many cities in the region have developed rail-based systems and some others are in planning stage in response to the shortcomings of road-based transport systems to meet growing demand in very large cities. Bangkok (Thailand), Busan, Incheon and Seoul (Republic of Korea), Kolkata, Mumbai and Delhi (India), Kuala Lumpur (Malaysia), Beijing, Guangzhou, Shanghai, Shenzhen, Daegu, and Tianjin (China) have implemented projects or are undertaking major extensions for their existing systems, while cities such as Bangalore, Dhaka, Hyderabad, Karachi, and few cities in China are actively considering rail-based systems. Almost all cities having rail-based system are considering possible extension of the existing system to meet the growing demands.

3.2.2 Switching to cleaner fuels to improve air quality

Air quality in many Asian cities has deteriorated and transport sector has been the main culprit. Delhi, Bangkok, Manila, and other mega-cities have experienced tremendous air pollution resulting from vehicular traffic. The present levels of air pollution have prompted many cities to undertake measures to improve air quality. Most common measures across cities include the introduction of lead-free petrol and low-sulphur diesel; the introduction of vehicle emission control standards and a mandatory regular vehicle inspection system; the promotion of cleaner fuels like liquefied petroleum gas (LPG) and compressed natural gas (CNG) for commercial vehicles (Table 2); the banning and phasing out of certain types of vehicles; and restrictions on diesel vehicles.

In such efforts to control pollution, Delhi has banned the operation of all diesel-powered buses and trucks and ordered the conversion of entire bus fleet to compressed natural gas (CNG). At present in Delhi, all public transport vehicles including the feeder services run on CNG. Other mega-cities like Mumbai are following similar conversion programmes (Yedla 2004). India has successfully implemented lead-free gasoline programme all over the country. Few such similar efforts to control pollution from urban transport in different cities are – Bangkok is implementing an air quality management project; Manila has an anti-smoke-belching programme; Jakarta has introduced an inspection and maintenance programme for private cars; Delhi and Mumbai imposing restriction on entry of old vehicles into the city area, ban on older vehicles, mandatory inspection and maintenance programme and Dhaka has undertaken a programme to phase out two-stroke engine three-wheelers (UN 2001). Unleaded petrol is now available in most of the countries. Nevertheless, its market share that is not very high in few developing cities due to improper pricing is slowly gaining momentum.

Table 2. CNG buses in different cities around the world (2000)

City	Total buses	CNG buses	% of CNG buses
Los Angeles	2,638	795	30.1
New York	5,675	358	6.3
New Jersey	3,094	55	1.8
Toronto	1,500	125	8.3
Berlin	1,700	10	0.6
Paris	4,000	53	1.3
Rome	2,383	40	1.7
Madrid	1,000	15	1.5
Athens	1,500	40	2.7
Sydney	3,900	254	6.5
Brisbane	1,100	12	1.1
Melbourne	1,400	24	1.7
Shanghai	18,500	330	1.8
Beijing	10,000	1,640	16.4
Seoul	8,200	880	10.7
Delhi	12,000	6,175	51.5

Source: NGV Statistics (2002)

Most of the cities with air quality management programmes have identified priority areas for improvement. Most of the cities in Asia, Bangkok and Delhi for instance, have identified particulates as the main target for improvement of air quality, and are therefore concentrating on interventions to target diesel-powered buses and trucks, since they are the major sources of PM10.

3.2.3 Private sector participation and partnerships

The increased participation of the private sector in providing urban transport infrastructure and services is an encouraging feature of transport development in many Asian cities. Major toll roads and rail transit systems have been developed in Bangkok, Kuala Lumpur, and Manila with private sector participation. The private sector is also assuming a greater role in providing transport services. The number of standard (non-air conditioned) buses operated by private operators in Bangkok has increased during 1996-2001. The deregulation of bus fares has encouraged private operators in Dhaka to introduce a large number of buses. Because of a new franchising scheme in Pakistan, the private corporate sector has introduced large fleets of buses in Lahore and Rawalpindi/Islamabad (UN 2001). Partnerships among major actors like public and private, national and international governments in proving urban environmental infrastructure is on rise and gaining momentum in Asian Cities (Chang et al. 2001).

3.2.4 Applications of Intelligent Transport Systems technology

The application of Intelligent Transport Systems (ITS) technology is an important mark of transport development in cities with relatively advanced systems of transportation. The major application areas of ITS technology include electronic road pricing, traffic management, integrated ticketing systems for different public transport modes, and traveller information. Typical applications like en-route traffic information systems using Variable Message Sign, traffic surveillance and incidence management are quite common, especially for the management of expressways. Electronic Toll Collection (ETC) is in use in many developing countries such as China, Malaysia, Philippines, and Thailand. Hong Kong and Singapore have introduced more comprehensive electronic toll and parking fee management systems. The introduction of smart card integrated ticketing systems for public transport systems is another significant development, with the first large-scale smart card integrated ticketing system introduced in Hong Kong in 1997. The contact less cards offer a common ticketing system for more than 30 transit operators providing bus, ferry and rail services (Frost 2001). A similar system is currently used in Singapore.

3.2.5 Participatory approaches to integrated comprehensive urban transport planning

The faster growth experienced in Asian cities and the trends of urbanization and expansion of already over crowded mega-cities sends alarming signals to the city planners and urban transport departments. The conventional approach of handling environmental problems in sectoral basis needs to be replaced by a "metropolitan" approach (IGES 2003). Such integrated approach is necessary in urban transportation. Involving community in planning process provides a better scope for the successful implementation of projects. These principles have been guiding the implementation of a pilot project in the Rattanakosin area of Bangkok, which is being jointly implemented by UN-ESCAP and the Bangkok Metropolitan Administration in close collaboration with the Government of the Netherlands (UN 2001). In contrast to top-down approaches, integrated approaches are based on methodologies that develop a broad-based consensus on an achievable vision of the future and clearly articulate the means by which the visions can be realized.

3.2.6 Integration of local pollution control measures and GHG mitigation measures

Urban transport sector in Asia has been contributing substantially to greenhouse gas (GHG) emissions and an action to control it is necessary. However, it is difficult to consider GHG mitigation in urban transportation planning because the developing cities in Asia do not have any obligation to control their GHG emissions. In addition, the policy makers are more towards controlling local pollution resulting from transportation. However, GHG mitigation presents a "win-win" situation for local policy makers with better financing opportunities from overseas actors. Hence, with the possibility of FDI and Clean Development Mechanism (CDM) projects in urban transportation, which is capital intensive, it was found that Asian cities are working actively in integrating GHG mitigation strategies and local pollution control strategies

while devising their urban transportation strategies. It was found that such integration results in substantial co-benefits; for instance, TSP and SOx could decrease in different scenarios for CO_2 mitigation (Yedla et al. 2003).

4. Municipal solid waste management

4.1 Issues and challenges on MSW management in Asia

Population growth, urbanization, and economic development are main driving forces for municipal solid waste management (MSWM) issues in Asia. The high population growth and urbanization together with economic growth greatly accelerate consumption rates in Asian developing cities; it also accelerates the generation of waste, as well the changes in waste components. The amount of waste rises to levels that are difficult and costly to manage. However, poor and developing cities of the region still lack the proper management capacity to deal with the increasing volume of waste and its changing characteristics. On the other hand, waste management in economically developed Asian countries is overwhelmed due to overpopulation and economic affluence (Mendes and Imura 2004a).

The volume of waste disposed tends to rise along with economic growth, but the current situation in developing countries may be worse than what Japan experienced in the past. Figure 3 shows a comparison of the garbage volume and GDP-PPP per capita for Asian countries and major cities. In Japanese cities, the waste problem attracted attention as a social problem in the 1970s, and then infrastructure improvements were promoted. Recycling and waste reduction were strongly encouraged after the "oil shock" of 1973. Municipal solid waste daily generation in Japan in 1970 was about 830 grams per capita. In countries and regions including Thailand, Malaysia, Sri Lanka, Shanghai and Hanoi, the income levels are still lower than Japan's was in 1970, but their waste daily generation have already exceeded 800 grams per capita.

4.1.1 Institutional, managerial, and regulatory aspects

Institutional deficiencies, inadequate legal provisions, and resource constraints are among common problems for MSWM in Asian developing countries. Long- and short-term plans are lacking due to capital and human resource limitations and there is a need for financing instruments for MSWM, training specialists and capacity building (Ogawa 1996, IGES 2001, Zurbrugg 2002, Mendes and Imura 2004a). In some areas, such as the Indian sub-continent, planning and management are strongly affected by bureaucracy; however, there is a trend for decentralization, i.e., municipalities are expected to play a major role in the management of waste. In cases where laws and regulations exist to deal with MSWM in developing Asian countries, they are inadequate. National policies are now being formulated in several countries; however, lack of authority to enforce effectively environmental regulations is a major problem.

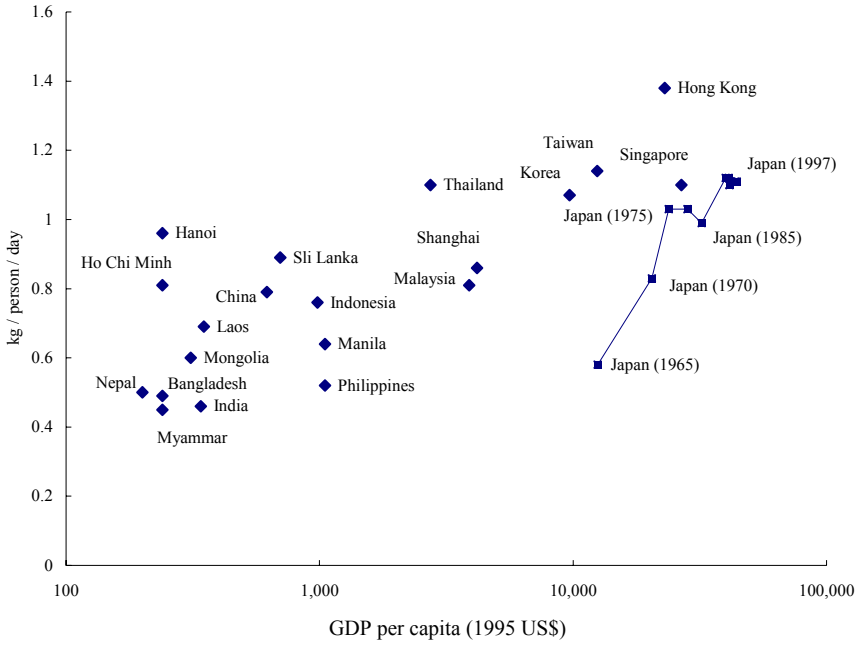

Figure 3. Waste Generation Rates for Selected Asian Cities

Source: World Bank (1999) and Nakagawa (2003)

In developed areas of the region, such as Japan, South Korea, Singapore, and Taiwan, the picture is different. Financial resources and skills are available, and plans are set up with short-, medium-, and long-term objectives. Although the waste is well managed, the large amount of waste as well as land scarcity poses challenges to waste managing authorities. The treatment usually consists of incineration of combustible waste and landfilling of inerts and residues from incineration. There are well-structured programs to monitor waste management operations, including leachate and gas emissions from landfill. Since the late 1990s, Japan, South Korea, Singapore, and Taiwan have been implementing policies for the promotion of recycling and more efficient use of resources in order to decrease the amount of waste for treatment.

Table 3 summarizes the conditions regarding urbanization, economic indicators, and waste management for cities at different per capita income level.

Low-income Asian cities, such as Dhaka, Kathmandu, and Phnom Penh, are challenged by urbanization and industrialization trends, increases in population, and consequent increases in waste. Poor government policy and response, lack of political will, lack of appropriate economic and human resources, technical inefficiency, and weak institutions at the local level, result in poor management of waste, especially in large cities. Another common problem is lack of transparency in budget use and corruption (personal communication). As a result, these cities face major problems related to public health and environmental pollution. Additionally, there is not enough experience and expertise on waste management.

Waste problem has been gradually recognized as an important issue in the policy arena of rapidly developing cities (middle-income cities). Despite the recognition of the importance of proper SWM, lack of funds, low capacity management, and

inefficient regulation enforcement together with the increasing amount of waste are barriers for a proper management (Mendes and Imura 2004a). Several national and local governments are structuring policies towards proper waste management, as in the Philippines and Indonesia; however, enforcement and monitoring has been deficient. Moreover, waste management plans, when existing, are somehow short-lived; their length depends on the political will and interests of the decision makers when there is a change on power.

Table 3. Overall MSW management issues in Asian cities by income level

	Low-income	**Middle-income**	**High-income**
PPP GNI per capita 2002	Less than 2,000	2,000-15,000	More than 15,000
Barriers	Poverty Financial constraints Poor management capacity	Urban growth Low management capacity	Excess of waste Varied waste composition Land scarcity
Waste characteristics	High bulk density High organic content	Evolving or changing characteristics (transition)	Low bulk density High plastic content
Waste management	Priority to collection and transportation	Gradual improvement of final disposal	Advanced treatment Appropriate and well monitored final disposal
MSW collection rate (%)	<70	80-95	95-100
Rate of expenditure in total budget (%)	15-40	5-25	1-5
MSW generation per capita (kg/p/d)	0.3-0.7	0.5-1.5	>1.0
Recycling	Informal	Formal + Informal	Formal
Examples	Dhaka, Kathmandu, Karachi, Phnom Penh	Beijing, Shanghai, Guangzhou, Bangkok, Kuala Lumpur, Manila	Tokyo, Taipei, Seoul, Hong Kong, Singapore, Macao

Note: a) GNI-PPP per capita is the gross national income in purchasing power parity.
Source: Mendes and Imura (2004a)

Although high-income Asian cities have the necessary skills and resources for SWM, it is a demanding activity due to the high amount of waste and lack of disposal sites. Developed cities across the region are highly populated, land prices are costly, and oppositionist reactions towards waste facility siting are strong ("Not In My Backyard" (NIMBY) syndrome) making the development of disposal sites difficult. In smaller cities, local governments involve the population in activities towards reuse and recycling of waste aiming at minimizing the amount of waste to be disposed. In larger cities, however, unsustainable lifestyles, characterized by high consumption patterns, busy lifestyles, and low incentives for reuse and recycling, have created a "throw-away" consumer culture, in which the amount of waste generated has increased in scale.

Table 4 presents a comparison of the institutional aspects of MSWM in Asian cities according their per capita income level. There is a clear distinction among the cities in several aspects of planning and management.

Table 4. Institutional aspects in Asian cities by their per capita income

	Low-income (< $2,000)	**Middle-income ($2,000 – 15,000)**	**High-income (> $15,000)**
Management capacity	Poor	Need of further capacity building and financing	Appropriate
Planning	Lack of planning	Short term plans	Medium and long term plans
Regulation	Lack of legal requirements (if any, poor enforcement and monitoring)	Some regulation on SWM and environment, but poor monitoring and enforcement	Well monitored and enforced legislation

4.1.2 Financial constraints and increasing expenditures

Financial constraints are one of the main barriers to proper SWM in less developed and developing Asian cities.

Particularly in low-income cities, there is a need for financing and improvements in management capacity. In these cities, despite MSWM services account for a high percentage of municipal budgets, the waste collection is inefficient. In some Asian cities, the expenses on MSWM can reach 40% of the municipal operating budget, and of this, 70-90% is spent on collection. For instance, Kathmandu spends 38% of the municipal budget in MSWM, while 93% of this is spent in sweeping, collection, transfer, and transport of the waste (Manandhar 2002). Financial options vary; in Phnom Penh, for instance, part of the collection service is performed by a private company, which directly issues the waste collection fee to households in their electricity bill. In Surabaya, the waste transport and disposal fee is collected together with the water bill in those households that are connected to water supply system.

Figure 4 shows the relationship between the per capita expenditure for municipal solid waste management and per capita income in Asian countries. It suggests that the increase in per capita income will accelerate the demand for both public and private services for MSW management. Larger expenditures will be necessary for collection services as well as construction and operation of treatment and disposal facilities (IGES 2001). Therefore, financing methods for the improvement of MSWM have become important for cities that have achieved a certain level of economic development.

4.1.3 Inadequate treatment and systemic inefficiency

There is a relationship between per capita income and status of the waste management. Municipal solid waste management tends to be more efficient in those cities with higher income as indicated in Figure 5, which presents the collection rate in selected Asian cities. It is worthy to point out that this corresponds to national average income; per capita income in the main cities tends to be higher than in remaining cities of the country. For instance, Shanghai's GRP is much higher than in other parts of China.

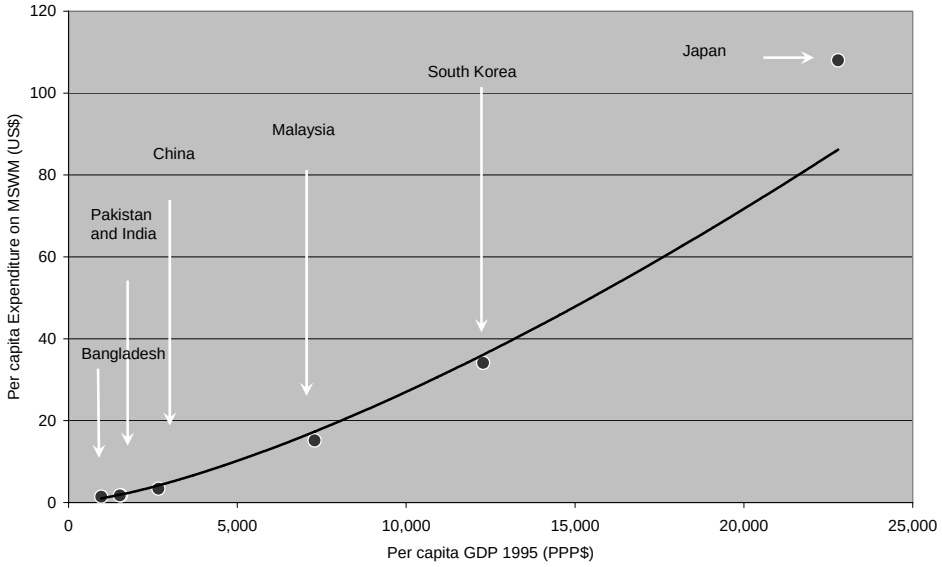

Figure 4. Relationship between expenditure on MSWM and PPP in Asian countries

Note: National data is used for the following countries: Japan, China and South Korea (1995). Data on selected cities is used for other countries: Kuala Lumpur, Malaysia (1994); Lahore, Pakistan (1985); Madras, India (1995) and Dhaka, Bangladesh (1995).
Source: IGES (2001)

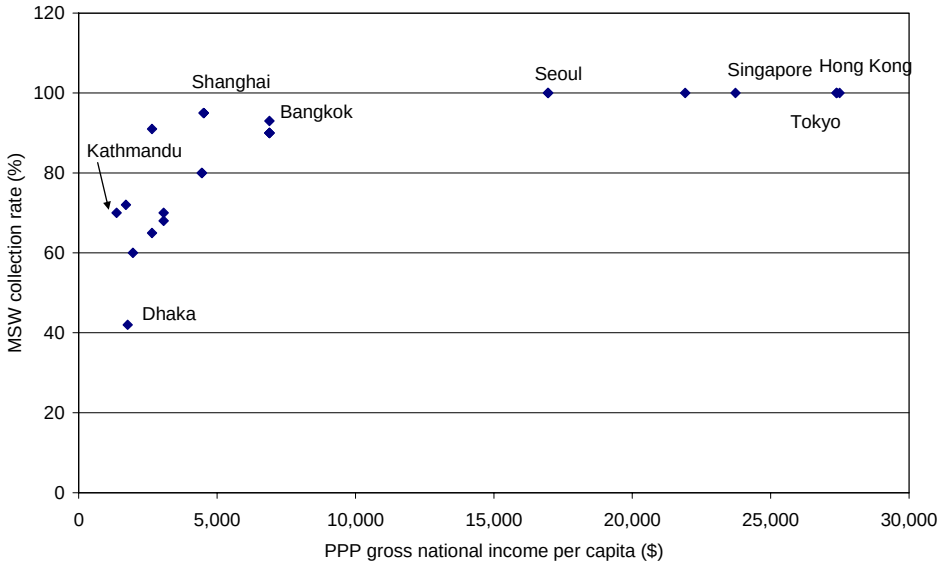

Figure 5. MSW collection rate vs. the national per capita income (PPP) for selected Asian cities

Source: IGES (2002) and Mendes (2005)

Inefficient waste management is common in several low-income cities. Reasons for this include lack of management capacity and economic resources as discussed previously. In these cities, waste collection can be very inefficient, i.e. with a low collection rate. For instance, Dhaka, a city of 10 million inhabitants, has a collection system with no more than 40% efficiency. Furthermore, the collected waste is not properly disposed.

Waste treatment is still missing or inadequate in most of the Asian cities. Open dump is still a main form of waste disposal in most less developed and developing cities; however, sanitary landfill is increasingly being adopted in cities in economic transition. Inadequate waste disposal leads to various health-related, environmental, and social impacts, such as spread of diseases, water and soil contamination, toxic and greenhouse gas emissions, loss of economic value of properties, and so on. Incineration is common in more developed areas such as Singapore as well as Taiwan, Japan and South Korea. Table 5 summarizes the current waste treatment and recycling options adopted in Asian cities at different income level.

Table 5. Technologies on SWM in Asian cities

	Low-income	**Middle-income**	**High-income**
Current status	Low technology, low costs	Intermediate situation, tendency to adopt higher cost technology	High technology
Waste treatment technology	Open dumps Community based or yard composting	Open dumps Composting Semi-engineered landfill Sanitary landfill Incineration	Mainly incineration Offshore landfilling Gas extraction from old landfill Electric home composter Ash treatment
Recycling	Low technology Low costs Collection by informal sector		High technology High costs Collection by formal sector, mainly municipalities

4.2 Meeting the challenges in waste management

As described previously, developed and developing cities are facing different sets of issues in MSW management. The major new trends of MSWM in developing cities are improved community participation and private-sector involvement in service provision. Trends in developed cities are toward strategies to realize a “sound material-cycle society”.

4.2.1 Private sector participation

As financing is one of the major constraints in MSW management, along with lack of efficiency, appropriate partnerships between the public and private sectors is potentially one of the most viable solutions, bringing in new resources and business know-how. Efforts are being made to introduce such partnerships in several Asian cities.

In East and Southeast Asian countries, the private sector is playing an increasing role in construction and operation of MSW-disposal facilities under lease and concession contracts. MSW-related business in Malaysia, including construction and operation of waste collection and disposal facilities, has been transferred to several private companies under concession contracts. Similar contracts have been tendered to private companies for construction and operation of MSW-disposal facilities, such as landfill and incineration plants, in the Philippines, Thailand, Hong Kong, Macao, and Singapore. However, the requirements for advanced technology and emissions control in such projects tend to be stricter than for those operated by local governments (IGES 2001). For this reason, the role of the private sector is mainly limited to collection and transfer of waste (Table 6).

Table 6. PSP examples in MSW management in selected Asian cities

Municipality	Private Sector Role
Bangkok[1)]	Transfer and disposal
Bhopal[2)]	Composting (20% of waste, 120ton/day)
Chiang Mai[1)]	Collection of waste
Kathmandu[2)]	Pilot project on privatization of the collection and transfer
Lampang[1)]	Collection and disposal of waste
Macao[3)]	
Pattaya[1)]	Collection and transfer of waste
Phnom Penh[3)]	Collection in central area
Phuket [1)]	Collection of 50% of waste, incinerator operation and fee collection
Ulaanbaatar[2)]	Collection and transfer
Yangon[2)]	Collection

Sources: 1) World Bank 2003a; 2) IGES 2002; 3) Memon et al. 2004

Two more examples demonstrate how much the success of private-sector participation in MSW management waste depends on context. Since 1994, the Municipality of Phnom Penh has entrusted its waste-management services to private contractors with franchise agreements allowing them a monopoly. However, the service provider has changed six times, mainly due to financial constraints (JICA 2003). Macao, with less than half a million population, has effectively involved the private sector in MSW collection and disposal. Since 1992, the collection and transportation of MSW and incineration have been contracted out to two private companies. This has improved both systemic and financial efficiency (UN 2003).

Another initiative receiving considerable attention is waste composting in Dhaka, Bangladesh. Waste Concern, a research-based NGO, started an initiative to promote

community-based efforts for primary collection of waste, as well as to encourage composting to reduce final waste disposal quantities. By developing a partnership with a private fertilizer company, they have managed to market successfully their compost, which is a key to the success of any composting project (Zurbrugg et al. 2002).

Although most of the initiatives described here have been relatively successful, they have faced many bottlenecks in their implementation. Moreover, such measures are situation specific and need to be devised on a case-by-case basis. For the most part, the public sector is likely to continue playing the dominant role in MSW management.

4.2.2 Promoting public awareness and participation

Municipal solid waste management is a complex activity due to its direct relation with people's behaviour. Therefore, environmental awareness and public participation are key factors in identifying long-term solutions for this problem. Management of solid waste in both developing cities and developed cities cannot be considered isolated; it has to be analyzed in the context of other issues, such as urbanisation level, stage of economic development, and educational level of the population (Mendes 2004).

In less developed cities, where sanitation is poor, waste problems emerge; for these cases, it is necessary to build awareness of hygienic and sanitary conditions. In rapidly industrialising cities, rapid urbanisation and a constant change in consumption patterns and social behaviour cause massive waste generation beyond the management capability of the local governments. Many local municipalities with their limited human, technical, financial, and institutional capability demonstrate low capacity to cope with the multi-dimensional problems of solid waste management. This leads to inadequate sanitary conditions in communities, creating a need for the involvement of other institutions, the private sector, NGOs, and residents to deal with these problems effectively and efficiently. In developing Asian countries, NGOs could play a more effective role in the improvement of solid waste management if they were given more recognition by the municipal authorities or if they were involved in the decision-making. Community participation in waste management is vital for improvement. Traditionally, decision-making has been top-down, with little or no input from local communities. However, a grass-root movement has started in places where the municipal authority does not carry out primary collection; in these areas, residents have created community organizations to collect waste (Mendes and Imura 2004a). Community-based waste collection has been adopted in several localities, for instance, Bangladesh (Dhaka), India (Bangalore, Madras, Mumbai), Indonesia (Jakarta), Sri Lanka (Colombo), Pakistan (Karachi), Nepal (Patan, Kathmandu), and the Philippines (Manila, Cebu, Quezon). The Philippines is among the countries that adopt a bottom-up approach towards environmental issues, including waste management; NGOs are active in the decision-making process of the local government. Increasing public participation at the collection stage is crucial to improve waste management. In Asia, there is a general trend towards raising public awareness and increasing participation, though significant public participation is still far from a reality.

Developed cities faced problems similar to those of developing cities in the past, and their population possess the experiences of coping with environmental issues,

including waste management. However, since the municipal authorities have now the necessary skills and resources to manage MSW, the management approach is centralized, and NGOs are not directly involved in the management of waste. In Japan, for instance, NGOs restrain their activities to awareness-raising and recycling activities (Mendes and Imura 2004a).

As an example of raising public participation, there is the case of Nonthaburi City, Thailand. The government of Nonthaburi City on the outskirts of Bangkok launched a pilot project under the Kitakyushu Initiative,[5] to reduce final waste by increasing the level of recycling through public participation. Through active dialogue with the public; distribution of information materials to every household about recycling through source segregation; and providing plastic bags and bins for recyclable material to every household, a 20-% reduction was achieved in the waste that needs to be disposed (UN 2003). Some similar efforts that have been documented include one by Waste Concern in Dhaka (Enayetullah and Sinha 1999), Stree Mukhthi Sanghatan, and Exnora in Mumbai, India (Yedla and Kansal 2003).[6]

The incentives for public participation in MSW management include improvement of the sanitary and environmental conditions, transparency of the decision-making process, and opportunities to provide input on decisions that affect the communities. Municipalities that implemented recycling programs report that the return of the revenue from selling recycled items to the community is one of the major incentives for participation in source separation. Table 7 shows an analytical framework for public participation in MSW management.

Table 7. Analytical framework for public participation in solid waste management

Driving forces	Forms	Approaches	Activities
Political will, governance, institutions: decentralization and regulation, economy and market, public pressure	Community participation, NGO and NPO involvement, participation of business owners, and other stakeholders	Grass-root (bottom-up) or top-down	Awareness campaign, source separation and recycling, cost sharing for waste treatment and disposal, site selection for waste treatment and disposal, decision on type of waste treatment

Source: Mendes (2004)

[5] More information on different cases of private sector participation in the countries listed can be found on the Kitakyushu Initiative home page: http://www.iges.or.jp/kitakyushu. The Kitakyushu Initiative was adopted during the Third Ministerial Conference on Environmental and Development held in Kitakyushu, Japan, in 2000.

[6] Most of these efforts are local in nature and carried out by NGOs and community-based organizations. However, the role of the state in such efforts is not inconsiderable. More information on such "best practices" can be found at http://www.iges.or.jp/kitakyushu.

4.2.3 Efforts towards achieving sound material- cycle society

In developed cities, the need has been felt for waste minimization and resource recovery in order to cope with the increasing volume and variety of waste, increased difficulty of processing, and shortage of landfill space. In several places, the 3 Rs – Reduce, Reuse, and Recycle – approach are being adopted (Mendes and Imura 2004a); better use of natural resources has been incorporated into national policy agendas with the intention of moving toward a "sound material-cycle society" or "cycling economy" (Figure 6).

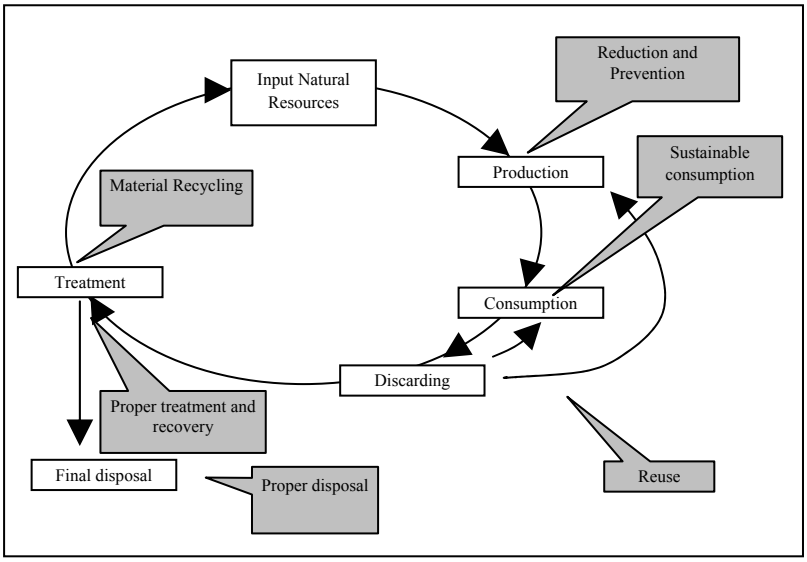

Figure 6. Concept of a sound material-cycle

Source: Modified MOE (2003)

The sound material cycle is an extension of the traditional waste management line both backwards, including the stages before the resource became waste (that is, consumption, production, natural resource extraction); and forwards, through recycling. A sound material-cycle society is characterized by the cycling of resources, by a lower input of natural resources, smarter design of products, more efficient manufacturing, and more sustainable consumption, as well as reuse, recycling, and proper treatment of materials that cannot be further utilized. Strategies towards a sound material-cycle society affect all stages of the life-cycle of a product, influence several industrial segments, and involve several actors, including governments, the private business sector, development organizations, media, public groups, and individual consumers (MOE 2003).

Since the late 1990s, Japan, South Korea, Singapore, and Taiwan have been implementing policies for the promotion of recycling and more efficient use of resources. Japan enacted the Law for the Promotion of the Recycling Oriented Society in 2000 (MOE 2003), renamed as Promotion of the Sound Material Cycle Society in 2003. In South Korea, the Act relating to Promotion of Resources Saving

and Reutilization was revised in 1999 with stronger fines and regulations (Seoul Metropolitan Government 2000). Singapore and other developed regions in Asia are following the same trend by launching specific policies promoting waste minimization and recycling. China, as well, has developed an ambitious development plan with the objective of attaining an overall well-off (*sha kong*) society involving the concept of a circular economy by the year 2020 (Cleaner Production China 2004, China Council for International Cooperation on Environment and Development 2004). However, these visions are still a long way from the reality, and developed cities continue to be confronted with very high waste-generation rates.

Specifically in Japan, the promotion of the sound material-cycle society has been involving policy actions towards (1) changes in lifestyle, (2) reduction of waste, and (3) changes on business activities. In order to achieve that, the Japanese Government is carrying out public-opinion surveys, has set targets on the amount of household and industrial waste disposal, and has been promoting green purchasing and environmental business management. Targets related to the material flow indicators, such as Resource Productivity, Cyclical Use Rate, and Final Disposal Amount, were set. Moreover, efforts are being done in order to promote the expansion of the discharging person's responsibility and extended producer responsibility (EPR); prevent illegal dumping; and utilize economic instruments to encourage self-management (MOE 2003). The manufacturing sector is being encouraged to promote changes in the production system such as promotion of industrial symbiosis, Design for Environment (DfE), and reverse manufacturing. Local governments are expected to enforce laws and regulations in order to adjust the flow of materials at urban level and to have a sound waste management. They are also expected to promote changes in lifestyle among residents and to play the role of coordinator among various entities, such as communities, non-governmental organizations (NGOs), and business and private organizations (MOE 2003). Local governments will play an important role in order to reach the targets on reduction of household waste generation.

At urban level, measures for a sustainable cycle of resources should focus on raising awareness and promoting sustainable patterns of consumption and waste minimisation strategies. Sustainable consumption and changes in lifestyle are a broad topic involving several fields of study and this report does not attempt to discuss them.

On the other hand, strategies for waste minimisation (EEA 2002, OECD 2002) are the main strategies for promoting the Sound Material-cycle and are expected to give a new realm to the field of MSW management. There is not a strict definition for waste minimisation; the Organisation for Economic Cooperation and Development (OECD) working definition includes various concepts**.**

Measures for waste minimisation can be categorized under the following classification: producer responsibility, voluntary agreements, legislative requirements, information programs (awareness campaign, dissemination of activities, promotion of waste minimisation clubs), and economic instruments, such as waste taxes and fees (OECD 2002). These measures are being carried out in developed cities and in high-income developing cities; however, their effectiveness is still limited. In less developed communities, the major potential for waste minimisation are the reuse of products, source separation of organic waste, composting, and improvement of conditions for waste pickers. Other examples of measures for waste minimisation are the awareness campaigns and the activities towards creation of cooperatives for waste pickers in several developing cities in Latin America and Asia. Some of these

measures can entail significant economic costs as pointed out by Braathen (2004); he discusses the economic impacts of some waste policy instruments such as 'pay as you throw' schemes, take-back and EPR schemes, DfE, and taxes on final disposal.

4.3 Outlook

Despite the challenges for managing the huge amounts of waste generated in Asia, as described in here, there is a trend towards a more sustainable approach – the so-called sound material-cycle society. This approach is extending from Japanese cities to other developed Asian cities. Therefore, there is a need to develop local strategies so these cities can advance from current unsanitary conditions to a "cycle economy". It is expected that developing and poor cities in the region will learn from the experience of developed cities and somehow benefit from later development, not facing such strong polluting stages in their waste management evolution.

The choice of processes and technologies for waste management are important, but not enough so ensure the sustainability of the system. Other aspects such as legislation, political will, partnerships, and public participation play a fundamental role. International cooperation related to urban environmental issues among cities will be a way to transfer the experiences of mature cities to developing cities. In Asia, such initiatives towards improvement of the urban environment have already started. From the experience from developed countries, there is an indication that legislation and institutional arrangements would be necessary to achieve higher levels of waste reduction and recycling.

Finally, it is important to emphasize that developing cities in Asia should observe the example of developed cities, and find and establish their own appropriate approaches for MSWM, taking into account their local and unique conditions.

5. Concluding remarks

As has been discussed in this section, cities in Asia are starting to take the initiative to improve environmental quality. Alongside sector-specific changes, there are some more general trends as following:

- promotion of public awareness and participation in environmental planning and provision of environmental services;
- relocation of heavy manufacturing industry out of cities;
- support to private-sector participation in civic and environmental services to increase investment and efficiency;
- multi-stakeholder partnerships;
- introduction of innovative finance mechanisms;
- improvement of environmental governance and environmental management capacity at different levels; and

- South-South cooperation for better exchange of information and cooperation.

Although these trends are often only in the initial stages of testing and are sometimes facing implementation bottlenecks, there is evidence to show that Asian cities are learning from one another, with increasing frequency. Continuous and persistent efforts in these directions are essential to achieve better environmental management and services.

According to the literature on the EKC discussed in Section I, these are the kinds of trends that should be able induce an earlier turning point, allowing economic development to continue and at the same time reducing the environmental cost. As already observed, the development of Asia's cities is unpredictable and diverse. The fate of environmental quality and services in Asia will depend on sound judgment and realistic measures. Most likely the key challenges currently facing Asian cities are to find how best to devise and execute multi-stakeholder partnerships with appropriate role and risk sharing; and how to find the ideal balance between provision of public goods and user charges in light of the ever-increasing populations of urban poor with high levels of insecurity in their lives. Urban environmental management strategies in this region needs to be focused not just on improving basic services but also on how to make those services reach the urban poor.

Note: Text written by Dr. Mara Regina Mendes, Dr. Mushtaq Ahmed Memon, and Dr. Sudhakar Yedla from the Urban Environmental Management Project of IGES.

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Section III – Case studies

1. Introduction

This section introduces two specific studies on urban environmental issues. The first part introduces the methodology of environmental management assets and its application to Kitakyushu City, Japan. Kitakyushu was chosen for this study because it witnessed earlier the transformations other Asian developing cities are facing currently: economic growth along with environmental degradation, which is being now followed by environmental revitalization. It is described in here how Kitakyushu City developed its assets on air quality, water and sanitation, and solid waste management and therefore overcome pollution.

The second is on energy consumption and greenhouse gas (GHG) emissions in selected East Asian mega-cities, viz. Tokyo, Seoul, Beijing, and Shanghai. The importance of studying urban environmental issues in mega-cities lies in the fact that the problems they are facing now could affect or are already affecting smaller cities. At present, reducing GHG emission is not a priority issue at local level in Asian cities. However, a better understanding of the structure and nature of GHG emission in cities are necessary in order to find the potential ways to integrate GHG consideration into local environmental management, especially in decisions that affect cities for decades to come.

In short, the first study focus on current issues in local environmental urban management: air quality, water and sanitation, and solid waste management, while the second addresses energy consumption and GHG emission, issues which are expected to grow in importance at local level in coming years. The first study looks mainly at problems that affect mostly the local and regional environment, the second, the global environment.

2. Evaluation of capacity of environmental management – Lessons from Kitakyushu

Environmental capacity means the ability of individuals and societies to respond effectively to environmental problems (OECD 1995). As a way to evaluate the environmental capacity of a city, the Urban Environmental Management Capacity Assessment system was developed (Kono et al. 2004). This assessment involves an inventory (qualitative, quantitative, or both) of the assets. It is recognized that while asset maintenance is important for creation of a sustainable society (Ekins 2003), the poor maintenance of institutions would reduce the assets. Comparing the "environmental management capacity assets" of different cities, for instance in the North and South, or with good environmental capacity and poor capacity, could give some indication of which aspects of environmental management could be improved although they are city dependent.

An inventory of the environmental management capacity assets was developed for Kitakyushu City in order to have this city as a model of environmental revitalization to other cities in Asia (IGES 2004).

2.1 Environmental Management Asset Approach

Initially the term "environmental assets" was related to the concept of natural environmental assets (or natural capital), such as clean air, clean water, forests, and so on, which provide environmental services to the population. Efforts have been made to systematically develop an inventory of these natural environmental assets and to conduct what is called "environmental resource accounting" as an attempt to evaluate the economic value of each asset (United Nations 1993, 2000, 2003). The concept of environmental assets was broadened and applied to urban areas. For cities, it is necessary to consider not only the natural assets, but also the human-made (artificial) assets such as parks, sewage systems, waste treatment facilities, as well as those assets without a physical form. These assets without a physical form, such as policies and measures, laws, governmental institutions, partnerships, and other elements of the urban environmental management, are designated as “environmental management capacity” assets. In short, the environmental assets can be broadly classified as physical (both natural and man-made) and non-physical assets or “environmental management capacity” assets.

The Urban Environmental Management Capacity Assessment broadened the idea of environmental accounting systems by considering the growth of environmental management capacity and analyzing the gaps of accumulation of environmental assets between developed and developing countries (Kono and Imura 2004, Kono et al. 2004). This system is innovative and practical for Urban Environmental Management: It focuses on the environmental management capacity of a city; it assesses the capacity of three stakeholders, viz. local governments, enterprises, and citizens; and it focuses on the local governance level, including supporting policies and actions from the national government and international cooperation (Kono and Imura 2004, Kono et al. 2004).

In this study, four types of assets are accounted for: (1) institutional assets, (2) social assets, (3) technological assets, and (4) environmental governance capacity. The focus is whether environmental management is using these assets in a comprehensively effective and efficient way.

(1) Institutional Assets

They represent the role and interventions of governments. They include plans, governmental institutions, laws and regulations, financial mechanisms, and so on, through which the role and capacity of the government is demonstrated.

(2) Social Assets

The roles of various stakeholders that make up society, including residents, corporations, and non-governmental organizations, are represented by social assets. They incorporate factors such as population’s environmental awareness, quality of the

human resources, existence of appropriate technologies and sufficient funds, existence and conditions of the NGOs working for environmental protection, quality of research, and so on. In this study, the term "social assets" refers communally to residents, corporations and NGOs, etc., that have a role in protecting the environment while "social capital" refers to mutual trust, norms, and network among those stakeholders.

(3) Technological Assets

The primary definition of technological assets is the technological *know-how* that has been accumulated within the city, but it can also include the technology acquired from outside the city. Since obtaining technology from outside generally costs more than using internal technology, the more technology is available locally, the better is considered the environmental management capacity of that city. The technologies considered are those for monitoring, pollution removal, and other technologies to be used to prevent or mitigate environmental problems.

(4) Environmental Governance

"Environmental governance" is the capacity to comprehensively oversee and control the overall assets, including physical and non-physical assets. Good leadership towards achieving environmental targets is an indication of good environmental governance.

The categories and details of each asset are shown in Table 1. These individual elements will not function effectively if used independently. It is only when these various elements are effectively connected that outcomes are enhanced; it is particularly valid regarding social capital and environmental governance.

Table 1. Categories of environmental assets

Categories		Components	
Physical assets	Natural environmental assets	Air, rivers, seas, water resources, flora and fauna	
	Artificial assets	Parks, sewer systems, waste treatment facilities, research facilities	
Non-physical assets	Environmental management capacity assets	Institutional assets	Plans, laws and regulations, governmental institutions & organizations, funds, others
		Social assets	Residents (with high environmental awareness), NGOs, corporations (human resources, funds, technologies), social capital
		Technological assets	Technological know-how such as pollution prevention, environmental monitoring, recycling, etc.
		Environmental governance	Leadership, political will and commitment to enforce laws

Source: IGES (2004)

2.2 Kitakyushu case study

2.2.1 Historical background

Kitakyushu city is one of the first industrial parks in Japan. Along the 20th century, Kitakyushu experienced both the prosperity brought by heavy and chemical industries, particularly steelmaking, and the serious pollution caused by them. In the context of the economic globalization and the transformation of industrial structure, the city is seeking to achieve sustainable development as an industrial city, while facing the challenges of declining manufacturing sector and a shrinking population. In response, the city has been making effort to foster new industries, especially those that are environmentally sound, trying to create a recycling-oriented society ,[1] and becoming a model for other industrial cities across Asia.

Kitakyushu is endowed with a rich natural environment, facing the sea on three sides (the Genkai Sea and Seto Inland Sea), and mountains on the fourth. However, during Japan's period of rapid industrial and economic growth after the 1950s, the sea and air became seriously polluted. Initially the image of a "grey city" was synonymous of prosperity and economic growth, but along the years the pollution started causing health-related problems and the need for a clean environment was felt. Starting from women groups' movements, and later involving local government and companies, actions were taken to clean up the city. Government, industry and citizens worked together in order to transform what was once a "grey city" into a "green city", with clean air and water and a better natural environment. This experience is now shared with cities in Asian countries such as China, Philippines, and Indonesia, through an international cooperation program.

These initiatives attracted international attention to Kitakyushu. The city received the UNEP Global 500 Award in 1990 and the UN Award for Local Governments in 1992. In September 2000, UN-ESCAP held its Fourth Ministerial Conference on Environment and Development in the Asia-Pacific (MCED4) in Kitakyushu and adopted the Kitakyushu Initiative for a Clean Environment. This is an implementation mechanism for a regional action plan to protect the environment in the Asia-Pacific region. It is based on considering the experiences of Kitakyushu to promote initiatives at the local level in ways that could improve the urban environment in this region, and seeks to strengthen international cooperation and collaboration among cities.

2.2.2. Air quality management

During the 1950s and 1960s, industrial air pollution was severe in Kitakyushu city and severe were the impacts on human health. Social assets, such as pollution control agreements, played an important role in lessening air pollution. In addition, technological assets enabled the introduction of Cleaner Production by companies.

[1] See section II on municipal solid waste management and sound material-cycle society.

The expertise acquired during this process of overcoming pollution problems became the base of the city's current international environmental cooperation.

In 1901, Yawata Steel Works was established leading to the creation of heavy and chemical industries, particularly steelmaking. After the Second World War, these factories were operating at full speed, along with the Japanese growing economy. By the 1950s, the smoke and dust emissions from the factories were causing problems for local residents. At that time, companies, government, and residents lacked adequate information about pollution sources and amount of emissions. Women's group activities provided the stimulus to start a movement demanding action. For instance, in 1950 the Women's Association of Nakabaru 36 District, based on their own research on pollution source and supported by relevant documentation, delivered a petition to the government demanding action to rectify the situation. They were able to prove that the closer to a factory, the worse the pollution was; then, negotiations towards establishing countermeasures against smoke started and finally the factory installed smokestack cleaners.

At that time, pollution-related health effects were not widely known and environmental countermeasures were considered less important than economic growth. It was in this context that the Women's Association studied the state of damage and pollution, called experts and university professors, approached the related institutions, raised broad support, and expanded their activities. In 1965, a group involving 6,000 women in 13 associations issued their report on air pollution entitled "We Want our Blue Skies Back". These activities of the women's associations were a trigger for women to tackle environmental problems and women's concerns from their own perspective, and they led to the creation of the Kitakyushu Forum on Asian Women (KFAW) and the Kitakyushu Municipal Gender Equality Centre "MOVE". In addition, the media took up pollution issues and played a role in spreading information about pollution impacts, as well as the responses by residents, government, and industry. The actions by the women's associations and the reports by the media brought the pollution issue to the forefront in society. This helped to raise the awareness of residents, government, and corporations about the environment, and led to stronger initiatives by governments and companies to address environmental issues.

This prompted the establishment of several initiatives involving institutional, legislative, financial, technological, and social aspects. Changes in administrative structure were taken, regulations were sanctioned, financial instruments for preventing pollution were created, monitoring stations were installed, and partnerships among government, companies, and civil society were established. These initiatives are described below and summarized in Table 2, which presents the assets regarding air quality management.

An office responsible for pollution issues was established within the Public Health Sector of the Health Bureau in 1963 to oversee pollution-related policies and establish inspections and air monitoring studies. The Pollution Prevention Council, established in 1964, consisting of representatives of academia, city councillors, residents' groups and corporations, was responsible for studying pollution countermeasures and proposing policies and specific measures for dealing with air pollution. To this day, the council still plays an important role in decisions on environmental policies.

Financing systems for small and medium-scale business were established to help companies to decrease their emissions by improving monitoring at plant level, by

installing equipments for pollution control, or by relocating the industrial plants to other sites. These initiatives gave origin to the Pollution Prevention Funding System, established in 1968. In the 1970s, several industries starting adopting cleaner production measures instead of end-of-pipe technologies, with the advantage of saving energy or other resources while decreasing the emissions.

Based on the first recommendation of the Pollution Prevention Council, research was enhanced by establishing the Kitakyushu City Health Research Institute in 1965, which was later denominated Kitakyushu City Environmental Sciences Research Institute.

Decentralization of the decision-making and expansion of the rights of the city government were important in order to take specific measures to avoid pollution. One such example is the "Smog Alert Initiative", through which the government could issue an order to industries to change temporally the fuel or halt the production in case of special weather pattern (e.g. inversions) that would lead to smog. In order to monitor for inversions the Mt. Sarakura Meteorological Observation Station was established to measure temperature at different altitudes while the Special Weather Information System was created to notify companies subject to regulation when a weather inversion had formed.

The Pollution Control Agreement involved a partnership between government and factories in order to have far-reaching outcomes than the temporary Smog Alert System. Finally, Kitakyushu City was able to overcome pollution by forming partnerships among residents, government, and companies through various activities that complemented legislation.

Table 2. Air Quality Management Assets for Kitakyushu City

Institutional Assets				Social Assets	Technological Assets
Plans	Organizations	Laws and regulations	Financial instruments	Citizens, NGOs, corporations, social capital	
"We Want our Blue Skies Back" The City of Kitakyushu Fundamental Plan for the Anti-Automobile Pollution Measures Environmental Pollution Control Plan	Kitakyushu Health Research Institute Pollution Monitoring Centre Group for inspections in industrial plants Pollution Prevention Council	Photochemical Smog Emergency Measure Implementation Guideline Pollution Control Ordinance Ordinance regarding special weather conditions Guidance Outline on NOx Emissions Regulation on Total Discharge of SOx Smoke Control Law	Pollution-related Health Damage Compensation System Pollution Prevention Funding System	The Environment Account Book Campaign Women's Association Pollution Control Agreement	Measurement of deposited dust Mt. Sarakura Meteorological Observation Station Smog Alert System (information system for special weather conditions) Cleaner Production

Source: Kitakyushu Environmental Asset Database (IGES 2004)

2.2.3 Bay recovery and water quality management

Dokai Bay was known as the "sea of death" after heavy and chemical industries caused water contamination with high concentrations of toxic substances such as heavy metals. Women's associations tackled this problem as they had done with air pollution, and their efforts were joined by Kitakyushu labour unions. Ultimately, the Polluter Pays Principle was applied, the contaminated bottom of the Dokai Bay was dredged out, and fish and shellfish were again found in the bay. Social assets created the impetus for decontaminating the bay and this process led to the creation of a variety of legal, institutional, and technological assets.

The shape of Dokai Bay has changed considerably along the years, especially during the 20th century (Figure 1). Its basic was wide and reaching deep inland, with the inner bay having a shallow depth of only 1.5 to 2.0 meters. The reclamation of Dokai Bay began during the 15th century to increase size of land for cultivation. In the 20th century, it was landfilled and dredged to function as a harbour for industry, turning it into a long, and narrow waterway stretching East and West. The shipping route was kept at a depth of about 10 meters, making it navigable by large ships. The waterfront was all dedicated to industrial or quasi-industrial zoning, and was artificially modified for almost its entire 44 kilometres, leaving almost no natural sections. Nowadays, there are efforts to make the bay waterfront more attractive to people. Although many clusters of heavy and chemical industry plants remain along the shore today, the water quality has improved remarkably. Along the shoreline, there is now some greening projects, such as the Dokai Biopark, the Dohoku Green Zone, and the Oku Dokai Bay Green Zone.

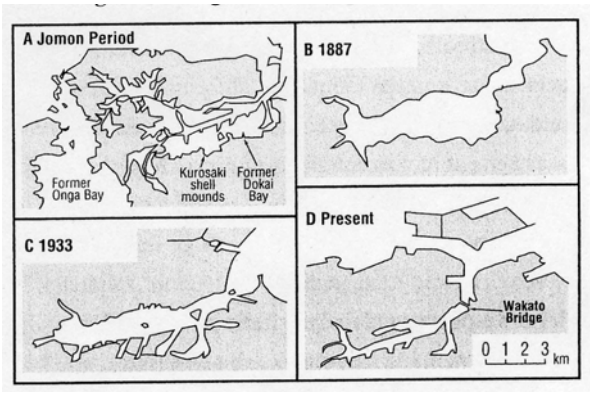

Figure 1. Shape of Dokai Bay along the years

Source: City of Kitakyushu (1999)

By 1930, the annual fish catch in Dokai Bay started to drop dramatically; by 1942, it reached zero. The number of workers in the fisheries was only a fraction of the number in industries; hence, they voluntarily abandoned their fishing rights. In 1968, the chemical oxygen demand (COD) reached as high as 74 ml/l, while in other large industrial cities like Kawasaki and Nagoya, it was 10 mg/l. In addition, cyanide, cadmium, arsenic, and mercury concentrations were the highest in Japan. These figures indicate that Dokai Bay probably had the most polluted coast in Asia at the

time, but since fishery activities stopped in the area, no contamination by consuming contaminated fish happened as in Minamata City.

Since the Dokai Bay's shoreline became an industrial zone, it was somehow removed from the daily lives of the average citizen and hard to get a view of, except for passing ferry passengers. However, action towards remediation started after the activities of women's associations and a report by the Kitakyushu Region Labour Union in 1971 on the state of pollution. With the objective of cleaning it up, the Dokai Bay Cleaning Study Group was created by the Kitakyushu Bay Management Union, which at the time was responsible for Dokai Bay. The study group evaluated the bottom contamination as well as dredging methods that could remove sediments economically without causing further pollution. The dredging was performed based on the on the Pollution Control Public Works Cost Allocation Law, which is based on the Polluter Pays Principle. As shown in Table 3, the costs were shared according the proportion of pollution source between industry (71%) and government (29%). Additionally, companies installed wastewater treatment systems while the government started sewage treatment projects thus decreasing the water emissions into the bay. By early 1970s, COD levels reached values lower than 10 ml/l.

Table 3. Dredging costs of polluted sediment in Dokai Bay

Payer	Item	Proportion of burden		Net share (%)	Amount (billion yen)
		Suspended solids (%)	Toxic substances (%)		
Industry	Industrial effluent	54	87	71	1.28
Governments [1)]	Household effluent [2)] (portion for bankrupt companies)	46	13	29	0.52

Notes: 1) National, prefectural, and municipal governments
2) It includes the portion for bankrupt companies
Source: City of Kitakyushu (1999).

In order to avoid further pollution, appropriate technology was necessary for dredging the bay's polluted sediments and for treating and disposing them in safe way. It took significant effort to develop appropriate method for reclaiming the contaminated material without risks of leakage.

Regarding legal and regulatory assets, they were both used and further developed with the process of recovering the Dokai Bay. The dredging started with requests to the national and prefectural governments in 1966 based on the Water Quality Control Law and the Factory Effluent Control Law; i.e., laws were used to generate action. On the other hand, some inadequacies were found in some regulations, which were revised in the 1970s. Later, Dokai Bay became a 'designated water body', thus specific water quality standards were established for the site. In 1973, Dokai Bay

Stringent Standards were established allowing the prefectural government to apply standards[2] much stricter than in other areas.

Because of these activities, Dokai Bay has become again a habitat for fish and prawns. Moreover, the leadership of local government and the cooperation with industries created the basis for international environmental cooperation activities nowadays. The experience of recovering the Dokai Bay continued to other activities, such as creating innovative organizations like the Kitakyushu International Techno-cooperative Association (KITA) and networks like the Kitakyushu Initiative for a Clean Environment.

Recently, new development initiatives started in the area around Dokai Bay. There are several local groups discussing action plans to transform the area, such as the "Wakamatsu Environmental Model Town" and the "Dokai Bay Charming Plan".

Table 4 presents the complete listing of management assets used for and created by the recovery of Dokai Bay.

2.2.4 River water quality management

The Murasaki River, which flows through the centre of the city, was polluted until the 1970s due to the lack of sewage and wastewater treatment facilities. During the post-war period, industrial wastewater was dumped into the river without treatment, which, along with untreated effluent from illegal dwellings along the riverbanks, led to water pollution and offensive odour. Citizens started activities towards cleaning up the river. Water quality of Murasaki River was improved by the construction of sewer systems and treatment facilities. Moreover, social assets like volunteer activities raised public's environmental awareness and created the foundations for the development of the "My Town My River Renovation Plan".

In 1963, citizens created a group called the "Council for Cleaning up the River" and launched volunteer efforts. The public's rising environmental awareness together with political will lead to the improvement of sanitation conditions by constructing sewer systems and treatment facilities[3]. From early 1970s, a pollution-related legal system was enacted, which included for instance the Water Pollution Control Law. When the Water Pollution Control Law came into effect, the authority for conducting inspections and regulating effluent from specified facilities as well as issuing directives for the improvement of facilities was transferred from the jurisdiction of the prefectural governor to the city's mayor. Around this time, the entire system for administration of pollution control measures[4] was reformed and the number of staff was increased from 22 to 47. In addition, between 1966 and 1980, the illegal dwellings that had contributed to the water pollution problem were removed; former residents of these areas were relocated to city-run public housing facilities.

[2] The Dokai Bay Stringent Standards covered six parameters: COD, suspended solids, N-hexane extracts, phenols, cyanide, and arsenic.

[3] By 2002, 98.5% of buildings were connected to sewer systems.

[4] Presently known as Environment Bureau.

Table 4. Water quality management assets related to the Dokai Bay recovery plan

Institutional Assets				Social Assets	Technology
Plans	Organizations	Laws and regulations	Financing mechanisms	Citizens, NGOs, corporations, social capital	
Wakamatsu Environmental Oriented Community Plan Dokai-bay Charming Plan	Aqua research centre The Environment Bureau Institute of Environmental Sciences	Water Quality Control Law Provincial Sediment Removal Standards Water Quality Conservation Law Dokai Bay Stringent Standards Factory Effluent Control Law Water Pollution Control Law Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea	Polluter Pays Principle	Dokai Bay Cleaning Group Kitakyushu Region Labour Union The activities of women's associations	Dredging technology for sediments removal and disposal Water recycling plan Technology to monitor environmental endocrine disrupters Comprehensive ecosystem monitoring program

Source: Kitakyushu Environmental Asset Database (IGES 2004)

As a result of these types of measures, the quality of the Murasaki River's water was gradually restored. Citizens' activities have continued since the water quality improvement but now focusing on improving the city's amenities. New efforts have also expanded, including improving garbage collection system, releasing *ayu* (a local fish) into the river, conducting environmental education for children, and holding environmental conservation workshops.

The area around the Murasaki River is currently the centrepiece of efforts for urban renewal. In 1988, Kitakyushu was designated under the national government's "My Town - My River Renovation Project". This project does not seek merely managing the river flow for flood control; it is linked with planned redevelopment of the surrounding roads and urban area and it seeks to create an appealing urban space. Besides various measures for flood control, such as expanding the width of the river's lower reaches and dredging the river bottom, this project revitalized the area by construction of bridges, parks, a water museum, a commercial complex, among other amenities.

2.2.5 Sanitary management

Natural assets restoration is due to the installation of sewage system. Kitakyushu has achieved a sewage system covering 98.5% of the city, which puts it near the top of Japan's 13 largest cities. The well-developed *social assets* in terms of volunteer activities made the policy-makers aware of the need for better sewage systems from an early stage. Thanks to the expansion of the sewage system, the BOD levels in the rivers steadily improved.

The expansion of Kitakyushu's sewage system started in 1963 in Wakamatsu. Public awareness prompted the necessary political will leading to the development of the so-called Phase 2 of the Sewage System Improvement Five-Year Plan, with which the construction of the sewage system proceeded more rapidly.

Kitakyushu was able to reach a high level of sewage connection due to three main reasons as following: 1) its geography, the residential areas are relatively dense; 2) city's tax revenues from companies rose during the country's period of rapid economic expansion; and 3) a user-pay system was introduced in 1967, which gave the city a higher priority in receiving subsides from the Ministry of Construction.

Reflecting society's need for a clean coastal environment, the sewage treatment plants are operating with advanced treatment methods that reduce levels of phosphorus, nitrogen and other substances. Some treatment plants use the locally developed MAP (Magnesium Ammonium Phosphate) Method to remove phosphorus and reuse it as a fertilizer. At the Kogasaki Treatment Centre, the treated effluent is sent to the neighbouring Dokai Biopark, where the natural ecosystem (water lily, etc.) is used to remove nutrients such as phosphorus and nitrogen. The treated water is then reused to create an aquatic biotope for insects such as dragonflies. Moreover, the park is used as a place of environmental learning, recreation, and relaxation for residents.

About 200 tons (dry weight) of sludge are daily produced from sewage treatment. Until late 1990s, this sludge was disposed in landfill, but due to land shortage, the treatment method has changed. Half of the sludge is used in cement ("eco-cement") production and the other half is dried and incinerated with general waste. This

process is being implemented with cooperation from the private sector and the city's incineration plants.

The City of Kitakyushu developed funding mechanisms for improving the sewage system and for integrating the larger number of residents to it. Costs for constructing facilities are mostly covered by subsidies from the national government and municipal bonds (long-term debt). Repayment of the bonds issued for sewage treatment is mostly covered by sewage treatment fees.

The City of Kitakyushu also offers loans and assistance to residents who start using the sewage system. Under the loan program, part of the construction costs are covered at zero interest when someone installs flush toilets, stops using a private sewage treatment tank and instead feeds into the public sewage system, or arranges for kitchen or bath wastewater to be used in the local residential area. Under the funding assistance program, people can receive grants if they convert from a pit toilet to a flush toilet, when they install common-use wastewater facilities, or when houses in low-lying areas use pumps in order to connect to the public sewage system.

Table 5 lists detailed information regarding the environmental management related to the Murasaki River water quality management and revitalization and the sewage system expansion.

2.2.6 Solid waste management

Kitakyushu City improved its solid waste management (SWM) along the years, from the 1950s, when waste collection was inefficient until now when the policies are concentrated on (1) addressing hazardous waste problems and (2) material recycling and promotion of sound material-cycle society. Improvements on waste management were achieved through to a series of actions, such as implementing changes on waste collection system, enacting specific legislation, developing or adopting new technologies, developing partnerships with the private sector, promoting public awareness and so on. All these activities and reforms, which can be classified as assets of urban management, led to the creation of proper conditions for (1) developing hazardous waste management strategies along with "risk communication" strategies and (2) promoting material recycling through the establishment of an eco-industrial park (Eco-Town Project).

The development of waste management in Kitakyushu city started with the launching of the national Public Cleansing Law in 1954, which made mandatory the cleaning of urban areas and the disposal of waste by municipalities; it also made the responsibility of residents to cooperate in local cleaning projects. This law received several amendments over the years; it was drastically reviewed in 1970, as the Waste Disposal and Public Cleansing Law, and in 1991, when the Law for the Promotion of Utilization of Recycled Resources was established. In 2000, the Waste Disposal Law was again amended and laws for promotion of recycling, including the Food Recycling Law and Construction Material Recycling Act, were established (Mendes and Imura 2004b).

Table 5. Environmental management assets related to the river water quality management and wastewater management

Institutional Asset				Social Assets	Technology
Plans	Organizations	Laws and regulations	Financing mechanisms	Citizens, NGOs, corporations, social capital	
My Town - My River Renovation Project	The City of Kitakyushu Construction Bureau, Water Environment Section, Firefly Subsection Conference on Measures of the City of Kitakyushu Against the Use of Detergents Environmental Museum of Water	The River Environment Standard Water Quality Class Designation The Reduction Guideline Concerning Phosphorous and Its Compounds The City of Kitakyushu Small Business Discharge Water Quality Improvement Guideline		The Takamiya Mariner Environmental Preservation Foundation Association of the Murasaki River's Fans The Murasaki River M-CAP Network Association to Beautify the Murasaki River	Additive-free soap of Shabondama Soap Corporation Biological Water Quality Survey Anti Synthetic Detergent Measures
The Sewage Maintenance Project	Installation System for Sewage Pump Facilities on Low Land The Aqua Research Centre The Public Sewage Construction System on Private Streets The Purification Centre	Drainage Ordinance The Sewage Law	Sewage fee Subsidy scheme for the Installation of Common Drainage Facilities The Drainage Facility Designated Constructor Loan scheme Corporate bond Government Subsidy Subsidy to Convert to Flushable Toilet Subsidy Scheme for the Installation of Sewage Pump Facilities, etc. on Low Land	"Sewage Day" street campaign Distribution of Pamphlets and Videos The Flushable Toilet Mediation Committee System The Sewage Drainage System Construction Technician Sewage expedition bus tour Social Studies Supplementary Reader "Sewage and Our Lives" The Flushable Toilet Diffusion Advisor System	The Magnesium Ammonium Phosphate Method The Dokai Bio Park Biosolids as substitute raw material of cement

Source: Kitakyushu Environmental Asset Database (IGES 2004)

In 1963, the Kitakyushu Bureau of Public Health developed a master plan for the collection, transportation and disposal of waste and excrement, and the ward departments operated waste disposal and collection. Waste management was enhanced as waste incineration facilities were completed at this time. Until the 1960's, household garbage was disposed of in garbage cans on the street and periodically collected by the cleaning office; however, efficiency was low, working conditions for the workers were bad, and several problems, such as foul odours and flies, arose. Hence, the collection from plastic containers started in 1963, resulting in higher waste collection efficiency (City of Kitakyushu 1999). This and other measures resulted in beautification of the town and improvement of the living and working environment. In 1991, a more efficient collection method using plastic bags at collection stations replaced the plastic container collection. Separated collection of cans and bottles started in 1993 and PET bottles, in 1997. In order to encourage residents to reduce waste generation, a pay-system using designated bags was introduced in 1998. Within the first year, general waste generation declined by 12% and resource recycling increased by same rate. The profits generated from revenues from the designated bag program, minus the costs of bag production, cover around 12% of the costs for waste management. Since its implementation in Kitakyushu, other cities established similar system; currently, 60% of the Japanese cities adopt the designated-bag system. Other cities in Asia are also adopting the same program.

From the late 1970s, efforts to encourage recycling started to gain momentum, including the organization of public events to promote recycling as well as awareness campaigns. In 1995, the *City of Kitakyushu Ordinance on the Reduction and Proper Treatment of Waste* was passed, and the basic philosophy of waste management shifted from *waste treatment* to *recycling*. Kitakyushu is taking a systematic approach to enact and implement measures and plans that make the most of the city's characteristics and strengths, such as the existence of local technology and expertise, in order to improve waste recycling and treatment. Following the national laws and directives, the *City of Kitakyushu Basic Plan on the Treatment of General Waste* was passed in 2001, moving further ahead from simple recycling to the development of an integrated resource cycle-based approach[5]. It has been encouraging greater demand for recycled goods, such as the green purchasing policy (IGES 2004b, Mendes and Imura 2004b). Additionally, it has been using financing mechanisms to decrease waste generation and promote recycling such as using a subsidy program for the installation of organic waste composters, and offering a support grant for organizations that collect used paper. Around 26,000 households have compost equipment.

In 1997, the Japanese Ministry of Economy, Trade and Industry (METI) launched the "Eco-Town Project" to provide assistance to local governments, which were planning to achieve regional development through the promotion of environmental industry. Local governments, if their master plans were approved, received various forms of financial aid from the national government, including subsidies[6] to private companies that agree to construct recycling and other facilities, and financial support for the exhibition of eco-technologies. As a mature industrial city, Kitakyushu retains vast

[5] An integrated approach based on 3Rs (Reduce, Reuse, Recycle).

[6] Two types of subsidies are provided to Eco-Towns: 1) Assistance for *'Soft'* Projects (Subsidy for Resource-Recycling Local Stimulation Project Costs) which covers up to 1/2 of costs, and 2) Assistance for *'Hard'* Projects (Subsidy for Resource-Recycling Local Stimulation Facilities Improvement Costs) which covers up to 1/2 of costs or 1/3 of costs (METI 2005)

land areas that were once developed for the siting of industrial facilities, but are almost abandoned today. On the other hand, it has accumulated technologies for the processing of metals, chemicals, and other materials, which can be applied to the development of resource recycling and recovery technologies. Kitakyushu has been promoting a new urban industrial development policy to invite recycling and other eco-industries to its unused reclaimed land. It launched the first Eco-Town Project in Japan, which is based on the *zero emission* concept and involves an eco-industrial complex (or *"environmental kombinat"*) and a research centre for the development and assessment of recycling technologies. The city provides various benefits to small- and medium-sized companies for the development of diverse technologies. So far, recycling factories for PET-bottles, cars, electric appliances, and construction materials have started operation. The ultimate aim of the Kitakyushu Eco-Town is not only to develop recycling industries, but also to create a new industrial system in which resources are used more efficiently and that generates no waste (Mendes and Imura 2004a, Mendes and Imura 2004b). Several new technologies are being developed in the site, such as the development of biodegradable plastic and use of waste fibreglass-reinforced plastic (FRP) from fishing boats (IGES 2004).

Regarding industrial wastes, through good coordination with neighbouring communities among other actions, Kitakyushu aims for their proper treatment. The city also developed several plans and regulations towards better treatment and disposal, such as the *Kitakyushu Guidelines Concerning Appropriate Treatment* associated with the *Movement of Industrial Waste* (1988), the *Kitakyushu Guidelines Concerning Conflict Prevention and Mediation Relating to Establishment of Industrial Waste Treatment Facilities* (1991), and the *Kitakyushu Ordinance and Regulations Concerning Reduction and Proper Treatment of Waste* (1994). In addition, the city passed the *Ordinance Concerning Treatment of General Waste Together with Industrial Waste* (1993) in order to increase the effectiveness of waste treatment. To deal with dioxins, which represent a new type of pollutant on the regulatory front, Kitakyushu also passed *Guidelines to Limit Dioxins from Small-Scale Incinerators* (1999), and based on the national *Law Concerning Special Measures against Dioxins* (2000), environmental quality standards were set and emissions standards and monitoring became mandatory for designated facilities. Financing industrial waste treatment measures became an issue requiring attention; thus a new tax, the *Environment Future Tax*, was imposed on the landfilling of industrial waste, and revenues are being used to secure final disposal sites as well as to promote environmental industries (IGES 2004).

Kitakyushu also developed capacity on hazardous waste management. For instance, it is handling the treatment of polychlorinated biphenyl (PCBs) for 17 prefectures in West Japan. PCBs were widely used in the past as an insulator in electrical condensers and transformers, but after a cooking oil poisoning incident[7], production was halted in 1973, and companies with PCB products were required to store their own PCBs. Due to citizen's concern about PCB contamination and opposition against construction of treatment facilities in their communities, thirty years passed with the PCBs still in storage; however, there was evidence of PCB contamination in several sites. Kitakyushu started a process of risk communication and discussion with stakeholders in order to attend the request from national government to install a

[7] It became known as the *Kanemi Yusho* or *Kanemi cooking oil syndrome*, which occurred in Kitakyushu in 1968 (Niida 2005).

chemical treatment facility. In 2001, the *Kitakyushu PCB Treatment Safety Discussion Committee* was established; 450 people participated in events for discussions. In addition, the city government made several presentations for providing clarifications and debating safety guarantees and responsibilities. After discussions, the location of the PCB treatment facility was approved. It was proactive efforts for information disclosure and a system that allowed monitoring and oversight by residents that made it possible to reach the decision to locate the PCB treatment facility in Kitakyushu.

Table 6 lists the assets related to solid waste treatment and recycling. It is noteworthy to point out that Kitakyushu used and produced several assets in this sector, such as regulations, financing mechanisms and technology development and application.

2.3 Outlook

This section summarized the example of Kitakyushu through air, water, and waste management. Each issue was reviewed through the environmental management capacity asset approach, which was introduced in the line of new paradigm of environmental capacity building. The methodology applied in this study allows cities to develop their own self-evaluation of their environmental management capacity. Kitakyushu City environmental assets database can be an example to other cities across Asia.

Note: Text written by Dr. Mara Regina Mendes based on research and documentation produced by Ms. Noriko Kono and Dr. Hiroaki Shirakawa in a work commissioned by the City of Kitakyushu.

Table 6. Solid Waste Management Assets for Kitakyushu City

Institutional Assets				Social Assets	Technology
Plans	Organizations	Laws and regulations	Financing mechanisms	Citizens, NGOs, corporations	
Kitakyushu Renaissance 3rd Implementation Plan "For Creation of a Future Environmental City" (1999-2003) Basic Plan on the Treatment of General Waste		National Law Concerning Special Measures against Dioxins Guidelines to limit dioxins from small-scale incinerators Kitakyushu guideline on movement and treatment of industrial waste Kitakyushu Ordinance and regulation concerning reduction and proper disposal of waste Ordinance Concerning Treatment of General Waste Together With Industrial Waste Kitakyushu Ordinance and enforcement regulations regarding prevention of littering rubbish	Designated bag fund Support grant for organizations collecting used paper Subsidy program for the installation of organic waste composers	"Clean-up day" City of Kitakyushu Environmental Health Convention Green City Month	PCB treatment Power generation from waste and dried sludge from wastewater treatment plant
The Kitakyushu Eco-Town Plan	Environmental Industries Promotion Office Environmental Industry Promotion Council	Kitakyushu City's guidelines for granting of subsidies for development of industrial recycling facilities (Eco-Town Centre Ordinance)	Eco-tax	Recycling Industry Council Eco-Town Electricity Cooperative Union Practical Research Area Promotion Council Eco-Town Disaster Reduction Council	Medical Wastes Recycling Recycle of office equipment, household electrical appliances, cooking oil and fat, bean curd refuse and other food residues, paper, construction wastes, fluorescent lamps, automobiles, styrene foam, pet bottles and cans Research and development of Shochu (distilled spirit) lees recycling technology Recycling of food wastes to produce bio-degradable plastics

Source: Kitakyushu Environmental Asset Database (IGES 2004)

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3. Energy consumption and GHG emissions in selected East Asian mega-cities

The trend of urbanization, especially in Asian developing countries, which was described previously, will increase energy use since per capita commercial energy uses in cities are higher than that of the rural areas. This will further contribute to worsen local as well as global environmental problems in the future from energy use.

One of the major factors driving clean energy debate today is due to increasing concerns for air pollution and climatic changes. The United Nations Framework Convention on Climate Change (UNFCCC), which was adopted in 1992, sets an ultimate objective of stabilizing GHG concentrations in the atmosphere at a level that would prevent dangerous human-induced interference with the climate system. It urges the parties to protect the climate system in accordance with their common but differentiated responsibilities. Within the Asian region, the significant increase of energy consumption and GHG emissions is expected to take place in mega-cities, which have rapidly expanding populations that enjoy higher living standards and material affluence than that of rural areas and smaller cities. Increasing demand for passenger mobility and freight transport will be reliant upon increases in the number of vehicles, which not only create problems such as traffic congestion, urban heat islands, air pollution, and noise but are also a major cause of increasing energy consumption and CO_2 emissions. The carbon sink within the mega-cities, primarily urban greenery, is insufficient to absorb emitted carbons.

Nowadays cities in the rapidly industrializing regions of Asia are confronted with multiple tasks for economic development and environmental protection. They tend to give priorities to immediate local issues and to regard global warming as a long-term and distant issue. Moreover, the nature of energy use and GHG emissions from cities is not well known in Asia. Municipal policies to reduce energy consumption may bring multiple benefits to the community. It will help to solve air pollution, urban heat island, and traffic congestion problems, and will facilitate the reduction of CO_2 emissions. Energy management at the city level was neither a priority, nor an important topic until recently because local energy related decisions are mostly made at the national level in most of the Asian countries with few exceptions. Recently, due to the growing concerns of climate change, efforts are being made to understand such phenomenon at the city level in more detail. City policy makers are under growing pressure to incorporate GHGs, especially CO_2 emissions into consideration while planning. However, any policy measure solely for CO_2 reduction is a distant possibility for cities in Asia with the exception of selected and relatively developed cities. Integrating energy consideration into policies, either by integrating energy concerns to overall urban development or by synergizing measures to reduce air pollution and CO_2 emissions, is therefore important.

In this context, apart from a broader picture and discussions, this chapter examines the linkages between energy use and CO_2 emissions and their other environmental implications, mainly air pollution and urban warming (popularly known as urban heat island[8]), in selected East Asian mega-cities, namely Tokyo, Seoul, Beijing and

[8] Urban heat warming is a phenomenon in which temperature of an urbanized area becomes significantly higher than its surrounding areas. Often, the term "heat island" is used to describe this phenomenon. In earlier times, higher latitude cities, mostly in Europe, experienced this

Shanghai. The sub-section also discusses a direct and indirect energy-CO_2 scenario and their sectoral performance in these cities. Based on the results, it provides a broader perspective on why some cities are more energy efficient than others. Further, this sub-section discuses these barriers and potential opportunities to reduce CO_2 emissions from energy use.

The four mega-cities in this study, Tokyo, Seoul, Beijing, and Shanghai, share common characteristics in terms of population, population density and they are the most important cities in their respective countries. However, they present differences on income level, development level, governance, and institutional capacity among others. In this case study, the so-called "city", or the geographical boundary for Tokyo, Seoul, Beijing, and Shanghai are respectively Tokyo-to (Tokyo Metropolitan Government administered area), Seoul City, Beijing, and Shanghai. Beijing and Shanghai are far greater in area than Tokyo and Seoul. However, the boundary of the core ward areas (built-up areas at the centre of ward areas) in Beijing and Shanghai are comparable to Tokyo and Seoul, although their city-boundaries have changed over time.

3.1 Urban energy use and its context

A compact city may have smaller per capita energy consumption due to compact transportation and distribution infrastructure; at the same time, the city may have smaller per capita building floor space, thus further reducing energy use. In Japan, the pattern of energy consumption shows that the per capita energy consumption in urban areas, which are denser, i.e. more compact, is lower than that of non-urban areas and this phenomenon is common in developed countries (Ichinose et al. 1993). In developing countries such as China and Thailand, the opposite trend is reported (Ichinose et al. 1993). The income gap between urban and rural areas is smaller in developed countries such as Japan, and therefore, the effect of urban density can be visible. In developing countries, the income gap is "large," whose effect surpasses the "effect of density" for commercial energy uses (non-commercial energy uses are not considered in many studies).

In general, energy consumption in Tokyo, Seoul, Beijing, and Shanghai is increasing in last three decades, with the exception of Beijing and Seoul (after the 1997 Asian financial crisis). Beijing seems to have followed the national trend, which reports that energy consumption and more specifically CO_2 emissions decreased after 1996. However, there is an ongoing controversy whether this reduction in China is real or has resulted due to accounting problems. In Beijing, the total energy consumption has increased by 15% in 1998-2002 (Wu 2004).

The per capita energy consumption of these cities is consistently increasing and is converging towards a common point in recent years (Figure 2). This means that

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phenomenon in winter times. Today it affects major cities in the world (Kubo 1997). Anthropogenic heat discharge due to energy uses is one of the major factors for urban heat island (Dhakal 2002). Other factors are linked to land use changes, which affect the characteristics of ground surfaces such as evaporative capacity, specific heat capacity, surface reflectivity and others. Apart from direct energy use and their heat discharges, urban built up structures also create imbalances in storage and release pattern of heat, and wind obstruction by which heat island become more phenomenal in late afternoon or evening hours (Dhakal et al. 2003a; Dhakal et al. 2004).

developing cities such as Beijing and Shanghai are rapidly approaching and even surpassing developed cities such as Tokyo and Seoul (Since 1998, Seoul's per capita energy consumption decreased due to the financial crisis in 1997. It is currently recovering).

In Tokyo, energy consumption has increased to about 85% in the last three decades (1970-98). Oil, urban gas, and electricity are major energy sources and coal has almost been eliminated. Electricity use, in particular, is rising compared to other fuel types both in terms of share and absolute volume and oil is decreasing. Industry has a nominal share in Tokyo in recent years (about 10%; national share is about 40%), unlike Beijing and Shanghai, where it contributes over 65% and 85%, respectively. Most of the energy use in Tokyo is by transportation and commercial activities. Within the commercial activities, offices consume a majority of the energy, followed by restaurants whose gap has significantly widened in last two decades due to increasing share of offices. Energy consumption by restaurants has decreased since 1995, most likely due to the economic recession (Dhakal et al. 2002, Dhakal et al. 2003b, and IGES 2004).

Seoul is very distinct in its high share of oil use; in recent years, coal has been eliminated and substituted with gas and electricity. Residential households consume the majority of energy in Seoul, followed by transportation. The provision for district heating is rapidly expanding. In 2001, over 350,000 households used district heating which is expected to increase to over 430,000 households by 2007 (Jung 2004).

The structure of energy use in Beijing and Shanghai has not changed significantly. The major characteristics of the energy profile in these cities are: (1) electricity share is somewhat increasing, (2) coal dominates energy use, and (3) the share of transport sector is between 5-10%. Despite high economic growth, the primary industry is shrinking in Beijing and Shanghai; significant economic growth is coming from the tertiary sector, which balances the energy profile to some extent so that per capita energy consumption does not overshoot. In Beijing for example, coal consumption of the secondary industry is growing in total final consumption, which is consistent with the economic growth trend of the secondary industry. Beijing replaced small coal-fired boilers to gas-fired boilers in residential sectors, and accordingly, coal consumption in this sector has reduced from 4.0 million tons in 1995 to 2.8 million tons in 1999 (BSY 2001). The use of natural gas has risen dramatically in Beijing and Shanghai in recent years but still accounts for a very small share. In Shanghai's energy structure, 6-7% reduction in coal shares has taken place from 1995-2000, which is largely substituted by oil. A rapid change in energy structure has taken place after 1998.

Table 11 in the Appendix presents detailed information about the four mega-cities.

3.2 Carbon dioxide emissions from cities

Commercial energy use and income are expected to have direct correlations. Accordingly, the per capita energy use has increased in these East Asian mega-cities. Interestingly, the trend of per capita energy is converging in these cities in between 1.3 and 1.6 TOE/person as shown in Figure 2. In contrast, per capita CO_2 emissions in Beijing and Shanghai are rapidly diverging from Tokyo and Seoul (Figure 3). In 1998, per capita CO_2 in Tokyo was 4.84 tons, which was 1.3 times higher than Seoul;

Beijing and Shanghai were respectively 1.3 and 1.6 times higher than Tokyo. Economic recession in Tokyo in the mid-1990s did not reduce CO_2 emissions because in Tokyo they are affected more by lifestyle factors which are resistant to changes. The 1997 Asian currency crisis shows a visible impact on Seoul as emissions reduced drastically from previous year in 1998. In contrast, Beijing and Shanghai transformed from "smaller economic growth" and "higher emission growth" phase in the 1980s to the "higher income" and "lower emission growth" phase in the 1990s as shown in Table 7. Several factors contributed to this transformation such as technological advancements, increases in market competitiveness, reform of inefficient state enterprises, emergence of a strong tertiary sector and massive energy efficiency improvements (IGES 2004, Dhakal et al. 2002, Dhakal et al. 2003b, Wu et al. 2005).

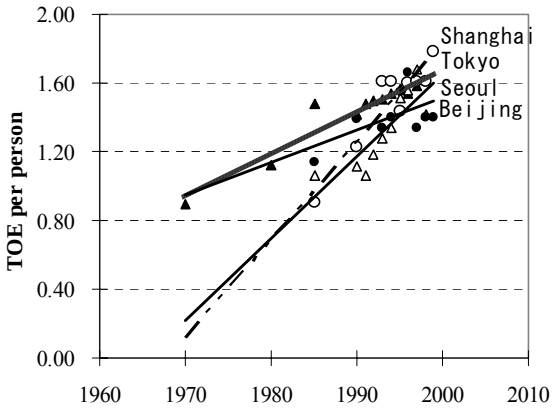

Figure 2. Trend of per capita energy consumption

Source: IGES (2004)

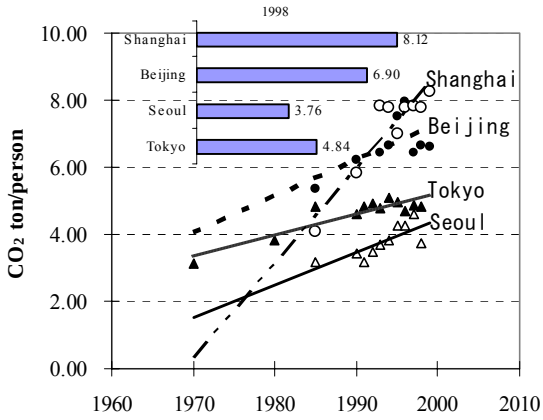

Figure 3. Trend of per capita CO_2 emission from energy use

Source: IGES (2004)

The differences in the sources of CO_2 emissions are quite contrasting in these cities. Tokyo is dominated by commercial and transport sectors where the share of industry's CO_2 emissions has diminished to less than 10% now from 35% in 1970. On the contrary, the household and transport sectors are dominant in Seoul. Most of the emissions in Beijing and Shanghai are dominated by industry, where the role of the transport sector is smaller (about 5-6%). Despite the fact that the role of transportation is smaller, it is growing rapidly with a rate of over 10%. Future growth is also expected to follow this trend in urban transportation due to continuous economic growth, financial market liberalization (availability of more credit mechanisms to buy vehicles) and WTO accession (Zhou and Sperling 2002, He et al. 2004a, He et al. 2004b). Since transportation related air pollution is already serious, such vehicle growth is alarming to local policy makers.

On the fuel side, structural changes in the share of fuel types in CO_2 emissions have been low in Beijing and Shanghai over the last two decades. However, ambitious plans exist in these cities to tap clean energy from the Three River Gorge Dam Project and from the national government's massive natural gas pipeline plan. In the case of Tokyo and Seoul, coal has been almost eliminated in recent years and electricity is

playing a greater role. Oil significantly dominates the market in Seoul due to its massive district heating and cooling systems which is essentially lacking in Tokyo.

Table 7. Economic and CO_2 emission transitions in cities

City	1970-80	1980-90		1990-1998	
		1980-85	1985-90	1990-97	1997-98
Tokyo	High economic growth (8.5%) Moderate emission growth 2.5%	High economic growth (6.3%) Moderate emission growth (2.3%)		Negative economic growth (-0.4%) Low emission growth (0.7%)	
Seoul				High economic growth (5.9%) Moderate emission growth (4.5%)	Negative economic growth (-16.3%) Negative emission growth (-19%)
Beijing			High economic growth (7.5%) High emission growth (6.5%)	High economic growth (14.5%) Low emission growth (2.7%	
Shanghai			Low economic growth (2.3%) High emission growth (11%)	High economic growth (20%) High emission growth (5.6%)	

Definition for high and low is subjective, over 5% is taken as high in this table for comparison purpose.
Source: IGES (2004)

The comparison of emissions between these cities with other OECD and major non-OECD countries based on per capita and per unit of economic activity shows that Tokyo is outstanding in its performance (Dhakal et al. 2002, IGES 2004). All these four cities have failed to perform better in terms of per capita but their performance is better in terms of per unit economic activities as shown in Figure 4.

3.3 Perspectives on indirect emissions of cities

In contrast to direct emissions, emissions embedded in consumption goods are often neglected in CO_2 debates. The true environmental load of a city, especially in case of location-nonbinding emissions such as CO_2, needs to be clarified to explore alternative urban development pathways. This essentially reduces the burden to upstream production processes and natural resource extraction. To extend such an approach, a detailed analysis of the consumption activities of urban dwellers is necessary. However, with the lack of such studies, industrial Input-Output Table based studies can provide at least some perspective on the extent of such loads. Such analyses show that the indirect emission of CO_2 in cities such as Tokyo and Shanghai could be over three times than that of direct emissions. However, cities do not always "consume" − it also exports goods which should be deducted; with that argument, the CO_2 emissions for which Tokyo, Beijing and Shanghai are "responsible" (responsible emission = direct emissions from energy use + indirect emissions embedded in input materials – emissions embedded in exported materials) could be about 70% of total

(direct and indirect) emissions (Kaneko et al. 2003). Although such estimation may not actually reflect all consumption-related indirect emissions, it essentially provides a sound basis to show and argue that indirect emissions from mega-cities are large and policy makers should consider it as an issue.

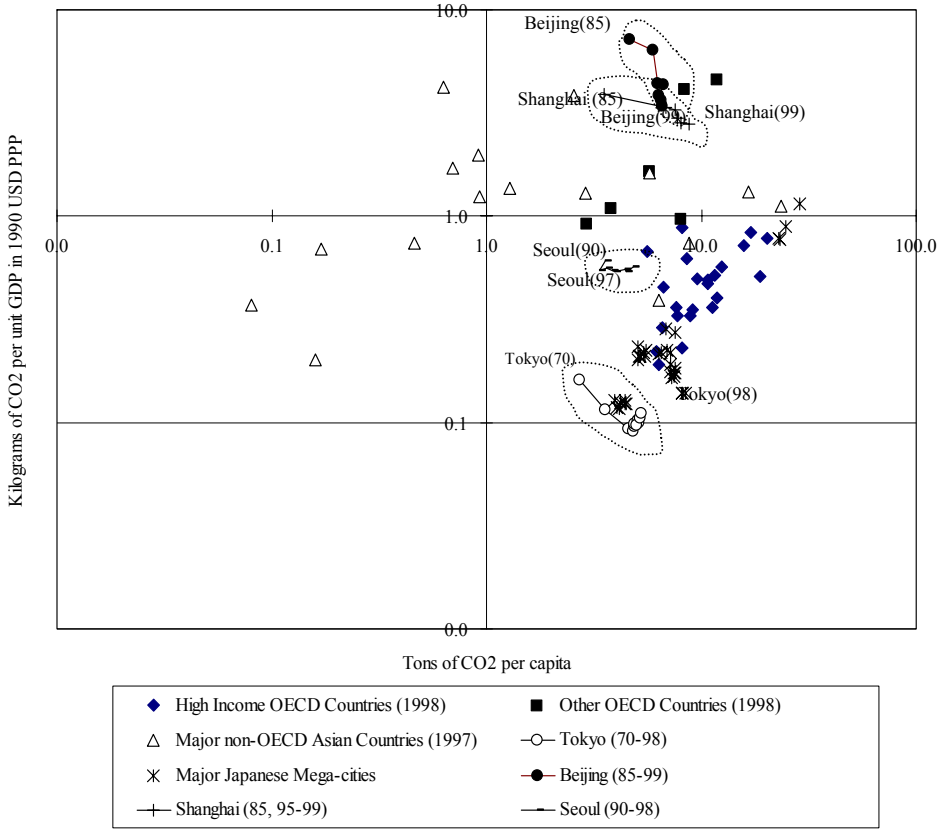

Figure 4. CO_2 emission in per capita and per unit GRP/GDP (in log-log scale)

Source: Dhakal et al. (2002)

3.4 Driving forces for CO_2 emissions

A number of factors influence energy use and resulting CO_2 emissions from cities. Among them, some major factors are compactness of urban settlements, urban spatial structure, and urban functions, nature of transportation systems, income and lifestyle, energy structure, energy efficiency of key technologies, industrial processes, building technologies, climate, and waste disposal methods. A decomposition analyses of CO_2 emissions of four factors (namely, emission per unit energy use, energy use per unit economic activity, per capita income and population) for 1970 – 1998 shows that the impact of the population on CO_2 emissions is very low in Tokyo, Seoul, Beijing and Shanghai (Dhakal et al. 2002, Dhakal et al. 2003b, IGES 2004). Income and lifestyle changes are the most influential factors in these cities in 1970-98. Improvements in

energy intensity (energy use per unit economic activity), which shows the direction of technological change and higher productivity of energy use, have played the most important role in reducing energy use and associated CO_2 emissions in general. The contributions of fuel quality improvements and fuel switching for reducing CO_2 emissions has become important in Seoul in recent years but their effect has been very low in Beijing and Shanghai over the last two decades. Most of the CO_2 related benefit has come from energy efficiency improvements in Beijing and Shanghai. In the transport sector, a rapid increase in vehicle number is the major reason for CO_2 emissions. The role of mass rail networks in Tokyo is a key factor for stabilizing emissions, but increases in the number of large cars is a primary cause of the increase in emissions (Dhakal 2003). In the household sector, household income is mostly responsible for the increase in emissions in cities. It was noted that the decreasing size of household, and consequently, the increasing number of households are primarily responsible in Seoul for increases in emissions in the household sector (Dhakal et al. 2003b).

The choice of waste treatment methods affects GHG emissions; for instance, CO_2 is emitted by incineration plants while methane is emitted by landfilling. While waste reduction at source avoids GHG emissions as shown in Table 8. Despite significant differences in income, Tokyo, Seoul, Beijing, and Shanghai have small differences in per capita waste generation (1.13, 1.06, 1.11, and 1.04 kg/person/day, respectively) (Yoon and Jo 2003a and 2003b). With prevailing open dump and landfilling and lesser efforts to reduce waste at source, GHG emissions from Beijing and Shanghai would increase dramatically.

Table 8. Net GHG emission from source reduction and MSWM options

Material	Source reduction	Recycling	Composting	Combustion	Landfilling
Newspaper	-0.91*	-0.86	NA	-0.22	-0.23
Office paper	-1.03	-0.82	NA	-0.19	0.53
Aluminium cans	-2.98	-3.88	NA	0.03	0.01
Glass	-0.14	-0.08	NA	0.02	0.01
PET	-0.98	-0.62	NA	0.24	0.01

Note: Emission counted from a waste generation reference point in MTCE/ton
Source: USEPA (1998)

Even under the most optimistic scenario, it has been found that the CO_2 emissions from these cities will not decrease (IGES 2004, He et al. 2004b, Matsumoto et al. 2003, Wei and Matsumoto 2003). The results from bottom-up models show that the vehicle population in Beijing and Shanghai is about one-tenth that of Tokyo in year 2000, but their total fuel consumption is only about one-third to one-half that of Tokyo because of lower fuel efficiency and larger vehicle mileage travel, among others (He et al. 2004b). As a result, a much smaller vehicle fleet in Beijing and Shanghai emit a larger amount of local pollutants and CO_2. In particular, light duty gasoline vehicles are expected to significantly contribute to the increase of CO_2 in the future in optimistic scenarios, and a more than twofold increase in fuel consumption from road transportation is expected in Beijing from 2000-2020. Policy measures to intervene in lifestyles and appliances will be the most important measures that would reduce the maximum volume of emissions from households and businesses in Tokyo (IGES 2004, Dhakal 2003).

The better performance of Tokyo for CO_2 emissions even at higher income level compared to other cities is attributed to a number of factors. These factors are divided into three groups. The first group of factors is geo-physical in nature, mainly location of cities and their climate in which Tokyo's location is favourable than other cities. The second group of factor is physical in nature mainly density of settlements, transportation infrastructure, industrial structure, automobile dependency, type of energy supply, technological efficiency of appliances and processes (for Shanghai see Table 9). In particular, a well-developed mass-transportation network, high commuting population and small contributions of industries in the city (city is commercial in nature) made Tokyo efficient. The third group of factors is non-physical in nature and is related to policies and institutions mainly level of awareness, institutional capacity, technology, and resources availability for interventions. Socio-cultural factors (household size, cultural preference, etc.) may have been responsible partly which could not be confirmed.

Table 9. Comparison of energy efficiency in Shanghai and in OECD countries, 1998 (Indicative)

	Unit	Shanghai	OECD countries
Coal-fired electricity production	(GJ el/GJ fuel)	0.38	0.40–0.44
Primary steel production	GJ/ton	20–25	18–20
Oil refining	GJ/GJ	0.03	0.03–0.07
Coal-fired industrial boilers 4–10t steam/ hr	(GJ steam/GJ fuel)	0.65	0.7–0.75
Passenger cars	L/100 km	10	8-14
Colour TV	Watts	100-150	70-120
Air conditioners	KW cold/KW el	3.6-4.4	3.8-5.5

Source: Gielen and Changhong (2001)

3.5 Local concerns and options for air quality and urban heat island

Apart from CO_2 emissions, several local air pollutants are already above healthy limits in some of these cities. Local experts suggest that the existing countermeasures in Beijing are not likely to meet WHO guidelines by the 2008 Olympic Games. Further increases in energy use in these cities would tremendously increase the health risks posed by local air pollutants.

The trend of air quality shows that Tokyo was successful in reducing the concentration of SO_2 drastically between the mid-1960s to the early 1970s, and Seoul after 1988 (Figure 5). Beijing and Shanghai suffer from higher concentrations of sulphur dioxide and particulate emissions compared to other cities as shown in Table 10. Rising emissions of air pollutants would further aggravate air quality. Since coal continues to dominate the energy sector in Beijing and Shanghai and the economy is growing at rapid rate, the development and implementation of serious policy efforts are necessary to bring these parameters into the acceptable limits.

Table 10. Air quality in selected cities, in micrograms per cubic meters

City	Particulates (1997), mg/m^3	Sulphur dioxide	Nitrogen dioxide
Beijing	377 (TSP)	71 (2000)	126 (NOx, 2000)
Shanghai	229 (TSP)	46 (2000)	91 (NOx, 2000)
Tokyo	45 (ward, SPM)	20 (ward 1997)	94 (city centre), 64 (ward) (NO_2 1998)
Seoul	72 (TSP), 68 (PM10)	31 (1997)	62 (NOx 2000)

TSP: Total suspended particles
Source: Compiled from statistical yearbooks of cities (cited in IGES 2004)

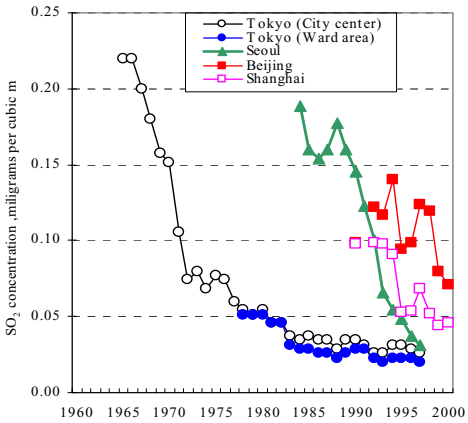

Figure 5. SO_2 concentration trends
Source: IGES (2004)

Although Tokyo has been successful in reducing concentrations of key industry-related air pollutants in the last three decades, which includes dust, carbon monoxide, and sulphur dioxide (SO_2), it has been struggling considerably to control suspended particulate matters (SPM), nitrogen oxide (NOx) and photochemical oxidants. Most are essentially emitted by businesses, households and lifestyle related activities. Therefore, a number of other problems other than GHGs are of the highest priority in Tokyo. Most Japanese cities, including Tokyo, suffer from SPM and NOx problems (Figure 6). Diesel vehicles were responsible for almost all particulate matters and about 70% of NOx emissions in Tokyo in 2003 (TMG 2003). A past estimation shows that automobiles were responsible for 67% of total NOx emissions, of which 73% was contributed by trucks and buses in 1995 (TEW 1997).

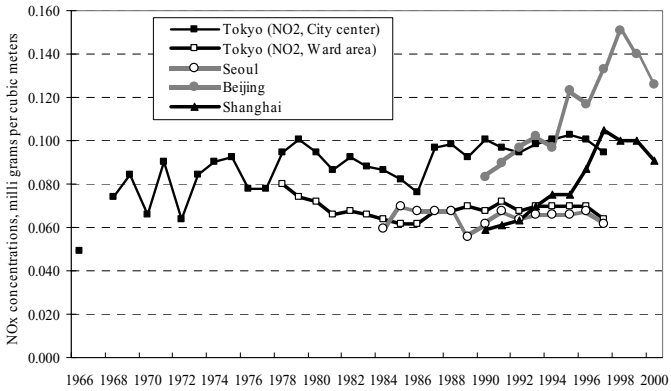

Figure 6. NOx concentration trends
Source: IGES (2004)

In Seoul, SO_2 and PM10 are not a major concern because they are within the WHO recommended guidelines, and in last two decades, their level has been decreasing with an increasing supply of clean fuel, better road pavements, and so on. However, the level of NOx (especially NO_2) and ozone are increasing, primarily due to the increase in volatile organic compounds (VOCs) and slowing road traffic flow (Jung 2004).

3.6 Policy challenges

Traditionally, energy management has not been a priority agenda for municipal policy makers. Major energy related decisions are usually made by national governments. Accordingly, no comprehensive policy framework exists for energy issues at the city level. Interventions in energy related policies at the local level emerge primarily from either energy security or environmental impacts, namely air pollution. Even for urban environmental management, a comprehensive policy framework is lacking in general and environmental policy response is often fragmented into different sectors and actors without proper coordination in developing Asian countries (IGES 2004).

Developed nations of Annex-I[9] of UNFCCC are still struggling to formulate response strategies at national levels. Such expectations from cities now are minimal. There are many challenges regarding energy and environment in cities; some of those core challenges are as following:

- lack of awareness among local policy makers on global issues;
- lack of scientific studies, inventories of energy and CO_2 emission, and related information;
- financial, human and technical resource limitations even to tackle urgent local air pollution;
- priority questions in resources allocation; and
- public awareness.

Despite such limitations, mega-cities, especially in Northeast and South-East Asia, are aware, to some extent, of the need to reduce CO_2 emissions. In a mega-city such as Tokyo, the volume of CO_2 emissions exceeds that of many nations (TMG 2002).

Less awareness and less priority of local governments to global issues impede the efforts of GHG mitigation, as resources are limited and existing challenges for local environmental management are tremendous in cities. With the exception of Tokyo, the other case study cities do not have explicit policies to reduce GHGs. Existing policy measures in Tokyo jointly tackle urban warming and GHG emission issues and intervene mostly in the building sector, voluntary information disclosure system and others, principally, in energy efficiency improvement programs (Dhakal 2003). Implicit considerations of GHG mitigation, through the implementation of local air

[9] Annex I countries agree to reduce their GHG emissions to target levels below their 1990 emissions levels. If they cannot do so, they must buy emission credits or invest in conservation.. The list includes most OECD member states and some countries from central and eastern Europe and the Commonwealth of Independent States that are undergoing the process of transition to a market economy.

pollution measures and energy sector restructuring, have been observed in other cities (IGES 2004). However, measures to improve air pollution do not necessarily contribute to the reduction of GHG emissions. Broader policy agendas, such as emissions trading and mandatory reductions in the corporate sector, do not exist in any of the cities. The market mechanisms in cities are less effectively used in the process. Consensus building is a major challenge for local policy makers to formulate plans to influence powerful stakeholders, such as the corporate sector. Institutional barriers exist in mainstreaming the concerns of GHGs in the overall policy agenda even in developed cities such as Tokyo, where mandate and role of the responsible unit is limited not only due to local priority issues but also due to institutional structure (Dhakal 2003, IGES 2004).

3.7 Towards sustainable development of Asian cities

IGES (2004) noted that a gap of about twenty years persists in major infrastructure and energy-emission related indicators amongst Tokyo, Seoul, and Beijing. This phase-gap may assist Beijing to learn from the past successes and failure of Tokyo and Seoul. Therefore, sharing of experiences amongst the cities is essential. Such sharing of experiences would be bi-directional amongst developing and developed cities. Promoting forums that can facilitate information exchange, inter-city cooperation, creation of an information base, and sharing lessons and best practices is essential. In particular, empowering the local authorities is essential; their role is limited and jurisdiction is often narrower in environmental management in general, especially in South and South-East Asia. Building their capacity is essential. As these authorities have fewer experiences, an improved local-national coordination mechanisms and concrete national support is essential.

Past experiences tells that policies and policy instruments might have been successful in intervening per unit activity such as emission efficiency of economic activities, and emission per unit vehicles travel, but they have largely failed to control the scale of activity and structural shift of environmentally adverse choices. For instance, in the transportation sector, existing standards based on emission per km alone are not sufficient; standards based on average emission of vehicles fleets for corporate sector and auto sellers is also necessary. In addition, existing policies usually intervene from sectoral viewpoints; a transition from such sectoral planning to urban level integrated planning is essential. Urban planning practices have serious challenges to deal with metropolitan growth, denser population, denser infrastructure and urban activities, and a new way of planning is essential which can accommodate energy efficiency and CO_2 concerns.

Promotion of mass transportation and energy/emission efficient transportation infrastructure is essential. This can be achieved through a number of ways depending on city situations, such as promoting bus networks, restricting private cars, providing bus lanes, developing rail-based mass transportation and others. From the investment side, it could be challenging, but new financial mechanisms such as Public-Private Partnership schemes and Foreign Direct Investment can bear such costs with the government if the government can facilitate a good working environment from a regulatory, institutional, and financial viewpoint. Asian cities, especially mega-cities, are rapidly developing and constructing massive infrastructure. Once construction is

completed, the cities will be in no position to significantly alter or change the infrastructure. Therefore, policy makers should incorporate the concept of energy efficiency and should consider of the environment during the construction of these infrastructures in order to avoid future "lock-in." It is not too late for policy makers to develop visionary policies to make energy-efficient-cities, in terms of infrastructure, although such windows are rapidly closing.

Due to priority questions, explicit GHG policies cannot be expected in the cities of developing countries at this time. Promoting integrated approaches, i.e., promoting those measures that can reduce GHGs without seriously compromising air pollution priorities is a promising strategy for addressing GHG emissions at local level. The synergy and conflicts between such measures have been poorly evaluated in the past. Even in those cases where it is evaluated, this has not been reflected in policy implementation due to the lack of serious consideration given to the issue. Such integrated approaches, to some extent, have gained interest in industries and power plants from the viewpoints of Clean Development Mechanisms and other financial/pollutant benefits. However, fewer efforts have been made in the evaluation of these benefits in the transportation sector. Therefore, finding barriers and opportunities at different scales of environmental governance is necessary and lobbying at the national and international level to extend support for integrated approaches is important, especially to bilateral and multilateral funding agencies and in their capacity building efforts.

Indirect CO_2 responsibility needs to be addressed in mega-cities, as they are focus of consumerism, income growth, and lifestyle changes. As more mega- and medium-size cities will grow in Asia, this issue will become more important in the future. At present, it may not be possible to have explicit polices however this should be addressed from other viewpoints, such as material and waste management and creation of a society with a sound material-cycle[10]. This contributes not only to emission reduction, but also reduces the consumption of precious natural resources. Drastic campaigns and awareness raising are necessary on the part of policymakers, non- governmental organizations (NGOs) and other concerned organizations, such as media.

Note: This article, written by Dr. Shobhakar Dhakal, is based on a research carried out within the Urban Environmental Project of Institute for Global Environmental Strategies under the theme "*Urban policy integration of energy related environmental issues in selected Asian cities.*" For further details, see a book recently published by the Project titled "Urban Energy Use and Greenhouse Gas Emissions in Asian Mega-cities: Policies for a Sustainable Future."[11]

[10] This concept is quite advanced in Europe and is penetrating into Japan and Korea, as discussed in Section II.

[11] The book is available for download from http://www.iges.or.jp/en/ue/report2.html

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3.9 Appendix

Table 11. Comparison of city attributes

Cities	Tokyo	Seoul	Beijing	Shanghai
Status	Matured city, well developed in terms of infrastructure and income	Thriving to catch up Tokyo	Rapidly developing	Rapidly developing
Population	Stabilized to 12 million since 1970, downtown population decreasing	Persistent population growth till 1990; decreasing population after 1990, about 10 million in 1999	About 11 million, growing rapidly, especially after 1980	Over 13 million, growth rate lower than Beijing
Passenger vehicles per 100 person	36	22	7	3
Modal split of passenger transportation volume	Majority of travel by rail and subway. Bus insignificant	Strong share of subway, bus and car. Less role of non-motorised mode.	Rapidly rising car's share since 1990. In 1990-98, 87% increase in number of buses but only 22% increase in passenger traffic	Majority of motorised transportation by bus. Highest level of non-motorized travel.
Vehicle population per road length in kilometre	200 (stagnant after 1990)	300	350 (rapidly increasing after 1990)	130
Rail network	250 km subway (Tokyo metropolitan regions are connected with 2,143 km of railway)	220 km subway	55 km subway (plans exist for over 250 km by 2008)	65 km subway
Share of tertiary sector (value added)	67% in 1980 to 78% in 1997	81% in 1997	26% in 1980 to 56% in 1997	21% in 1980 to 48% in 1997
Fuel structure	Oil, electricity and gas dominated	Oil and electricity	Heavily coal dominated	Heavily coal dominated
Share of industry sector in energy demand	10%	16%	64	85
Energy efficiency of major technologies	High	High	Low	Low

Note: Data mostly corresponds to year 1998 or 2000.

Section IV – Urban sustainability: the Japanese experience, new concepts and the shift towards information technology

This section concludes the report discussing the concept of sustainable cities and topical concepts and tools in urban environmental management, such as urban ecosystems, ecological footprints, information technology, and "digital society." These concepts are discussed presenting the example of Japanese cities, which are already moving towards incorporating these issues into the environmental policy agenda. In order to understand the Japanese experience, the section starts with a description of this transformation in Japanese cities and then follows the discussion of the concepts cited above. Finally, overall closing remarks on urban issues are made.

1. Cities in industrial transformation and the Japanese experience

Japan is the first Asian country to introduce modern Western-style industry and attain the same development status as Western developed countries. Japan's record of successes and failures relating to urban development and environmental problems is rich with implications for the future of Asian cities.

After the Industrial Revolution, many cities around the world developed as industrial towns. In Japan, Osaka, Nagoya, Kawasaki, and Kitakyushu developed with the industrialization process. The classic environmental problems of modern industry − air and water pollution − appeared first in these industrial towns. Japan's history of modern urban environmental management also started in its industrial towns[1]. Air and water pollution arose in many cities, and were often considered as small problems compared to the benefits of economic development. Serious attention was first given to the environmental problems of modern industrial societies in the 1960s.

Expansion occurred in three major fields during the technological revolution after the Second World War − energy, raw materials, and information − and these brought about major changes in the nature of environmental issues. On the energy dimension, due to abundant oil supplies from the Middle East, coal was substituted by oil in many industries, backing the development of heavy industry to support the production of basic materials such as steel, cement, and plastics. Meanwhile, industrial towns became manufacturing bases and they grew by absorbing a large number of labourers from rural communities. However, along with the growing sophistication of industry, the city's role in industrial production began to decline. In pursuit of cheap labour, the industrial production bases moved overseas mainly to developing countries. And the core industries in Japanese cities shifted from heavy and chemical to electronics and machinery industries. Many of Japan's cities today focus on service industries. There are also examples like Kitakyushu City, as described in Section III, which aims to create new environmental industries while maintaining its traditional role as an industrial town.

Along with these industrial trends, changes in urban environmental problems as well as in the way they are managed are seen throughout history. In the shift toward heavy

[1] The history of environmental management in Kitakyushu City is described in Section III.

and chemical industries after the Second World War, it was Japan's cities that faced some of the world's most serious pollution problems. In the 1960s, Tokyo, Osaka, Nagoya, Yokohama, and many other large Japanese cities were industrial towns. Smaller cities located away from the big urban centres also eagerly tried to attract factories in order to promote local economic development. The result was industrial pollution − air and water pollution. From the 1960s through the 1970s, many of Japan's cities suffered air and water pollution problems, and to overcome these problems the country put major efforts into establishing laws and institutions, and introducing technological solutions. By the end of the 1980s, Japan had largely overcome the problems of industrial pollution. What emerged next, however, was a type of environmental problem brought on by mass production and its counterpart, mass consumption. People enjoyed wealthier lifestyles, but at the same time water consumption increased, as did domestic wastewater discharge. The result was serious pollution of the cities and surrounding water bodies. In addition, urban air pollution worsened due to an increase in vehicle traffic.

During the 1990s, the disposal of the massive amount of waste that results from mass consumption became a problem, and environmental policies to promote recycling of resources and to create a recycling-oriented society[2] emerged as important issues as presented in Section II. In addition, as global warming became a key issue internationally, urban environmental policies to create cities with low energy consumption and low greenhouse gas (GHG) emissions started to take centre stage. For instance, Tokyo has plans to take into account climate change concerns in its policies. Energy profile and GHG emissions of Tokyo as well as other Asian mega-cities were discussed in a case study in Section III.

Many cities in Asia are now on a path to experience the similar development processes as that of Japan's cities, but over a shorter period. This situation presents major problems, and at the same time great opportunities, such as the creation of "sustainable cities," which is discussed below. In order to achieve urban sustainability, several new concepts are being developed such as eco-efficiency in the urban management, urban metabolism, ecological footprints, and the use of information technology towards environment. Some of these concepts are also discussed along this section.

2. Sustainable cities

The concept of "sustainable development" was proposed at the UN Conference on Environment and Development, held in Rio de Janeiro in 1992 (also known as the Earth Summit). Consequently, the idea of "sustainability" − which suggests that actions are in harmony with the global environment − started to catch attention in governmental policies and corporate management, as well as in personal lifestyle decisions. Related to this, the term "sustainable cities" began to enter the vernacular when discussing cities.

However, if one is to attempt a discussion on the concept of sustainable cities, it is impossible to avoid one basic question: Exactly what is sustainable development and

[2] Recycling oriented-society or sound material-cycle society.

sustainability? There has already been much debate about the meaning of these terms, but it is not easy to offer a simple answer. First, there is a difference of opinion between developed and developing countries in terms of priority − should the emphasis be on improving human standards of living, or on protecting the environment? People in developed countries that have already achieved a certain level of material wealth might emphasize environmental protection, but for people in developing countries now seeking to improve their own material wealth, the emphasis on environmental protection may seem self-centred. On top of this, opinions are divided about whether or not humans should actually be managing the Earth's ecosystems. In short, there is a diversity of opinion when it comes to the topic of sustainability. Some hold the extreme view that unless modern materialistic civilization based on the factory is entirely rejected and return to agricultural societies, sustainable development will be impossible. Besides the issues above, there are socio-political challenges such as eliminating urban poverty, protecting the vulnerable people in society, ensuring equity, and securing public participation in political decision-making processes. The ways chosen to address these challenges are also important topics for sustainable cities.

In this context, when environmental impacts of urban activities and the sustainability of cities are considered, came the question of balance with the "eco-space" or the "carrying capacity" of cities. It is necessary to consider both the *absolute measures* of urban activity (for example, urban population, area, or resource consumption of the city), and the *intensity* of each item per unit of area. For example, because rivers have a self-cleaning function, if the concentration of pollutants discharged from urban activities is low, the river will clean itself up on the local scale. However, if the urban area is large, even if the environmental load is small on the local scale, the total load will be large and may exceed the environmental space of the region.

In particular, the most important to control the environmental burden is "growth management," which means the exertion of controls on the expansion of urban population and economic activity. Many difficulties arise, however, when attempting to achieve economic and environmental goals at once. One approach to reduce energy consumption is to concentrate the urban population and office districts, and so on, close together, in order to reduce the travel distances of people and goods., In other words, denser cities are more energy-efficient as reported in the case study on the mega-cities (Section III). If that can be accomplished, the horizontal movement of people and goods is minimized, which means that the length of roads and sewage lines can be reduced proportionally. If buildings are built higher, however, more conduits and elevators become necessary for vertical movement. One concept that has emerged to consider these factors is the "compact city." By promoting residential living in the city centre, work and residences are closer to each other, traffic volume decreases, and congestion is less likely to occur. In addition, it becomes possible to rationalize municipal solid waste collection for greater efficiency. However, can such compact cities really ensure a comfortable life for its residents?

Problems are thus complex, but one clear method to discuss urban sustainability is to look at cities as circulation systems of resources and energy. To support the activities that go on within them, cities can be seen as ecosystems that take in massive inflows of resources and release the resulting waste back into the environment (air, water, soil). If the scale of urban activities become excessive, the circulation of materials, energy and information stops functioning normally, creating a drag on further city's

economic development and generating a variety of environmental problems. In other words, the city suffers from problems with its circulatory functions. Measures of urban activity are therefore important indicators of the environmental impacts of cities.

Newman and Kenworthy (1999) see cities as ecosystems, and define the objective of achieving urban sustainability as managing cities within the local, regional, and global environmental space, by reducing a city's use of natural resources and the generation of waste, at the same time as raising its liveability. Meanwhile, the Organization for Economic Co-operation and Development (OECD 1998) has proposed the concept of "eco-efficiency" for corporations and households, but this concept can also be useful when discussing cities, and it has many common points with the discussion by Newman and Kenworthy (1999). These models are based on seeing cities − places where humans to live, play and work − as natural ecosystems. It must be noted, however, that the object of analysis here is the metabolism consisting of material or energy budgets; actually, many elements that make up a natural ecosystem − such as flora and fauna, climate, and hydrological cycle − are not fully considered. Very little analysis has been done of urban ecosystems by comprehensively considering such elements and virtually no debate has been conducted about sustainability based on such a comprehensive approach.

3. Transportation and environment

As cities expand in area, high-speed transportation systems are needed that efficiently link parts within the cities and that link the inside with the outside. In European cities, networks of subways, trams, and buses were created for these purposes at the end of the nineteenth century. By the end of the twentieth century, however, as the automobile became the dominant mode of transportation particularly in countries like the United States and Australia, the "auto city" emerged, with a heavy dependence on private car ownership. In such cities, people live far away from the city centre in the suburbs in houses with large yards surrounded by fields. This type of urban development was praised for releasing people from the cramped living conditions in the city centres. However, such low-density, decentralized cities depend on massive levels of oil consumption for automobile use, and they are built on the assumption that energy prices will remain stable. The ascending gasoline prices during the oil crisis in 1973 alarmed cities built on transportation systems that depend so much on the automobile. During the 1990s, global warming caused by carbon dioxide from fossil fuel consumption emerged as a huge problem for humanity, forcing many people to reconsider their heavy use of the automobile.

As a result, two major trends have emerged since the 1990s. The first is the development of innovative automobile technologies aiming to improve significantly fuel consumption, and the second is a modal shift from private car ownership towards public transportation systems. In terms of automobile technologies, the development of small cars labelled as **"**eco-cars," as well as accelerated development of new technologies such as electric and hydrogen (or fuel cell) cars are observed. As for "modal shift" of transportation options, in Germany and other Western countries, cities have introduced park-and-ride systems, while trams and Light Rapid Transit (LRT) have obtained renewed popularity. While such trends have been evident in mature cities in the West, urban development based on automobile dependency has

been growing unabated in many young cities in developing countries. In other cases, cities are sprawling outward with no clear vision of urban development, and the number of automobiles on the road is expanding rapidly despite inadequate road infrastructure. Major reasons for these outcomes include a shortage of the funds needed for improving mass public transportation systems like subways, and the lack of vision in urban planning in the relevant central or local governments. Freedom of movement (in other words, mobility) is one of the basic human desires. Even in countries with relatively low incomes per capita, the number of automobiles on the road is exploding. Old cars in need of proper maintenance are also a large source of air pollution.

In Japan, it is noteworthy the large differences between large and small or medium cities in terms of their transportation systems. In large cities like Tokyo, Osaka, and Nagoya, mass rapid transit systems such as subways create a dense transportation network and the use of private automobiles for commuting is discouraged. In contrast, in regional small and medium cities it is not viable to move around without a car because public transportation systems are not well developed. Japan's history of motorization spans only about forty years, starting in the 1960s. Because of this short history, early policies emphasized improvements in road networks, and the major interests of transportation research were focused on construction of economically efficient road networks compatible with regional development and land use planning, as well as methods to relieve traffic congestion. In recent years, however, consideration of the global environment has been given greater emphasis, and research has paid more attention to the creation of transportation systems that have low energy consumption and low carbon dioxide emissions.

Low-density, decentralized cities in countries like the United States and Australia rely on massive consumption of gasoline. Newman and Kenworthy (1999) studied cities around the world to determine the relationship between population density and per capita energy consumption for personal transportation and plotted their findings. They found an inverse relationship between the two: higher the population density, lower was automobile usage and fuel consumption. Their chart shows that annual gasoline consumption was less than 100 litres per capita for residents of Hong Kong, which had the highest population density, at 30,000 people per square kilometre; in contrast, it soared to between 1,500 and 1,700 litres per capita for American cities like Los Angeles and Detroit with about 1,000 persons per square kilometre (1990).

4. Urban resources, energy metabolism and environmental impacts

Modern cities depend on the consumption of a wide variety of materials for the lifestyles of residents and the activities of businesses. They also depend on the consumption of energy such as in the form of electricity and natural gas − and they generate considerable amount of waste.

In physical aspects, a city consists of houses, offices, commercial buildings, and infrastructure, such as roads; these are brought to life by the activities done there and by the flows of people, goods, energy, and information. To support this activity, inside and outside the city, it is found a complex net weaved of roads, railway lines, water supply and sewage pipes, electrical and gas lines, and communications lines.

These networks, if compared to the human body, would be the equivalent of the blood circulation and nervous systems. The materials, energy, and information that flow through these networks would be the equivalent of the body's blood and nerve signals. The blood in arteries coming from the lungs would then take up waste material from each part of the body and become the blood in the veins. In the body, organs such as the liver and kidneys would deal with these waste materials. In the city, the equivalent would be environmental infrastructure such as sewage treatment and waste treatment facilities that handle respectively wastewater treatment and purification and municipal solid waste treatment and disposal.

A variety of resources are being consumed to support the lifestyles and activities of the average Japanese resident, including 1.4 kilograms of food per day, 320 litres of water, and the equivalent of 2.4 kilograms of crude oil (the total for the household and private car). As a result, a variety of pollutants and waste are generated, including 1.1 kilograms per day of domestic waste, 320 litres of sewage water, and the equivalent of 8.8 kilograms of carbon dioxide. These are the amounts associated with the materials and energy directly consumed by individuals; not counted here are the amounts resulting from industrial and commercial activities. The industrial and commercial portions ultimately support all economic activities, and are essential for realization of affluent lifestyles, so it can be considered that these amounts are being consumed indirectly for individuals. If these amounts were included in the calculation, the values above would be much higher. This individual-based accounting of resource and energy consumption can also be applied for cities, which are in essence gatherings of people.

To protect the environment, it is important for individuals to account for their own resource and energy consumption and the resultant environmental burdens, and by improving their lifestyles, to continue making an effort to actually reduce the parts that can be reduced. Household environmental budgets are one way to accomplish this. Besides evaluation of activities at the individual level, it is also important to evaluate and devise strategies for collective activities at the regional level. For global environmental protection, responses are also necessary at macro levels like the entire human race or country level. It is at the level of the micro-economic entity (i.e., the individual/household or corporate level), however, where concrete measures are implemented. The sum total of the behaviour of micro-level entities is reflected in macro-level effects. For micro-level entities, however, it is certainly not easy to ascertain the effect of one's own small behaviour on the macro system. It is more important to determine the effects by community unit or by region, and give this feedback to the micro-level entities. For this is necessary to quantify the environmental burden arising from resource and energy consumption, and to quantify the effects of countermeasures, at the proper level, i.e., the city or community level.

The "metabolism" of the input and transformation of resources and energy associated with urban activities closely resembles that of natural ecosystems. Nevertheless, whereas the metabolism of the natural world forms a perfect circulation system, the metabolism of modern cities has only a one-way flow, with resources and energy brought in from outside and then generating waste that is hard to dispose. In recent years, more attention has been going into efforts to reform urban circulation systems by learning from the natural world. Many of these are initiatives to promote resource recycling. As one example, as discussed in Section II, the government of Japan has enacted the Law for Establishment of a Sound Material-cycle Society (2000).

Cities are heavily dependent on outside resources to support their activities. Taking as an example the food ingested by residents, it is mainly brought in from outside the city, and to support the affluent urban food lifestyle a significant consumption occurs − of land, water, fertilizer, machinery, fuel and so on. Rees and Wackernagel (1996) defined "ecological footprint" as the total amount of land required to supply food and timber products to cities, plus the land required for forests to absorb the carbon dioxide generated from the city. As one example, Girardet (1999) calculated London's ecological footprint. London covers an area of 1,580 square kilometres, but its ecological footprint is 125 times that, equivalent to 80% of UK's entire land area.

In the case of Japan, which imports more than half of the food it consumes, the country is using a huge amount of land and water resources overseas for production of food and timber. Japan's production and consumption activities depend heavily on natural resources collected from Japan and overseas. It should be noted that the resources used here include those that are priced and transacted on the market and those that are not. The former consists of resource flows that can be counted as economic goods, and these are recorded in economic statistics such as Input-Output tables as the "material flows" associated with economic transactions. In contrast, the latter are not recorded and simply neglected in economic accounting. These are the "hidden flows," and these include, for example, the soil dug up during construction, the discarded rocks and tailings from extractive mining, the soil that is eroded from cultivated land, and the trees inadvertently cut in clear-cut logging, and so on (Environment Agency of Japan 1998). These hidden flows have also been called the "ecological rucksacks."

A calculation of Japan's overall material flows in 1996 indicated that the "surface flows" of resources that are inputs into Japan's economic activities amounted to 2.01 billion tons, but the hidden flows within Japan amounted to 1.15 billion tons, while the hidden flows overseas were 2.53 billion tons. The impacts of human activities on the environment are intimately related to the amount of resource consumption, but these cannot be fully known just by describing the surface flows. As shown above, to properly evaluate the environmental impacts of the construction and maintenance of intensive human activities in cities it is also necessary to include the hidden flows.

5. Urban environmental infrastructure

Technological systems to deal with urban sewerage and waste collection, incineration, and disposal are essential parts of the urban resource and energy metabolism. Even in a modern city like Tokyo, as recently as 1965, sewage systems serviced only about 10% of the population, and there were no modern waste incineration facilities. This urban environmental infrastructure has since then been more or less completed thanks to huge investments over the past forty years, which were covered by fiscal programmes. It can be said that because the economy was in a period of growth this achievement could be realized. Meanwhile, a huge amount of investment will be needed in the coming years in many Asian cities for sewage and waste treatment, particularly for the construction of facilities. Moreover, some countries first need to complete the necessary water supply systems as pointed out in Section II. How to address the financial burden for those items is a serious issue for cities in developing countries. The funds of national and local governments may be limited, and there are

limits to how much a country can rely on assistance from aid organizations. Thus, new approaches attracting attention include "public private partnerships" and "private financial incentives" which entrust construction, maintenance, and operations to the private sector.

6. Information-based societies and the shift toward participatory decision-making

Cities of the 21st century are being transformed into advanced information-based societies due to remarkable advances in communications and information technologies, including both hardware and software. As a sign of this, terms like "information superhighway" have also entered the language. Until now, roads railways, water supply, and sewage systems have been considered as the main urban infrastructures, but cities of the future will place greater importance on information and communications networks as well.

The construction, use, and maintenance of roads and railways require many resources and land, causing pollution and noise, particularly in the case of road transportation. In comparison, information and communications networks appear − at least initially − to be more energy efficient and better at resources conservation. If the use of information technologies can replace the movement of people, it might be possible to significantly reduce the required time and energy as well as the environmental impacts related to it. Despite the development of information technologies, the paper and energy consumption in offices have been rising. It has also been pointed out that information equipments contain hazardous substances, and that their disposal requires special management. Thus, there has been much debate about the environmental impacts of advanced information societies, but so for no clear conclusions have emerged.

The direct and indirect effects of the information age are many. In particular, the indirect impacts have been called the "rebound effect," and some argue that the time and income saved through greater efficiency from the better use of information have shifted to other economic activities, so that the overall environmental burden actually increases. "Teleworking," in which people use information technologies to work at home or commute to satellite offices, has attracted interest as it has the potential to replace the movement of people with the better use of information. A number of estimates have been made on the interesting question of how much energy consumption is reduced by requiring less movement.

The development of transportation and information/communications systems also brings about enormous changes to social networks − the inter-linkages between various entities that make up the city. When serious environmental problems emerged from Japan's rapid economic growth, the mass media were a major force in raising the public's awareness of problems and pressing corporations and governments to take countermeasures. In particular, it was news coverage by television, which was at the time spreading rapidly through households that played an important role in national and local environmental policy-making. Today, the Internet is playing a similar role. The Internet is making it increasingly easier to obtain

information on a wide range of environmental problems. Meanwhile, another major trend is increased information disclosure by central and local governments.

Through advances in "physical networks," the structure and functions of "social networks" have changed significantly and as a result the individual roles and interactions of each entity in measures to tackle environmental problems are also in the process of changing. For example, even a small residents' group in a local city is now able to spread information worldwide through the Internet and attract the world's attention to a local issue. Similarly, any person can participate in Internet discussions about environmental issues in their free time independent of the type of job they have. In addition, one can also find many websites carrying success stories of environmental measures around the world. Information systems are expected to facilitate participatory decision-making at various levels including international, national, and local levels. Moreover, information systems are changing market systems and this will affect the environment through changes in people's purchase behaviour.

7. Concluding remarks

Cities in Asia are diverse in terms of size, economic development, industrial activity, cultural background, and so on. There are "expanding" and "mature," poor and rich, industrial and service-oriented, small and large, compact and sprawled cities. These different cities face different challenges and are at different stages of development; therefore the responses for these challenges must be oriented to their unique conditions. Moreover, Asian cities are facing rapid transformation. All this make urban environmental management a challenging task, one which requires attention from both local and national policy makers.

Less developed cities are in need of strengthening their institutions and legislations, creating monitoring schemes and financing urban infrastructure. Mature cities face problems due to mass consumption and must address these problems, moving towards resource conservation and eco-efficiency. In Japan, policies for these issues are under the umbrella of promoting of sound material-cycle societies. This concept is spreading to other Asian countries like South Korea and China. In addition, information and communication technologies are expected to decrease the burden on urban infrastructure, especially transport, thus decreasing environmental impacts, as well as increasing public awareness and participation.

The Japanese experience of overcoming pollution can be valuable for other Asian cities. Therefore, international cooperation between Japanese cities and other Asian cities has been encouraged in order to transfer the experiences in managing the urban environment.

Note: Text written by Prof. Hidefumi Imura, affiliated to the Department of Urban Environmental Studies of Nagoya University, and Director of the Kitakyushu Office of IGES.

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